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International Principles for the Prioritisation of Grid Connections

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Brief summary

The Swedish Government has tasked Energimarknadsinspektionen's with analysing possible solutions to resolve the excess demand for network connection in several urban areas within Sweden relative to the existing network infrastructure's ability to serve these new connections. This study aims to support Energimarknadsinspektionen's work by looking at connection processes in Denmark, Finland, Germany, Great Britain, Italy and Norway. We find that all of these countries effectively use first-come-first-serve prioritisation for connections, occasionally with special priority given to renewable generators. The only alternatives to have received consideration are the use of open seasons, with applications within an application window processed collectively, and the use of auctions. However, only one such open season was ever held and thinking about auctions has never progressed beyond the initial concept stage. More thinking is instead being done about the use of conditional connections and reforms to network access rights. However, only conditional connections are actually in regular use, primarily in Great Britain.

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1 INTRODUCTION

Network capacity is limited and connection processes typically do not incorporate market mechanisms to ration scarce capacity. As a result, large connection waiting lists can form. There are a range of potential regulatory reforms that might be considered to reduce waiting lists and encourage more efficient waiting list management. In this report, we consider how connection processes work in Denmark, Finland, Germany, Great Britain, Italy and Norway with a view to identifying potentially relevant approaches for consideration in Sweden.

1.1 The fundamental challenge

The electricity network's capacity to transmit power is limited and therefore potentially scarce. Growth in electricity demand and in applications to connect to the network mean that the network requirements needed to serve would-be connecting parties now significantly exceed available network capacity in several areas within Sweden (e.g. Stockholm, Uppsala, Västerås and Malmö). In response, the Swedish Government has tasked Energimarknadsinspektionen's with analysing possible solutions.

Connections are not governed by a market clearing process that would restrict effective demand through a higher connection cost. Instead, connections are handled through an administrative procedure in which connecting parties face a cost that both excludes any scarcity premium and often fails to reflect the full costs of implied works (due to the challenges of sensibly allocating wider network reinforcement costs). Given this, it is possible for connection requests to significantly outstrip the ability of the network to serve these customers and for long waiting lists to form.

This study considers international practice regarding connection processes, the management of such waiting lists and efforts to prevent such waiting lists from forming or growing longer.

1.2 Connection versus access

It is worth distinguishing between connection and access. Connection refers to putting in place the physical infrastructure necessary to connect the connecting party's building or asset to the wider power network. Network access refers to the rights that a connected party has to inject or withdraw power to or from the network. These concepts are distinct, and often governed by separate processes, but are also closely interlinked. There is obviously no point establishing a connection to the network if you cannot access it or in establishing access rights that you cannot use due to physical limitations associated with the connection. As such, connection processes are often explicitly or implicitly linked to the ability to provide network access to the connecting party. In many systems, especially at lower voltage levels, parties with a connection are assumed to have access rights up to the physical limits implied by their connection and, in such systems, connection and network access are effectively bundled into a common product.

1.3 Alternative regulatory responses

There are broadly four sets of regulatory responses that we can see as theoretically relevant, although, to our knowledge, some of them have never been applied in the specific context of electricity network connections.[1] These are:

- Market-based allocation;
- The prioritisation of connections (waiting list management);

[1] There is arguably another approach, which is to simply require that connections are made ahead of the completion of the associated reinforcement work. This obviously creates its own problems, as the networks must then find ways to manage the resultant congestion. However, this is effectively the approach taken under Great Britain's Connect and Manage regime, as described in section 5.1.

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- Conditional connections (flexible/interruptible contracts); and,
- Reforming access rights.

Market-based allocation

Market-based allocation involves using a connection price to ration capacity and determine those who will be allowed to connect first. In practice, it would likely involve auctioning available capacity among those connecting parties placed in a waiting list. Those parties willing to pay more will receive priority access. Those unwilling to pay will have their connections delayed. Such an approach is theoretically attractive, in that it should prioritise the projects that will get the greatest private value from an earlier connection, as reflected in their willingness to pay. However, it may be challenging to design a market framework that suitably accounts for the specific circumstances of multiple different potential connecting parties or that accounts for any social benefits distinct from the connecting parties' private gains.

Prioritisation of connections

An alternative approach would be to have a rule-based prioritisation process that favours certain types of would-be connecting parties. An obvious example of this is the prioritisation of renewable generators to help meet national renewables targets. Although we did not observe practical examples of prioritisation criteria other the prioritisation of renewables, one can imagine that prioritisation could be based on an assessment of the relative social welfare impacts of providing different parties access, or be designed to prioritise certain classes of grid user, e.g. hospitals or citizen energy communities. In theory, such rules could make sure that the social costs of the waiting list are minimised.

Conditional connections

Conditional connections involve offering a connection contract that is bundled with limited or conditional network access rights. The network access can be provided without lengthy reinforcements but falls short of a standard connection offer, which would typically provide firm network access. In general, such connection offers allow the network to constrain the connecting party's access down, or off, as necessary to secure the network's operation.

The use of conditional connections helps to ensure that where some residual network capacity is available, there is a way for the connecting party to access this capacity without excessive delay. In doing so, such contracts support the efficient utilisation of existing network capacity.

Reforming access rights

The final set of responses that are potentially relevant include efforts to reform the system's network access right regime more broadly. Where connection is effectively bundled with an implicit or explicit right to use the connection up to the technical limits of the connection infrastructure, network planners face the risk that connected parties exercise their rights to use this capacity. This can result in genuinely available network capacity being 'sterilised', i.e. denied to connecting parties because it is required to serve this potential demand from parties with existing connections.

Access right reform involves establishing a system of explicit network access rights for connected parties that, critically, allows these access rights to be better tailored to connected parties' actual needs (and to differ from the technical capabilities of their physical connections). This supports efficient network use in several ways. First, the reformed access right system will generally accommodate a mechanism to encourage or ensure that users respect the limitations of the access rights they have, either by technically limiting their injections and withdrawals or else penalising them financially for excessive use. This forces or encourages users to manage their network demand themselves, for example by retiming demand. Second, the reformed access right arrangements should allow network planners to predict what capacity can be made available to connecting parties with greater certainty, thereby reducing the need for safety margins. And finally, the ability to make more tailored access right offers means that, where network companies have some residual

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capacity, but this capacity could not be used to provide a traditional firm access right, it might at least be possible to offer the capacity as part of a tailored access right, reflecting the nature of the residual capacity.

1.4 Structure of the report

In the remainder of the report, we look at the connection processes used in Denmark, Finland, Germany, Great Britain, Italy and Norway. We also look at the sorts of measures that are being used, or have been considered, to help resolve issues of insufficient network capacity in these countries. Chapter 8 then concludes with some summary observations and a list of learning points relevant to Energimarknadsinspektionen's work to identify possible solutions.

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2 DENMARK

Connections in Denmark generally occur on a first-come-first-served basis. Work is underway to develop conditional connection offers on the mid-voltage and transmission network level that would likely be compensated through reduced tariffs.

2.1 Transmission network connection process

The connection process is governed by the Electricity Act (Lov om elforsyning). This law imposes a general duty on the networks to connect new customers according to standard conditions. There are no notable exceptions to this duty. The standard conditions imply that the connecting customers must pay the direct cost of connection (shallow connection charges).

Energinet has proposed an alternative method and tariff structure that could be used for the conditional connection of customers, described further below.

New connections

The connections process involves the steps below. There is no distinction between generation and load in the general process. RES generation (solar and wind) does, however, have some special rights under the RES regulation. Connection basically follows the first-come, first-serve principle.

- The customer (owner of the new facility) contacts the relevant grid company to clarify the intended connection point.
- The local DNO and Energinet carry out a screening exercise to determine whether the facility should be connected to the transmission or to the distribution grid.
- The DNO and Energinet collectively determine the appropriate point at which to connect to the existing network.
- The relevant network notifies the customer of the decision.

When a connection to a new generation facility is ready, the facility will be issued a time-limited connection permit with a duration not exceeding 24 months. This permit allows the plant to apply voltage to the grid and draw power but is only intended to enable testing to ensure that the facility meets the required technical standards. This is not a conditional connection contract, which are instead discussed further below. Subject to the approval of the test results, the facility is granted a permanent permit to operate via the connection point.

A general condition for the connection of new customers is that the security of supply of existing customers should not be weakened by the connection of a new customer. Thus, if the transmission grid capacity is not sufficient and Energinet has to invest in order to sustain the reliability of the grid, the customer cannot be connected until network capacity is expanded. As Energinet has to get investments approved by the Ministry, they cannot issue a definite date of connection for new customers in cases where general grid reinforcements are required.

2.2 Distribution network connection process

The only difference in the network connection process relative to transmission-level connections is that the distribution network cannot offer temporary testing permits as described above.

For connection to the distribution grid, a system connection charge that is fixed per kW applies in addition to the direct costs of connection.

2.3 Measures to deal with scarce network capacity

The measures under consideration to deal with scarce network capacity in Denmark are conditional contracts. As of April, DNOs can now offer conditional contracts according to an industry guideline developed by Dansk Energi. The Danish TSO, Energinet, is also currently preparing a proposal for

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conditional contracts that it plans to submit to the regulatory authority (Forsyningstilsynet). As a result, experience with conditional contracts in Denmark is still very limited.

2.3.1 Conditional connections

New offers to be made available for connections to the mid-voltage network

Last year, an industry guideline developed by the industry association, Dansk Energi, set out a proposal for a new interruptible product that the grid companies could offer to new grid customers.[2] Forsyningstilsynet officially took note of the proposed method for conditional grid connection on March 20, 2020. On April 23, 2020 Forsyningstilsynet approved the first application from a Danish grid company to start offering such contracts.

