'Feed-in socket' concept

Proactive approach to grid connection of renewable energy plants

The targets of the energy transition are unprecedented in terms of their scale and speed. Conventional grid connection concepts are reaching their limits with the massive expansion of renewable energy systems. New ideas and solutions are needed to achieve the goal of climate neutrality quickly, cost-effectively and technically efficiently. With this in mind, Bayernwerk and Lechwerke, together with E-Bridge Consulting, have developed the 'feed-in socket' concept. This is a proactive approach to simplifying the grid connection of renewable energy systems.

As part of the so called 'Easter package, (Osterpaket) the German government set the course in 2022 to increase the share of renewable energies in gross electricity consumption to at least 80 % by 2030 with a consistent, significantly faster expansion. Compared to the current installed capacity of renewable energies, a further massive increase in the expansion of renewable energies in Bavaria will be necessary in the coming years in order to achieve the political targets (Figure 1). Bayernwerk and Lechwerke are clearly feeling the momentum of the energy transition: grid connection requests from feeders have doubled at both companies in 2023 compared to 2022 - already starting from a high level.

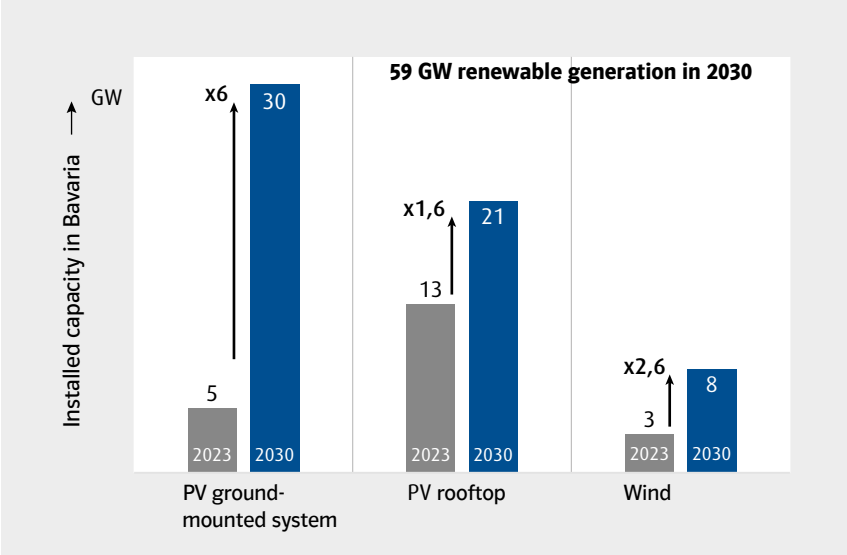

Figure 1: Installed capacity in Bavaria according to the 'Osterpaket' ('Easter package`)

Background

High grid connection costs slow down the expansion of renewable energies

Under the current legal framework, grid operators are obliged to assess each grid connection request individually and to name the technically and economically most favourable grid connection point. This isolated processing has several disadvantages for the parties involved. Project planners of renewable energy plants have a high degree of planning uncertainty for their project locations until the grid connection point is awarded and are sometimes confronted with high grid connection costs after the award. For grid operators, the case-by-case examination of connection requests leads to high calculation costs, long processing times and reactive grid expansion. The many individual construction measures required as a result lead to inefficient, fragmented and unstructured grid expansion.

Orientation towards free grid capacities can significantly increase the feed-in of renewable energies.

Existing capacities in the electricity grids are a crucial basis for the technically and economically efficient connection of generation plants. Due to the rapid ramp-up of renewable energies, the grids are increasingly reaching their load limits. For plant operators, this is increasingly leading to distant and sometimes uneconomical grid connection points. This can be remedied by consistent grid expansion. Bayernwerk and Lechwerke are pushing ahead with this and have expanded their electricity distribution grids to over 1,600 km in length in 2022 alone. However, the expansion of the high-voltage grid in particular often takes many times longer than the construction of a new ground-mounted PV or wind energy plant. As a result, the gap between the expansion of the electricity grid and the expansion of renewable energy plants is widening.

This is also causing constantly rising costs for necessary redispatch measures due to grid bottlenecks. Therefore, in order to better utilise the existing electricity grids, the expansion of renewable energies must be more closely aligned with the available grid capacities.

Conflict potential - technically and economically most favourable grid connection point

Another problem is the potential for conflict that arises when different system operators compete for limited grid capacities.

Often the most economically favourable grid connection points are not economically viable for the system operator. Plant operators are therefore increasingly filing complaints or demanding the disclosure of grid data as part of the connection request. This leads both to high costs for the distribution grid operators (DSOs) and to a delay in the necessary expansion of renewable energy systems

Solution proposal

Feed-in socket concept - fast, cost-effective and technically efficient

With this in mind, Bayernwerk and Lechwerke have developed the feed-in socket concept. A feed-in socket is a grid technology concept that integrates renewable energy systems into the power grid in a quick, simplified (N-0-safe) and bundled manner **(Figure 2).**

In the current project, the feed-in socket is, for example, a HV/MV substation or a HV/MV transformer, which can be scaled up in the future using the modular principle. Feed-in sockets are particularly advantageous where load centres are located nearby in order to exploit synergies between feed-in and consumption. In the future, it should be considered to build new HV lines with several HV/MV feed-in sockets and to transport the generated energy directly into the European interconnected grid via a grid coupling point.

The DSO can use this feed-in socket in two ways, as described below. These two types can be mixed in practical implementation:

1. The DSO proactively builds connection capacities for renewable energies:
Instead of waiting for requests, grid operators provide grid capacity in advance in the form of a feed-in socket to enable the integration of renewable energies. This reduces delays and overall economic costs. However, it must be ensured that there is sufficient available space in the vicinity of the feed-in socket for the expansion of renewable energy systems. The municipal partners are therefore involved in the planning for a new feed-in socket at an early stage. This will ensure that the municipalities designate sufficient areas in their land use plans and support the construction of new renewable energy plants.