The conditional contract developed by Dansk Energi and described in the guideline implies that new distribution network customers can ask for a limited network access contract. Customers connecting to the network on the basis of limited access contracts would pay a rebated connection charge. The contract would only be offered to new customers or existing customers who apply for increased capacity and, in the latter case, any benefits would only apply to the increase in the subscription. This means that the conditional contract is only attractive for new customers, as existing customers on standard contracts have already paid the full connection charge. Conditional contracts can only be awarded to customers connected to the mid-voltage grid level (10–60 kV) and to customers whose consumption is interruptible in practice. The grid company is obliged to inform prospective customers about the expected number of hours of interruption. If supply is interrupted, all customers with interruptible contracts will be constrained pro rata.

The customer can, at any time, ask to be transferred to a standard contract on standard terms, in which case the grid company would be obliged to deliver the same quality of supply as for other grid customers and the customer will be subject to standard connection charges.

Proposed method and tariff for conditional connections to the transmission grid

Energinet has had two public consultations on conditional connections. The most recent public consultation was concluded in February 2020. Based on the responses, Energinet is now preparing a proposal to be submitted to Forsyningstilsynet later this year.

According to the first consultation document,[3] released early 2019, facilities with up to 500 full load hours could be offered conditional grid connections. Energinet would assess the appropriateness of a conditional connection on a case-by-case basis and notify the prospective customer of its assessment. The public consultation responses (4 in total) raised a number of issues that require further consideration and, in May 2019, Energinet adjourned the process.

In December 2019, Energinet published a new public consultation on a proposal for grid tariffs for permanent interruptible load contracts and temporary interruptible load contracts.[4] The explicit purpose of the permanent contracts is to reduce the need for investments in the grid and to cater for better capacity utilisation in the grid. The permanent interruptible load contracts (Begrænset netadgang) would be voluntary and the interruptability would be compensated through a grid tariff rebate. Temporary interruptible load contracts (Midlertidigt begrænset netadgang) could be offered to customers who wish to connect to the grid before Energinet is able to reinforce the transmission grid sufficiently to offer the customer firm grid access. Such customers would pay a rebated grid tariff, corresponding to the rebate for the permanent interruptible contracts, as long as their grid

[2] https://www.danskenergi.dk/sites/danskenergi.dk/files/media/dokumenter/2020-03/Vilkaar_og_betingelser_for_tilslutning_med_begraenset_netadgang.pdf
[3] Link to the consultation document is found here: https://energinet.dk/El/Horinger/Afsluttede-horinger/Metode-for-begraenset-netadgang-for-forbrugsanlaeg
[4] Link to the consultation document is found here: https://energinet.dk/El/Horinger/Afsluttede-horinger/2019-12-Begraenset-og-midlertidigt-begraenset-netadgang-dec-2019

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access is limited. According to the new proposal, the right to ask for an interruptible load contract in the transmission grid would apply in general to all transmission grid customers.

The rebate for the conditional contract would apply to the Danish transmission grid tariff, which is levied on a unit energy basis. The customer would still need to cover the direct connection costs (shallow connection charge). The total transmission grid tariff consists of a system element (systemtarif), which covers common or fixed grid costs, and a network use element (nettariff) that covers interest, depreciation, reinvestments, operation, maintenance and grid losses. Both elements are charged according to the customer's energy consumption, i.e. per kWh. Energinet has proposed two overarching principles for the charging level for such contracts:

1. that charges should be higher than the marginal costs imposed by the customer though their use of the grid to make sure that the cost for customers on regular contracts does not increase, and
2. that the overall level of charges be well below that of customers with regular contracts.

Based on these principles, they propose a rebate that corresponds to the interest and depreciation costs elements of the energy tariff. These cost elements are estimated to account for approximately 25 percent of the total grid tariff in 2019.

For customers with permanent interruptible load contracts, Energinet would not strengthen the grid to the level required to offer firm grid access. Instead, conditional grid access would imply that Energinet could, at any time and without warning, request that the customer cuts or reduces its load within 15 minutes where doing so is necessary to maintain the safe operation of the grid. Such curtailment would not be directly compensated. Customers on interruptible contracts would also not be eligible to be compensated for up-regulation to handle local grid congestion but could provide other system services.

Customers on permanent interruptible load contracts can at any time apply for a regular grid contract, in which case the same provisions apply as for new customers, i.e. the transition is subject to available grid capacity. Energinet does, however, propose that customers cannot revert to an interruptible contract for a period of 5 years, counted from the date at which the capacity is made available to the customer. This provision is intended to prevent a situation in which Energinet incurs investment costs to secure firm access for the connecting party, and the party then avoids network charges by switching to an interruptible contract (which does not need to be interrupted). For changes in the contractual arrangements, a 1-year notification period applies.

2.3.2 Ongoing considerations

There are emerging discussions about capacity-based tariffs and the introduction of flexibility markets in Denmark, but no concrete proposals have been presented yet.

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3 FINLAND

Network capacity in Finland is, in practice, allocated on a first-come-first-served basis. There are no special arrangements in the regulation for managing connections when network capacity is limited or rules regarding special tariffs.

3.1 Transmission network connection process

The legal framework for network connection is set out in the Electricity Market Act (386/2013 with later amendments) and the Electricity Market Decree (65/2009). The regulatory authority Energiavirasto is responsible for approving the rules for connection in the network companies and the conditions for access, including the tariff principles, and can also intervene in the connection process within the limits set by the Electricity Market Act if network companies fail to meet their obligations under the Act.

There is a general obligation to connect new customers to the grid, provided the customers meet the technical requirements for connection (§20 of the Electricity Market Act). The conditions and technical requirements for connection shall be transparent, fair and non-discriminatory, and shall take into account the reliability and efficiency of the electricity system. Hence, connection may require investment in the grid and a connection charge may be applicable if this is the case. For transmission lines at voltages of 110 kV or higher, a separate licence from Energiavirasto is necessary. Only if the customer refuses to pay the connection charge is there an exemption from the obligation to connect. However, for transmission grid connections, a customer may be obliged to build its own connecting line to the transmission grid.

Upon receipt of a connection request, the network operator must provide the customer with a comprehensive and sufficiently detailed estimate of the connection costs and an estimate of the time required to finalise the connection. The customer must be connected to the electricity network within 24 months of signing the connection agreement, provided that it is possible to carry out any network investments required within that timeframe. Importantly, in Finland, it is often the customer that undertakes the construction of the sole use transmission assets.

The process for connecting to Fingrid's transmission grid has the following steps:[5]

1. The customer provides information to Fingrid on required capacity, type of consumption or generation and location.
2. Fingrid determines possible connection solutions, which may involve more detailed analysis and possible measures to strengthen the grid.
3. Fingrid specifies the preliminary connection solution and informs the customer. This solution is not binding.
4. The customer draws up detailed connection plans and submits them to Fingrid for review.
5. A binding connection agreement is entered into and the connection charge paid.
6. The connection is put into operation within 24 months of signing the agreement, otherwise Fingrid has the right to terminate the agreement.

3.2 Distribution network connection process

The distribution network connection process follows the same main principles as the transmission grid, with the main difference being that there is no individual asset licence obligation in the distribution grid below 110 kV. For assets in the local or regional high-voltage distribution grids at the 110 kV level, an individual licence is still required.

[5] https://www.fingrid.fi/globalassets/dokumentit/en/customers/grid-connection/kantaverkkoon-liittyjan-opas_en.pdf

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The connection process follows the same principles as for transmission, and with the same deadlines for finalising a connection.

The main principle for connection is that distribution network companies will supply electricity with the same quality (e.g. outage risk) to all customers in all geographical areas. Amendments to the Electricity Market Act in 2013 introduced an obligation on distribution network companies on the maximum duration of outages:

- 6 hours in cities and urban areas
- 36 hours in other areas

According to the Electricity Market Act (§119), these targets must be met within the following timeframes (excluding holiday homes):

- 50 per cent of the distribution grid customers by the end of 2019
- 75 per cent by the end of 2023
- 100 per cent by the end of 2028

3.3 Measures to deal with scarce network capacity

There are no obligations or restrictions for DNOs to offer special tariffs for interruptible loads. The Finnish Electricity Act states that the network company must not hinder demand flexibility in any way unless there are special reasons to do so. The same paragraph (24 b) states that both the costs and benefits of demand response may be reflected in the grid tariffs.

3.3.1 Prioritisation of connections

Connection in Finland is generally done on a first-come-first-served basis. There is no priority access for specific customers, including renewable energy generation.

3.3.2 Conditional connections

There are no rules on conditional connections in the Finnish legislation. In general, connection and system use contracts are permanent (but the customer may always choose to terminate the connection). However, there are some instances of temporary connections. These temporary connections are used for customers with a need for capacity that is time-limited (e.g. building projects) and are not used for managing scarce network capacity or avoiding investments.

3.3.3 Alternative access rights

We have not found any information on discussions regarding alternative access rights in the Finnish regulation.

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4 GERMANY

There is currently no differentiation in network connection and access for consumers in Germany. Renewables enjoy priority connection to the grid. However, some flexibility options, as well as legislation that will be put forward in June will foster differentiation of connections to incentivise consumers to use electricity in a more grid-friendly manner.

Under the German Energy Act (EnWG – Energiewirtschaftsgesetz), network operators are required to connect, i.e. physically link, end customers, lower voltage supply networks, and generation and storage facilities on reasonable, non-discriminatory and transparent terms (§17 para. 1, EnWG). §20 stipulates the same for access to the network.

This provision excludes any unequal treatment in terms of network access conditions. However, operators of electricity networks can refuse access to their networks if they can prove that it is not possible or unreasonable for them to grant network access for operational, economic or technical reasons with regard to the objectives of §1 EnWG, i.e. the need to guarantee a secure, affordable, user-friendly, efficient and eco-friendly supply of electricity. Technical reasons can include, for example, physical or contractual lack of capacity where access to the network would endanger the secure provision of grid services to other consumers. The rejection must be justified in text form and the Federal Network Agency (BNetzA) must be informed immediately when such a decision is taken.

Grid expansion happens according to a grid development plan that foresees increased network use on the distribution and transmission levels and currently focuses especially on accommodating decentralised generation. All consumers and generators have the right to connection and to use the grid according to their needs. According to BNetzA, the grid must be expanded to handle capacity constraints and until expansion has been completed, other measures must be used to deal with constraints in the interim. A closer description on what these measures entail is not outlined in the regulation but in practice handled on an individual basis at the discretion of the grid company. Due to the need to carry out the grid adaptation in response to increased loads stemming from e.g. heat pumps or EV uptake, minor connection delays can occur.

Network users are entitled to enter into a network use contract. This contract regulates, among other things, the provision of transmission and distribution capacity as well as system services by the network operator. A contract contains e.g. details on the requirements for network use, balancing group assignment and billing. Grid operators are required to transparently publish their general terms and conditions for network connection and use of connection points for end customers in low-voltage networks and must connect customers requesting access to their networks under these provisions. The contracts must follow the legal requirements closely and are usually almost identical to the contract template published by the regulator.[6] Grid companies are entitled to charge customers appropriate connection costs and contributions towards installations costs.

The Ordinance on Electricity Grid Tariffs (StromNEV – Stromnetzentgeltverordnung) regulates that consumers have to bear the costs of the grid. According to §16 para. 1, the principle of causation requires those who are responsible for grid costs to pay them. For example, grid participants with atypical usage that help limit grid costs should benefit from individual contracts that account for their grid-friendly consumption patterns. §19 requires grid operators to offer an individual grid tariff to consumers that can either shift their load away from times of peak load defined by the grid operator, have a very high and steady demand profile for at least 7000 hours per year, only consume power intensively for a limited time or storage devices that store power from the grid and feed that electricity in at a later point in time.

A number of studies have been carried out in recent years on the flexibility of the power grid, which commonly identify the need to revise the current legal framework. In particular, they conclude that the use of flexibility should be incentivised more, both on the part of consumers and by network operators. §14a EnWG is often highlighted as a suitable solution for enabling flexibility on the low-

[6] The standard contract (in German) can be found here.

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voltage grid. The paragraph states that grid operators have to reduce a supplier's or end-user's grid tariff if they are provided with the ability to steer loads in a grid-friendly manner. The article also explicitly includes EVs and states that the government has the right to specify how exactly such measures can be contractually set up. Conversely, market-based approaches at this level are perceived as difficult to implement due to limited liquidity and greater uncertainty regarding delivery and the resultant efficiency of network use. In general, the importance of expanding smart grid infrastructure as an enabler of the necessary visibility and steering capabilities is also emphasised.

4.1 Transmission network connection process

Germany does not prioritise the connection of any generation or load other than renewable power plants. It handles connection requests on a first-come-first-served basis and ranks renewable generation automatically prior to conventional power sources. In contrast to the UK or the Netherlands, there are no "connect and manage" regimes in place and the connection order is not specified in further detail.

The network connection process on the transmission level in Germany is mostly relevant for generation and industrial loads connected at high voltage levels. On the generation side, the request for network connection has to be submitted in written form and fulfil the criteria laid out in the Energy Act.

§3 of the Electricity Grid Access Ordinance (StromNZV – Stromnetzzugangsverordnung) stresses that the right to use the grid is limited by the respective capacities of the electricity network. §15 states that constraint management with aid of grid- and market-based measures is allowed to manage capacity constraints and that the income grid operators generate when managing grid constraints should be used to alleviate such constraints. Accordingly, the provision suggests that measures such as demand response used to alleviate constraints should be compensated with lower grid tariffs or direct payments.

Renewable energy generation generally benefits from priority connection under the German regulation as stipulated in §8 para. 1 of the Renewable Energy Act (EEG – Erneuerbare Energien Gesetz). This is obligatory even when the new generation can be accommodated only through grid expansion (§8 para. 4 EEG). The law states that such priority connections are subject to the requirement that the connection is "economically reasonable", with the interests of the grid operator and the renewable power plant operator weighed against each other.

One major case where the grid operator's interest outweighs the power plant operator's interest and thus allows the denial or restriction of network connection is a lack of grid capacity, potentially due to increased feed-in from renewable energy generation. The burden of proof for denying a connection under these exceptions is imposed on the owner of the grid and has to be handled with regard to the non-discrimination rule. The network operator has three instruments available to manage the occurrence of such a capacity constraint: prevention e.g. through denying grid connection requests in case of a lack in wheeling capacities, congestion management and network expansion.

In the absence of a compelling reason to refuse a grid connection, grid operators are obliged to accept and transmit the generated electricity of all forms of renewable power (§11 para. 1 EEG) even in the absence of the existence of a delivery contract. Even when grid capacity cannot handle the entire generation of a plant that is to be connected, the grid operator has to connect it as soon as possible without having to take care of potentially necessary grid expansion prior to that. The grid thus "follows the needs of generators" (and consumers). Curtailment costs (lost revenue) are almost fully borne by the grid operators since an absolute priority of German power system planning lies in the expansion of the RES feed-in.

The process of connecting a plant at the transmission level is described in the Ordinance for Regulating Grid Connection of Electricity Generating Assets (KraftNAV – Kraftwerks-Netzanschlussverordnung). When a power plant operator applies for connection, the grid operator can ask for specifications regarding the connection in the first week and then needs to inform the

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connecting party of the required processes and costs within two weeks from the connection request. As soon as an advance payment of 25% of the grid auditing costs is made, a feasibility study needs to be performed by the grid operator. Within three months of the payment date, the results have to be published and the connection established if there are no further clarifications needed by the applicant or reasons to deny the application. Following the payment of a reservation fee of 1000 €/MW and the remainder of the pending costs, both parties enter into a cooperation agreement that results in an implementation roadmap and contracts between the parties covering both grid connection and network access rights. If the grid connection requires grid reinforcement up to the next network node, this is also specified at this stage. Eventually, the fulfilment of the requirements in this contract results in an obligation to establish the connection within 12 months.

For renewable energy generation, the grid connection process is set out in the EEG but is similar to that for a conventional plant. Slight differences do however exist. An application for connection is sent to the grid operator and the operator then provides, without further delay, a timetable listing the steps to fulfil the connection request (§ 8 para. 5 EEG). In contrast to conventional connections, the grid operators are given 8 weeks after they receive the necessary information from the plant owners to provide a precise cost estimate, the grid system data required to test grid compatibility and the necessary information on the technical requirements which the plant has to fulfil (§ 8 para. 6 EEG). This technical audit is divided into two phases: a technical coordination that must be concluded in less than four weeks, followed by the grid connection feasibility study that has to be conducted in the same timeframe. As soon as a location for the connection has been agreed upon, the grid operator assigns a connection point, makes a connection offer and the contract between renewable energy generator and grid company can be signed. The grid owner then receives a maximum of 20 months in case of an already existing grid connection point and 26 months in the absence of one before the renewable energy power plant has the right to be commissioned.

In contrast to the partly more detailed regulations for power generation, the connection of loads on the transmission as well as the distribution grid level are regulated more loosely. The claim of the connection applicant is limited to the establishment of a sufficiently dimensioned network connection under non-discriminatory conditions (connection costs, construction cost grants) according to §§ 17-19 EnWG. § 6 of the Low-voltage Connection Ordinance (NAV – Niederspannungsanschluss-verordnung) requires the grid operator to inform the consumer of the expected time required to establish the network connection. There is no obligation to connect at any point on the network chosen by the end-user, regardless of the current and expected future network utilization. The grid operator is obliged to determine the cheapest connection point in the interest of the entirety of grid users, taking into account the expected network load.

4.2 Distribution network connection process

The connection process for generation at the distribution level is very similar to the transmission network and rather loosely regulated. In Germany, each grid operator is free to determine an individual connection process. Without exception, all distribution network connections are physically firm.

For connecting loads, the NAV and the Basic Electricity Supply Ordinance (StromGVV – Stromgrundversorgungsverordnung) regulate the grid connection process at the distribution level. When applying for a network connection, the consumer must request a connection in writing using a form provided by the network operator. The network operator must then immediately inform the connecting party of the expected time required to establish the network connection. The StromGVV regulates the basic supply obligation between grid operators and households. The exceptions to the obligation to connect on the distribution level are akin to the provisions on the transmission level.

The construction cost charge for low-voltage power connections may only be charged for that part of the power requirement that exceeds 30 kW and can be calculated based on a lump sum estimate. Thus, when connecting a typical house, the owner is not typically obliged to pay construction charges to the grid operator. The threshold is intended to encourage users to stay below this capacity when setting up a connection. Where applied, connection charges encourage end-users to base the

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amount of the connection capacity on their actual needs and avoid higher fuse sizes that might impose unnecessarily high capacity requirements on the distribution grid. If the existing network connection changes, e.g. in the event of an increase in performance or a change in the connection network level requested by the customer, then these construction grants can be demanded again.

§16 of the NAV states that if a contract for network access ("Anschlussnutzungsverhältnis") exists, the network operator is obliged to enable the consumer to use his network connection at any time to the extent provided for in the agreement. According to §17 and §24, access can however be interrupted to prevent an impending network outage or to avoid disruptions to other grid users or the grid operator's facilities.

4.3 Measures to deal with scarce network capacity

The most interesting measures being considered in Germany consist of proposals to redefine the network access regime to directly recognise, and therefore support, loads that are controlled directly by the network operator.

4.3.1 Access right reform

Germany has been moving towards a model in which users are encouraged to give networks direct control of flexible loads in exchange for lower tariffs, and these changes will be underpinned by planned reforms to the wider access right regime. With the ordinance on grid charges (StromNEV), the legislator has allowed grid companies to reduce network tariffs if consumers support the network through their consumption patterns or acts "to relieve the grid". §14a of the EnWG, which was reformed in 2016, defines the possibility of grid-friendly load steering more clearly. Interruptible consumption devices with a separate metering point can be switched off or regulated down by the network operator during peak load periods subject to the signing of an agreement. In return, network use tariffs can be reduced by up to 80 percent. Currently this is mainly used for night storage heating on low-voltage levels, but could be extended to cover EVs, storage and other household appliances. However, further regulatory details to ensure the sensible and transparent application of this option by the network operator is still missing.

In 2018, the Federal Ministry for Economic Affairs and Energy (BMWi) published a study on how to make loads more flexible in response to the challenge of meeting higher demand due to electrification of different end uses. Based on the results, Germany will, in June 2020, put forward a legislative proposal to more narrowly define and reform §14a EnWG to prevent congestion at low-voltage levels. It will allow grid companies to directly access flexible loads, e.g. heat pumps, night storage heaters and EV charging processes. The preferred approach involves the separation of connections into two categories:

- **Unconditional capacity**: This service is always available to the grid connection user. The network operator has no right to intervene. Due to its inflexibility, it constitutes the main cost driver for the power grid. Higher tariffs, as well as a higher cost compensation for the establishment of a connection should accompany this type of capacity.
- **Conditional capacity**: Conditional capacity is available to the network user for a large part of the time. The grid operator can reduce the amount of capacity and the time it is available. The grid-friendly connection should be significantly cheaper than unconditional capacity to incentivise consumers to provide more flexible load.

Under the proposal, called "Spitzenglättungsmodell" ("peak shaving model"), different types of customers can be incentivised to adapt their consumption according to how much flexibility they can provide through differentiated network tariffs. The amount of the unconditionally or conditionally available power will be determined by the user.

The current proposal foresees that additional capacity can be ordered by the consumer if the need arises and that consumers can procure as much unconditional capacity as they wish, provided they pay the associated costs. As unconditional capacity cannot be used to manage congestion, subscribing for unconditional capacity in excess of the level of an average household will result in

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cost penalties. If grid restrictions can be easily predicted, the expectation is that flexible loads can generally be handled without loss of comfort for the customer.

A standard grid customer who does not add new sources of load would not see any changes to his grid tariffs under the proposal. This reflects the principle of causation as set out in the relevant legislation - these customers will not add further to peak demand and therefore only insignificantly affect the need for grid expansion.

The “Task Force Load Management” will allocate the available capacity. Under the proposals accompanying the research commissioned by BMWi, household connections would be generally limited to 5 kW. Higher capacity would be provided free of charge but only if the grid status permits it. Alternatively, higher unconditional capacity can be guaranteed by the user against payment.

The proposed model relies on the direct control of assets by the network operator, rather than response to price incentives. This helps to guarantee the desired response and enables a high utilisation of the existing network.

One of the goals of the reforms is ensuring efficient EV charging. Westnetz GmbH recently introduced a tariff offer in which they forfeit connection charges if the consumer consents to giving the grid company the ability to steer the charging infrastructure. The consolidation of the provisions in §14a EnWG should give all grid companies the possibility to make use of such tools via differentiated tariffs for different types of connections.

For the time being, the proposed solution will be favoured over the introduction of a market-based approach, such as the introduction of flexibility markets. However, the new legislation does not shut the door to the introduction of such markets at a later date. BNetzA is generally sceptical that decentralised flexibility markets will be cheaper than centralised management of grid constraints. In particular, they are keen that resources are managed to handle congestion not only locally on lower voltage levels but also pan-regionally or on the transmission level. Such a process might be more efficiently implemented by grid operators rather than market-based approaches.

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5 GREAT BRITAIN

Connections in Great Britain occur on a first-come-first-served basis, although delayed projects may be demoted or removed from the connection queue. Prioritisation is only being considered for projects that will effectively release network capacity. Distribution networks offer conditional (interruptible) connection agreements were network capacity is limited. The regulator is considering more general reforms to the access right regime that could support the more common use of interruptible or time-profiled network access.

5.1 Transmission network connection process

In accordance with the Electricity Act 1989, transmission owners must be licensed in Great Britain and their obligation to connect is set out in condition C8 of the transmission standard license conditions.[7] This condition establishes a duty to offer a bilateral agreement and/or construction agreement to any person applying for a connection within three months of receiving the application. Paragraph six of condition C8 sets out the exemptions to this general obligation. Put simply, these exemptions cover cases in which making such an offer would be illegal, violate safety standards or in which the would-be connecting party refuses to be bound by the applicable industry codes or ceases to have the required licenses from the regulator.

In general, the connection process will be handled between the connecting party, the system operator and the relevant transmission owner. The general connections process is as follows. The connecting party will usually engage with the transmission owner informally at first and be allocated a customer account manager. An initial and pre-application meeting will be held between the parties to understand their requirements and a short desktop assessment of the chosen area will be conducted. The connecting party will then submit a formal application to the system operator and must pay an application fee that varies based on the size and nature of the project. The application includes the relevant technical details and is supported by the transmission owner's customer account manager. Once a complete application is received, the three-month response window begins. Connection and, if relevant, construction agreements will then be drawn up for the project and sent to the connecting party for approval. Connecting parties are liable for the cost of local assets and must provide securities to ensure that, if the connecting project is cancelled, the cost of any works in progress is not born by other consumers. There is then a detailed planning and design process, undertaken by the transmission owner. When a final detailed proposal is decided on, the connecting party must confirm their commitment to the chosen option. The transmission owner also checks that the necessary funds are available and creates the project plan with details on procurement and delivery. This is followed by the construction work and ultimately the connection.

It is important to note that the connection of generators to the transmission network is governed by the Connect and Manage regime. Put simply, this regime requires the transmission owner to identify both the minimum transmission reinforcement works required to connect the generator to the transmission network, irrespective of whether the connection is compliant with wider system security standards (the so-called 'enabling works') and the 'wider works' required to reinforce the rest of the network. Generators are offered an initial connection date based on the completion of the enabling works only. The system operator is required to then manage any congestion issues, with any additional congestion management costs due to the early connection socialised through balancing charges.

Although the transmission networks do not formally offer a set of 'flexible' connection contracts, connection contracts made under the Connect and Manage regime do typically include specific

[7] https://epr.ofgem.gov.uk//Content/Documents/Electricity%20transmission%20full%20set%20of%20consolidated%20standard%20licence%20conditions%20-%20Current%20Version.pdf?utm_source=ofgem&utm_medium=&utm_term=&utm_content=licencecondition&utm_campaign=epr

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conditions that allow the customer to be constrained off at no cost to the network or system operator. These conditions typically cover the period after connection but before the completion of enabling works and will specify the circumstances in which the connection can be curtailed for free. An example of such a circumstance might be a network fault on a specific part of the network. Connecting parties may be willing to accept these conditions either because it enables an earlier connection and or reduces the cost of the local construction work for which they are directly liable. In general, outside of the specific circumstances listed in the connection contract, generators must be compensated for any restriction to their network access.

5.2 Distribution network connection process

The standard distribution connections process is also governed by the Electricity Act 1989[8], notably section 16-17, and the standard license conditions (SLCs)[9] imposed on all distribution network operators by the regulator. Sections 16-17 of the Electricity Act impose an obligation to make an offer of a connection when asked for one by the owner or occupier of a property. Section 17 lists exemptions from this duty. This broadly covers cases in the which the network does not have the required legal powers or consent to make a connection, but also includes cases in which "it is not reasonable in all the circumstances for him to be required to do so." Although this allows room for some regulatory and judicial discretion, in practice, the network must offer to connect all applicants where they can legally realise a connection. Importantly, section 22 of the Act allows for so-called 'special agreements with respect to connection' and effectively allows for the connecting party and network to bilaterally agree arrangements distinct from the standard connection process. These arrangements are used to create conditional connection agreements as described under 5.3.3.

Regarding the standard licence conditions, standard licence conditions (SLC) 12 requires that the connection offer provided include specific information, including the charges to be paid, and sets a time limit of 65 working days for the submission of an offer. SLC 19 requires that network operators must not discriminate when carrying out works related to connections. In practice this means a network operator cannot *unduly* discriminate between one type of customer and another.

The standard connection process is fairly simple. Connecting parties contact the relevant network and provide some basic information on the nature of the required connection. The network then produces connection offers on a first-come-first-serve basis based on the application time. There is no prioritisation of offers. In doing so, the network will identify the 'minimum scheme', the solution designed to provide the necessary capacity at the lowest overall capacity cost. The DNO may also design and propose an enhanced scheme, for example that is designed for anticipated future network requirements, but the connection charge quoted to the customer will, in any event, be equal to the costs implied by the minimum scheme.

In some cases, the network will receive applications that cannot be independently resolved because the connections imply use of the same scarce network capacity and the network could not provide network access to the connecting parties consistent with the required engineering standards if all the connections were made. In this case, the offers are deemed 'interactive'. Processes differ among the networks on the treatment of interactive offers but, critically, connection prioritisation is always first-come-first-served based on the time the minimum required information on the connection request was received, which is usually when the initial application was received. The process related to interactive offers only alters the time available for the connecting party to accept or reject their offer.

The customer may request additional work, for example alternative routing to support easier planning permission, but will then be liable for the costs of any additional work, including the costs of operating

[8] http://www.legislation.gov.uk/ukpga/1989/29/contents

[9] https://epr.ofgem.gov.uk/Content/Documents/Electricity%20Distribution%20Consolidated%20Standard%20Licence%20Conditions%20-%20Current%20Version.pdf

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and maintaining any additional assets over their lifetime. The connection charge quoted will comprise:

- The full costs of any assets that:
  - will be used solely by the connecting customer, or
  - are over and above the minimum scheme when requested by the connecting customer;
- A proportion of the cost of reinforcement proportional to the customer's use of the additional capacity created (and generally limited in depth to reinforcement occurring up to one voltage step above the connecting voltage);
- If relevant, a rebate for the use of assets installed and paid for by a previous connecting party in the last five years.

Although connections are not prioritised, the distribution networks do apply so-called queue management, which applies to those parties that have accepted a connection offer. This system was put in place to prevent delays in higher priority connections holding up subsequent connections unnecessarily. The system also acts as a means to prevent parties from seeking speculative connection agreements that could then be resold to other developers. In practice, the connection agreement places a number of milestone requirements on the connecting party, as appropriate, to make sure their project is progressing. If the connecting party fails to meet a milestone, the distribution network can choose either to extend the milestones or to terminate the connection offer. In effect, the connection offers are made conditional on meeting the milestones. The milestones used cover the following:

- Initiated Planning Permission;
- Secured Planning Permission;
- Land rights;
- TSO interface;
- Contestable works design submission;
- Commence and progress works; and
- Project construction.

5.3 Measures to deal with scarce network capacity

The main measure currently employed in Great Britain is the use of conditional contracts for market access, notably for distribution-network connected generators. However, work currently underway is seriously considering reforms to the access right (and tariff) regimes that might support the more efficient use of network capacity more generally. We discuss these issues below, as well as the brief consideration of market-based allocation and very limited proposals for the prioritisation of flexibility projects.

5.3.1 Market-based allocation

The regulator briefly considered the use of an auctions to allocate scarce capacity where significant queues exist.[10] However, further consideration of this approach was deprioritised as the challenges involved were considered to outweigh the likely gains. The key challenges identified included the need to better define access rights, the difficulty in ensuring competitive auctions (outside of areas with extensive queues) and the possibility that the process would exclude or disadvantage new entrants and/or community projects.

[10] See section 3.42 of https://www.ofgem.gov.uk/system/files/docs/2018/07/network_access_consultation_july_2018_-_final.pdf

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5.3.2 Prioritisation of connections

As noted above, connections are made on a first-come-first-served basis in Great Britain. However, the Energy Networks Association has put forward a proposal for a modification of the current queue management process that would effectively prioritise flexibility providers.[11] Under this proposal, where a connection request (by a flexibility provider) would actually enable the connection of additional applicants without the need for further reinforcement, this enabling connection request would be moved up the connection queue. Such prioritisation would require that the network satisfied itself that the connection would actual alleviate the relevant network constraint(s). This might involve the use a specific contract between the connecting party and the network that would ensure alleviation of the constraint.

5.3.3 Conditional connections

Distribution networks in Great Britain offer conditional connections to those connecting parties that request them. These connection contracts are bundled with limits on the user's access rights and allow the network to curtail the user to ensure network security. In return, the connecting party can potentially secure an earlier connection date and lower connection charges. There is no effect on network charges beyond the potential direct impact on energy use and therefore the charging base. These connection agreements (which are made possible by section 22 of Electricity Act 1989) are not time limited. However, the connecting party may subsequently request a firm connection through the normal connections process, at which point they will again be liable for the relevant costs. Such connection offers are available to both load and generation, but are only used in practice by connecting generators.

Where such connection offers are made, the network will also include a non-binding projection of curtailment. In all cases, the connecting party bears the full curtailment risk, although there are preliminary discussions by the regulator on potentially enabling networks to bear some of this risk. This would, however, require wider changes to the way that networks are reimbursed.

The networks we spoke with offered a variety of different curtailment regimes based on the size of the connection. In general, larger connections involved more sophisticated monitoring and control mechanisms as, in these cases, the costs of the associated (communications) assets could be justified. For small connections (<1 MW) the connection would typically be limited based on a fixed schedule, e.g. reduced or constrained off during fixed peak times. For larger connections, simple constraints were imposed based on network conditions and implemented through the network's SCADA system. Finally, for the most advanced cases, constraints were based on an Active Network Management system that monitored network flows and constrained down use by the relevant parties according to the system's algorithms in order to prevent violations of the safety limits included in the system.

Although early trials of such contracts constrained all parties with relevant conditional connections down on a pro-rata basis, the current industry standard is to constrain parties based on Last In First Out (LIFO) priority. Under this approach, connecting parties with conditional contracts are curtailed in a fixed order based on when they applied for a connection, with more recent applicants curtailed first. Only when one generator has been fully curtailed, is another asked to reduce output. The advantage of LIFO is that it efficiently discourages parties that would trigger significant curtailment from connecting by avoiding a situation in which such curtailments are socialised among other parties. In effect, LIFO protects parties on conditional contracts from the risk that they might be made worse off by a wave of subsequent connections all wanting to use the same assets. Work is currently underway to consider an ability for parties to trade their positions within the curtailment queue.[12]

[11] See section 3.5.3 of https://www.energynetworks.org/assets/files/ONP-WS2-Interactivity%20and%20Queue%20Management%20Consultation-PUBLISHED.pdf

[12] https://www.energynetworks.org/assets/files/Product%201%20and%20Product%202%20Combined%20Report_V.1-PUBLISHED.pdf

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The networks interviewed noted that, although conditional connections were widely available, they were not very popular, with something like 5-10% of generators taking them up. They speculated that this was potentially due to unwillingness on behalf of the projects' financial backers to accept the (uncertain) constraint risk, such that it was generally preferable to incur the higher upfront cost of a firm connection. However, it was also noted that such contracts could be very valuable where generators were seeking to connect ahead of regulatory or legislative cut-off dates.

5.3.4 Access rights reform

Ofgem's access rights work

The British regulator, Ofgem, is currently conducting a so-called Significant Code Review to consider large reforms to the elements of the regulatory framework. Part of this Review covers possible reforms to network access arrangements that are, in part, intended to enable the more efficient use of scarce network capacity. The Review has yet to conclude and so the discussion here reflects ongoing thinking and not changes that have been implemented. Ofgem is due to release its minded to position on these issues around November, with final proposals not due until March-April of 2021. These would not be implemented until 2023.

At present, the vast majority of network users have an implicit right to access the network up to a fixed maximum level at any time, a 'firm' right. Often the maximum level is not even contractually defined. It is hoped that reforms to the access right regime and, in particular, the inclusion of non-firm access rights will allow users to better manage curtailment risk and allow networks to better understand and meet their users' needs.

There are a variety of elements of the access right regime that have or are being considered as part of the review process. These include firmness, time profiling, and the sharing of access as described below.

Firmness

Firmness covers the extent to which the access right may be curtailed and the consequences of such curtailment. Current rights are genuinely very firm, enabling curtailment only for essential maintenance. This may not reflect the value consumers place on firmness. Two types of firmness are identified: physical and financial. The concept of physical firmness concerns the security of supply of the connection. Some users may wish to pay extra for dual circuit access, for example, as this ensure greater physical firmness. Financial firmness refers to the financial compensation arrangements in place in the event of an interruption. A connection that is financial firm will ensure that the connecting party is at least financially compensated in the event of physical curtailment. The current conditional connection contracts in Britain are not financially firm, meaning that no compensation is paid. They are lower cost, but arguably also less attractive, as a result.

Time profiling

Current access rights arrangements are generally not time profiled. However, they could have variations that alter with a fixed schedule, like under the simplest conditional connection arrangements. They could also have dynamic time-profiles, e.g. that are dependent on wind conditions or the power price.

Shared access

Current access rights are linked to exclusively to a specific site. Shared access arrangements would set access arrangements for a portfolio of sites, with the relevant parties responsible for coordinating among themselves to ensure that network use remains within the jointly agreed level.

Other considerations

The Significant Code Review also considered the use of short-term rights and new access conditions. Short-term rights would allow for time-limited access rights, e.g. for one year, where the

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parties did not wish to make a long-term commitment. New access conditions, such as use-it-or-lose-it or use-it-or-sell-it conditions were also considered as a means to encourage the release of unused capacity.

Access rights trading

The Energy Networks Association is separately, as part of the Significant Code Review, considering options to allow for the trading of existing access rights. This is already technically possible at the transmission level. This work is still at its earliest stages, with a consultation on the key principles published in January.[13]

[13] https://www.energynetworks.org/assets/files/Product%201%20and%20Product%202%20Combined%20Report_V.1-PUBLISHED.pdf

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6 ITALY

Italy deals with grid strain through measures other than conditional connections or alternative access rights. Under special circumstances, the regulator allows TSO and DNOs to introduce an open season, i.e. a connection application window which helps the grid operator to collect requests and devise the best technical connection solution to remedy constraints based on the gathered information. Renewables enjoy priority grid connection and network access.

Legislative Decree 79/99 (art. 3 para. 3), which sets the overall electricity market structure according to the European framework, establishes that access to electricity transmission and distribution grids in Italy is free under the principles of equal treatment, impartiality, and neutrality, as ensured by the decisions of ARERA, the independent regulator (similar principles also apply to dispatch, see ARERA Resolution No. 111/06). The third-party access obligation opens the grid to anyone on request (ARERA decision 281/05 and subsequent changes). Resolution No. 33/08 is aimed at guaranteeing access to electricity networks based on transparent and non-discriminatory rules, independently of the specific distribution operator who owns and manages the grid. In general, the connection process in Italy is clearly defined in the legal and regulatory documents. The provisions outline the steps in a structured and detailed manner, allotting unambiguously the responsibilities and timeframes of each step in the connection procedure.

In Italy, connection charges are essentially shallow (proportional to power requested and distance from existing grid) at low- and medium-voltage levels, but deep (i.e. reflecting the actual costs borne by the grid operator) at higher voltage levels (>35 kV). Special conditions apply to renewable generation and high efficiency CHP that results in lower connection charges than would otherwise be the case, with the cost difference being socialised. In addition, if the grid has to be strengthened in order to accommodate new RES generation, the costs of such an expansion are not incurred by the plant operator but are socialised through the grid company.

The TIC (Electricity Connection Code for final customers) and TICA (Electricity Connection Code for active network users) provisions regulate ordinary grid connections.

The TIC regulates the connection of passive end-users and sets out the overall rules and connection charges. The TIQE (Electricity Quality of Service Code, regulating both technical and “commercial” quality of electricity supply),) defines the maximum allowed times for connection and activation for passive end-users. Prosumers and generation, on the other hand, are regulated exclusively under TICA.

According to the TICA, the connection request for generators must be filed with either:

- The local DNO if the injection power requested is below 10 MW.
- Terna, the TSO, if the injection power requested is equal to or above 10 MW.

6.1 Transmission network connection process

For power plants larger than 10 MW, Terna is responsible for managing the grid connection process (§ 6.1 TICA – Integrated regulation text on active connections, Annex A, ARERA Resolution 99/08). To obtain a cost estimate (*preventivo per la connessione*) of the grid connection requested, the generator has to pay 2500€. From then on, the system operator has to evaluate the connection as well as provide a cost estimate within 90 working days of the payment (Terna Network Code, § 1A 5.2.1). In addition to the lump sum payment for the cost estimate, the generator must pay 0.5€/kW for the connection up to a maximum of 50000€ plus authorisation management costs that have to be paid separately. RES generation receives a 50% discount on the sum, whereas CHP plants can save 20% of the cost.

In the next step, the applicant must communicate their acceptance of the cost estimate within 120 days (§ 19.4 TICA). When agreed upon, the applicant has the option of either building the connection

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line independently or letting the grid operator carry out the works on the very-high-, high- and medium-voltage levels. If the applicant builds the connection, it bears the full cost directly and is reimbursed for the relevant connection charges paid to the grid operator. The applicant is not entitled to carry out works in the case of low-voltage connections.

If the grid operator is chosen undertake the construction and 30% of the connection charges are paid by the generator, Terna receives 90 to 120 working days, depending on whether the plant is connected at high- or very-high voltage, until the authorisation requests need to be finalised. After obtaining the authorisations, the system operator is required to find the optimal technical solution for connecting the plant to the grid. When preparatory work by the power plant operator is done, for which it receives a time window of 18 months, and the rest of the connection charges are paid, the TSO has 30 days to complete “simple works” (*lavori semplici*) and 90 days for “complex works” (*lavori complessi*), with an added 15 days per kilometre of transmission line building for all distances larger than the first kilometre (§ 10.1a TICA). When the RES plant is commissioned, the connection has to be finalised within 10 working days and the power plant registered by the operator before it can start exporting to the grid.

If the connection of renewable power generation requires grid expansion, the process obtains priority over other performed expansions (§ 15.1 & § 29.1 TICA).

6.2 Distribution network connection process

Generation

On the distribution level, timeframes for the distribution network operator to respond to the application and provide the cost estimate range from 20 days for a capacity below 100 kW to 60 days for power of up to 10 MW (§ 7.1 TICA). The plant operator then has 45 days to accept the document brought forward by the grid operator (§ 7.2 TICA). Similar to the transmission level, all connection applicants, except on low voltage levels, have the possibility to construct the connection line themselves and to have the relevant connection charges reimbursed by the grid operator.

If the DNO is tasked with the construction works, it receives 30 days for the authorisation request at low-voltage and 60 days at medium-voltage levels (§ 9.3, 9.5). When the request is filed, a timeframe of 30 to 90 days opens up during which all involved administrations participate in the authorisation procedure. After a successful procedure, the plant construction can begin within 12 months. The final connection process is the same as for the transmission level.

For small RES connections, below 20 kW, especially pertaining to rooftop PV, ARERA implemented a simplification in 2015. It states that the connection process can be initiated without reliance on a connection cost estimate by the DNO with the applicant paying a fixed fee of €100.

Demand

When a connection request is presented to the electricity retailer by an end-user, the former has to coordinate with the relevant distribution network operator in order to provide a cost estimate of the works to be performed. After the customer confirms the connection request, the request needs to be passed on and handled by the grid operator within 2 working days. The grid company must make the price estimate available to the retailer within 15 working days and the retailer then has 2 working days to send it to the customer. If a consumer directly approaches the grid operator, the timeframes for the distribution network operator do not change.

At this point, the work to be performed to connect is divided into two categories: if it is “simple work”, the distribution operator must make the connection within 10 working days from the date of receipt of the acceptance of the estimate. In the case of “complex work”, where e.g. grid expansion is required, the connection must be made within 50 working days from the date of receipt of the acceptance.

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If additional permits are needed to perform the grid connection, the DNO can suspend the time it takes to obtain the necessary authorisations subject to having requested the permits within the first 30 working days after acceptance of the connection request.

In case of delays of simple work, the customer receives automatic compensation depending on the delay (€35-210). For delays of "complex work", no compensation is given.

As soon as the contribution to access the grid is paid in full, the consumer obtains the right to withdraw electricity from the grid according to the capacity limits specified in his contract.

6.3 Measures to deal with scarce network capacity

In Italy, all grid connections are completely firm. The grid operators use the first-come-first-served principle with no prioritisation of connection requests unless under extremely special conditions e.g. the connection of a new hospital during the Covid-pandemic emergency. Conditional connections do not currently exist.

In the past, Terna, the Italian TSO, encountered difficulties connecting new plants. When the TSO receives a connection request from renewable generation, it must reserve capacity on the grid for the new plant. Since connection requests can be filed with no expiry date, grid operators are often faced with applications before construction of the plant has begun.

With scarce grid capacity, the expansion of renewables and a large request for new connections in the same location led to the "virtual saturation" of the grid.[14] Although the network was not physically congested, the entirety of its capacity was reserved for connecting new RES generation, since producers opened several authorisation procedures in parallel and for speculative reasons. This meant that the TSO could not allocate new capacity in due time despite having available physical capacity to do so. The practice made network planning difficult and increased the complexity of load forecasting on the grid.

ARERA took it upon themselves to identify critical areas and introduce measures to alleviate the issue. The regulator simplified and standardised the authorisation procedures to reduce the backlog that had resulted from the original process. This freed up capacity for the connection of RES plants that were further advanced in their authorisation process and more likely to be built. ARERA stressed that while this topic was very critical around 8-9 years ago, nowadays it poses no longer an issue.

6.3.1 Prioritisation of connections

The TICA regulation (§ 4) defines colour-coded levels for the extent of network saturation. Network companies cannot deny a connection request that meets the technical requirements due to a lack of grid capacity. However, in areas facing critical capacity shortages as identified by these colour-coded levels, the local DNO and the TSO have the option to activate a so-called open season for an initial period of three months. The procedural regulations as well as the timeframe of the open season measure are the same on the transmission and distribution level. After publishing information about the planned open season one month in advance, the grid operator has the right to collect connection requests over the span of the three-month application window. Household connection requests do not fall within the scope of this provision. The open season is an exception from the usual grid connection process, which functions according to a first-come-first-served criterion. During the open season window, connection applications are collected but not immediately processed. Instead, all the applications are jointly assessed after the window closes in order to develop a plan that realises all the connections efficiently, minimising costs and network interruptions. The open season can be prolonged for another three months should the grid issues still pertain after the first window. The process may be supplemented by agreements that limit power supply. This facilitates better coordination and short-term planning in critical areas.

[14] ARERA (2018, 20th of February), PUC-LV Workshop, Luca Lo Schiavo

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The open season application window process was only used once in 2012 to deal with distribution grid constraints due to a massive number of connection requests for distributed renewable energy generation. Since then, no “red zones” eligible for such a process have existed in Italy. This is also the result of coordination between the DNOs and TSO to find an optimal transmission grid development plan that allows the DNOs to absorb more generation at the distribution level, as specified in TICA. DNOs are, however, still obliged to publish the levels of network saturation for each province online.

6.3.2 Conditional connections

According to ARERA, no flexible or conditional connections have been considered for the current regulatory period from 2016 until 2023. However, such provisions might feature in the upcoming period starting in 2024. Rather than using conditional connections for dealing with the uptake of EVs and heat pumps on the distribution grid, ARERA has been using dispatching regulation and a recent grid tariff reform for household consumers to incentivise grid-friendly use of these flexible loads.

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7 NORWAY

Relatively deep connection charges in Norway tend to dissuade connections requiring extensive reinforcement. Norwegian networks have some discretion as to how they prioritise connections, provided they meet legislative principles. In practice, connections are processed first-come-first-served with some variation to account for project maturity. Options for conditional connections were launched in 2019 and, currently, conditional connection offers for demand customers are expected to be temporary. However, RME has recommended that permanent conditional connections for demand be considered.

7.1 Transmission network connection process

The transmission network connection process is regulated through the Energy Act ("energiloven") and the Regulation on Network Regulation and the Electricity Market ("forskrift om nettregulering og energimarkedet"). The transmission network in the definition of the Electricity Directive consists of assets from 132 kV and up to 420 kV, with Statnett as the main owner.[15] Licences in the transmission grid are awarded per individual asset.[16] The Norwegian Water Resources and Energy Directorate (NVE) is the licensing authority, with the exception of large line projects (voltage 300 kV or above and a length of at least 20 km, applies to both overhead lines and underground cables). For the latter projects the Ministry of Petroleum and Energy awards licences, with NVE responsible for giving a recommendation to the ministry. In addition, Statnett holds the system operator licence that authorises the company as the TSO.

The Norwegian Energy Regulatory Authority (RME) is responsible for setting the detailed rules and oversees the network companies' practices with respect to connection. RME is formally a part of NVE but has its own budget and cannot be instructed by the Ministry.

There is a general obligation on all network licensees to connect new customers or existing customers who require increased capacity.[17] There are no special rules on e.g. priority access for specific types of customers. If the grid capacity is not sufficient, there is an obligation on the network licensee to invest to ensure that connection is possible.

A network licensee may get an exemption from the obligation to connect in the following cases:

- For generators: If connection is not deemed to be rational from the perspective of society.[18]
- For consumption: Only in extraordinary circumstances.[19]

Some connections may require a licence under the Energy Act for connection to grid facilities, e.g. generators and certain consumption assets that require network assets for connection such as

[15] Some 132 kV assets are part of regional grids and hence classified as distribution. The delineation between transmission and distribution depends on the actual function of the assets and not voltage level alone. Note also that Statnett currently does not own all transmission assets, but the company is in the process of buying the remaining assets to meet the unbundling and certification requirements on transmission asset owners.
[16] The Electricity Act §3-1.
[17] The Electricity Act §3-4 and §3-4a. The legal obligation to connect consumption and generation at all grid levels was introduced in 2010. Previously the connection obligation only formally applied to end-users in the distribution grid and not the regional and transmission grids, but the authorities and the network companies practised a similar obligation at all levels. For generation there was no similar regulation or practice previously.
[18] The Norwegian wording is that connection can be denied if it is not «samfunnsmessig rasjonelt». Economic efficiency (i.e. the ratio of benefits to costs) is a key factor, but the concept is wider than economic efficiency (see Investeringer i kraftproduksjon og nett. En rettslig studie by professor dr. juris Ulf Hammer, 2007, prepared for the Ministry of Petroleum and Energy).
[19] The concept of extraordinary circumstances is not clearly defined in the Act or underlying Regulations, but in the proposal to Parliament the Ministry referred to situations where connection would be extremely difficult for the power system, with respect to costs and time or the regional or national power balance. See Ot.prp. nr. 62 (2008-2009).

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offshore petroleum facilities. In the latter case, it will typically be necessary to have a licence for the cable from the onshore point of connection to the offshore facilities.

A generator or a consumer may at any time request connection, regardless of whether the necessary licences or other permits are in place or not. However, actual connection will not take place before all legal requirements are met.

Statnett's general process for connection is as follows:

1. Customers who consider connecting to Statnett's grid directly or to an underlying regional grid are requested to give information to Statnett and/or the regional grid company (if relevant) about their plans. Statnett has created templates for the required information, and also requests updates on the plans. Statnett will provide an initial view on whether there is sufficient capacity for connection and what measures may be necessary. Reservation of capacity cannot be made at this stage.
2. Customers and/or regional grids apply to Statnett for connection with information on the type of connection, required capacity (also long-term plans for upscaling), load or generation profile, location, timeline for the project seeking connection including any licences required and investment decisions. Grid owners who apply on behalf of their customers are required to provide additional information on the development of electricity consumption and generation in the area, grid development plans and the point of connection to the transmission grid.
3. Statnett considers the capacity in the transmission grid and carries out grid analyses. At this stage no costs are charged to the customer.
4. If there is available capacity, capacity is reserved, and an offer is made by Statnett to the customer (for direct connection to Statnett's grid) or the regional grid company on behalf of its customer to order grid capacity within a deadline. If the deadline is not met, the capacity is released. If the project requesting connection does not move forward sufficiently fast, Statnett will enter into dialogue with the customer and possibly cancel the reservation.
5. If the capacity is ordered, Statnett will confirm that the capacity is reserved, and a final grid connection contract is entered into before the customer's project comes into operation.
6. If there is not sufficient capacity, Statnett will carry out studies of possible measures at the customer's request and subject to the customer paying a share of the study costs. If the customer accepts, an agreement for the grid studies is signed ("KVU" or concept choice study"), followed by an agreement on coordinated project development (of the grid and consumption or generation projects) and finally an agreement to pay a connection charge if the project moves forward. It is not possible to reserve capacity before Statnett has sent a licence application for the necessary grid reinforcements.

Note that the connection contract and contract for grid access are bundled into one agreement with Statnett.

7.2 Distribution network connection process

The Norwegian distribution grid consists of two separate grid levels historically:

- The regional grid, which typically includes voltages from 33-132 kV, and where licences are given for individual assets.
- The distribution grid, which typically consists of grids from 22 kV and below. Here, licences are awarded per area which gives the distribution company a local monopoly on building grids.[20] Individual assets do not need a licence.

[20] The Electricity Act §3-2.

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The obligation to connect is similar to the transmission grid, including the exemption possibilities. Typically, the contracts for connection and grid access are bundled in one agreement as in the transmission grid.

7.3 Measures to deal with scarce network capacity

7.3.1 General incentive mechanisms

The Norwegian regulation and market design provide a set of general incentive mechanisms that serve to allocate scarce capacity according to the willingness to pay for consumption.

Firstly, a customer requesting connection or increased capacity that exceeds the currently available capacity will be faced with covering the cost of necessary grid studies and is also obliged to pay a connection charge if investments are necessary. From 2019 the connection charge can also include a share of investment costs in the meshed grids, in addition to customer-specific investment costs. If the customer does not want to pay for the cost of grid studies or pay a connection charge, the network company is not obliged to invest, and connection will effectively be denied.

In addition, the transmission tariff model contains geographical price signals in the shape of energy charges based on nodal marginal losses for both generation and consumption. Area price differences in the wholesale market give similar long-term signals about where grid connection is particularly expensive for the system. Finally, there is a capacity-based tariff for consumption that is differentiated based on co-localisation of generation and consumption per node.

The tariff model in the distribution and transmission grid also enables network companies to offer their customers a discount on the tariff for interruptible consumption. This is however primarily an operational measure used to balance the grid in specific situations (e.g. outages or bottlenecks in a limited area) and is not intended to be used for managing connections after the obligation to connect was introduced at all grid levels in 2010. It is also not allowed to keep customers on an interruptible contract indefinitely without the customer's consent and demand a connection charge if the customer at some point wants an ordinary connection contract. Prior to 2010 customers who requested a contract for interruptible connection were required to have their own reserve capacity and the scheme was used as an alternative to network investments in some cases. In the transmission grid, such contracts are formally handled as an addendum to the standard contract for connection and grid access.

7.3.2 Prioritisation of connections

If several customers request connection at a point in the grid with restricted capacity, there are no rules on the primary or secondary legislation on prioritisation. Rather, RME gives the network companies the discretionary power to handle connections in their own grids, provided the general principles underlying the Energy Act with respect to economic efficiency, transparency and non-discrimination are fulfilled.

The default option for the network companies is that capacity is allocated on a first-come-first-served basis. However, RME accepts that network companies use other criteria such as project maturity to give priority to customers. For instance, a generator with a licence under the Electricity Act can be given capacity before a generator who does not yet hold a licence. In such cases it is not possible for the customer to reserve grid capacity indefinitely. The duration of a capacity reservation can vary between projects. RME has accepted a maximum limit of one year for small-scale hydropower projects with a licence as the building time for such project typically is one year or less. In other cases, a longer reservation period may be applicable. A longer period may be necessary for e.g. a public transport authority or purchaser such as a county or the Norwegian Public Roads Administration who wants to reserve capacity for connecting charging infrastructure for electrical ferries. The authority or purchaser must have access to grid capacity before the service is tendered. In the latter case the public tendering process may last for significantly more than a year, and hence capacity must be reserved for a corresponding period. According to RME this is fully acceptable, but obviously depending on the circumstances in each individual case.

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Statnett has developed a system for assessing the maturity of projects seeking connection to the transmission, which applies to both generation and consumption. It considers the maturity of projects before capacity is reserved. Factors that go into the maturity assessment include:

- The need for licences according to the Energy Act and other permits (building permits, licences under the water resources legislation, environmental permits)
- Project progress plan and milestones
- Quality of information submitted

Statnett has also, in one case, given guidance to underlying regional grid companies in an area with several regional grids on how these grids can gather information and assess the maturity of consumption projects in their respective grids. Such information is important for Statnett in order to assess the consequences for the transmission grid and the possible need for investments by Statnett.

7.3.3 Conditional connections

For generation, it is possible to enter into a conditional connection contract with a network company. This option is available at all grid levels, but both the network company and the generator must be in agreement for the arrangement to be used. A conditional connection agreement may for instance entail that the generator is not allowed to feed its maximum capacity into the grid if grid capacity is constrained. The conditional connection arrangement was introduced to give network companies and generators the opportunity to avoid expensive network investments and corresponding connection charges to cover a need for capacity that will only arise a few hours annually.

The conditional connection option was introduced in 2019, and according to Statnett there has been considerable interest from some generators already, particularly wind power producers.[21] While Statnett has not yet entered into any such agreements, there are at least two cases where conditional connection is being discussed. For the generators a key driver is that they consider it unlikely that all generators in an area will generate at maximum capacity simultaneously, thus making conditional connection commercially interesting if a connection charge can be avoided.

For consumption, conditional connection is only accepted as a temporary measure that allows faster connection while awaiting network investments. NVE recently recommended that the Troll and Oseberg petroleum installations in the North Sea should be given the required network licences for connecting to Statnett's transmission grid, subject to a curtailment condition.[22] Specifically, in the event of a strained grid situation in the Bergen area due to unforeseen events or maintenance work, the petroleum installations can be disconnected from the grid.

In March 2020 RME sent a letter to the Ministry of Petroleum and Energy recommending that the Ministry considers introducing voluntary connection agreements with conditions for consumption also.[23] The network operator and the consumer must both agree to the conditions, no party has the right to request such an agreement. This is similar to the conditional connection scheme for generation. The background for RME's initiative is the increasing demand for connection from data centres, electric ferries and offshore petroleum installations. These end-users are characterised by a need for quickly resolving whether connection is possible and they often have their own reserve capacity, and are often willing to accept restrictions on their network use if a connection charge can be avoided or reduced.

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[21] The Regulation on network regulation and the energy market, §3-3.

[22] https://www.nve.no/nytt-fra-nve/nyheter-konsesjon/tilrar-loyve-til-kraftforsyning-til-troll-og-oseberg-fra-kollsnes/ (Available in Norwegian only.)

[23] https://www.nve.no/reguleringsmyndigheten/nytt-fra-rme/nyheter-reguleringsmyndigheten-for-energi/reguleringsmyndigheten-for-energi-foreslar-tilknytningsavtaler-med-vilkar-som-alternativ-til-nettinvesteringer/ (Available in Norwegian only.)

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The relevant regulation (the Regulation on network regulation and the energy market) is handled by the Ministry and not RME, and hence RME can only make a recommendation. As of 29 April 2020, the Ministry has not published its response to the recommendation.

7.3.4 Access right reform

At present there are no regulatory plans for introducing alternative access rights, e.g. in the form of auctioning of network capacity or local market arrangements for network access including connect and manage schemes that utilise local flexibility. However, there is increasing R&D activity on local flexibility mechanisms and similar arrangements that touch upon the topic of access rights, and RME is monitoring these projects closely.

RME has also recently introduced a regulatory sandbox, which means that network companies can apply for time-limited exemptions from their ordinary obligations as part of R&D work.

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8 SUMMARY AND LEARNING POINTS

In this study, we have looked at the electricity network connection processes in Denmark, Finland, Germany, Great Britain, Italy and Norway. In this section, we briefly summarise our findings with a view to possible connection management reforms in Sweden.

All of the systems examined share some fundamental design principles. In all cases, the relevant regulation places strong obligations on networks to connect parties requesting a connection. Where exceptions to these obligations exist, they exist only to prevent conflicts with the networks' other legal duties, safety or security of supply considerations or else to cover exceptional circumstances, not including general cases of network congestion.

All of these systems broadly use a system of first-come-first-served prioritisation for connections, although the rationale for this approach is not set out explicitly. We speculate that because connections will naturally be processed in order of receipt during periods when network capacity is not significantly constrained this approach has simply been continued even where there is significant competition for connection. First-come-first-served prioritisation also has the advantages of administrative ease, transparency and appears to be broadly accepted by stakeholders as fair or reasonable.

The most conspicuous exceptions to first-come-first-served prioritisation are special rules that allow for the prioritisation of renewable generation and these can be seen as a means of trying to recognise the social value such connections can play in terms of supporting the achievement of national environmental and energy policy goals. Other modifications to simple first-come-first-served prioritisation also exist to address possible hold-ups, for example, when a project with an early application has its connection delayed for reasons related to the project's development or difficulties in the consenting process and where, in the absence of such modifications, these delays might hold up later applications that are ready to connect. Modifications may also exist to prevent speculative connection applications, especially where network capacity is anticipated to be scarce. In general, connection offers may be made conditional on progress in developing the project to help address these problems.

The most interesting experience and thinking regarding prioritisation appears to come from Italy and Great Britain. In Italy, in response to a wave of connection applications for distributed generation, an open season process was introduced. Importantly however, this process was only ever used once in 2012, so experience is rather limited. Under this process, connection requests are gathered during a three- to six-month application window and then processed collectively to help ensure the rationality of reinforcement work and minimise disruption to the network. In such cases, the specific timing of an application within the window ceases to be a determining factor in the connection queue and connections and the associated construction works are instead timed so as to minimise costs and disruptions from a network planning perspective.

In Great Britain, proposals are currently being consulted on that would enable the prioritisation of users that, through the provision of flexibility, would actually release network capacity and thereby enable additional connections. Arguably however, this is more a case of rationalising the existing process to account for connections that can free up capacity than a genuine attempt at prioritisation. More dramatic changes to prioritisation, in which new network capacity would be auctioned, were briefly considered by the British regulator in 2018, but the challenges involved were considered to outweigh the likely gains. The key challenges identified included the need to better define network access rights (and therefore the need for significant regulatory effort), the difficulty in ensuring competitive auctions (outside of areas with extensive queues) and the possibility that the process would exclude or disadvantage new entrants and/or community projects.

Innovative approaches to dealing with connections in areas with scarce network capacity have instead focussed more on the development of conditional connection offers and, to a lesser extent, wider reforms to network access arrangements. Conditional connections involve offering connections with limited network access rights to avoid the need for network reinforcement. They only appear to be widely used in Great Britain, although similar mechanisms are being developed

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for use in Denmark. In Great Britain, they are primarily used to accommodate the connection of variable renewable generation to the distribution network and allow the connecting party to lower their connection charge and, generally, to connect more quickly.

Both Great Britain and Germany are also considering broader reforms to the system defining network users' access rights with the intention that available network capacity can be more explicitly and efficiently distributed among users. These reforms have yet to be implemented, but offer the promise of increased spare capacity on the existing network and more commonplace use of the sorts of conditional connections described above.

In conclusion, all of the countries surveyed effectively use first-come-first-serve prioritisation for connections, occasionally with special priority given to renewable generators. The only alternatives to have received consideration are the use of open seasons, with applications within the application window processed collectively, and the use of auctions. However, only one such open season was ever held and thinking about auctions has never progressed beyond the initial concept stage. More thinking is instead being done about the use of conditional connections and reforms to network access rights. However, only conditional connections are actually in regular use, primarily in Great Britain.

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GLOSSARY

ARERA	Italian Grid Regulator - Regulatory Authority for Electricity Gas and Water (Autorità di Regolazione per Energia Reti e Ambiente)
BMWi	Federal German Ministry for Economic Affairs and Energy (Bundesministerium für Wirtschaft und Energie)
BNetzA	German Grid Regulator - Federal Network Agency (Bundesnetzagentur)
CHP	Combined heat and power
Citizen energy community	A type of community as defined in EU legislation (Directive (EU) 2019/944). Essentially these are community energy projects not primarily driven by a profit motive.
Connection contract	A contract between a network company and connecting party establishing the terms under which a physical connection to the network will be established
Contracts for grid access	A contract between a network or system operator and a network user establish the terms under which the network users may inject or withdraw power
DNO	Distribution Network Operator
EEG	German Renewable Energy Act (Erneuerbare-Energien-Gesetz)
EnWG	German Energy Act (Energiewirtschaftsgesetz)
EV	Electric Vehicle
KraftNAV	German Ordinance for Regulating Grid Connection of Electricity Generating Assets (Kraftwerks-Netzanschlussverordnung)
LIFO	Last In First Out – A system in which users are curtailed in sequential order, with the party with the most recent connection application curtailed first
NAV	German Low-Voltage Connection Ordinance (Niederspannungsanschluss-verordnung)
Open Season	Italian measure to deal with grid capacity shortages due to excess connection applications. Connection applications are still collected but their treatment halted during a three- or six-month period after which they are jointly assessed to optimise grid utilisation and management
PV	Photovoltaics
RES	Renewable energy sources
SCADA	Supervisory Control and Data Acquisition
SLC	Standard License Condition
Spitzenglättungsmodell	German “peak shaving model” that divides connections into conditional and unconditional connections based on their importance to users and how flexible they are. The proposal to reform connection rights will be discussed by the German legislation in June 2020.
StromGVV	German Basic Electricity Supply Ordinance (Stromgrundversorgungsverordnung)
StromNEV	German Ordinance on Electricity Grid Tariffs (Stromnetzentgeltverordnung)
StromNZV	German Electricity Grid Access Ordinance (Stromnetzzugangsverordnung)
Terna	Italian TSO

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TIC	Italian Integrated Connections Provision (Regulation for passive grid connections [consumers] – Testo integrato delle condizioni economiche per l'erogazione del servizio di connessione)
TICA	Italian Integrated Active Connections Provision (Regulation for active grid connections – Testo integrato delle connessioni attive)
TIQE	Italian Integrated Quality of Electrical Services Provision (Regulation on quality of electricity service provision – Testo integrato della regolazione output-based dei servizi di distribuzione e misura dell'energia elettrica)
TSO	Transmission System Operator
UK	United Kingdom

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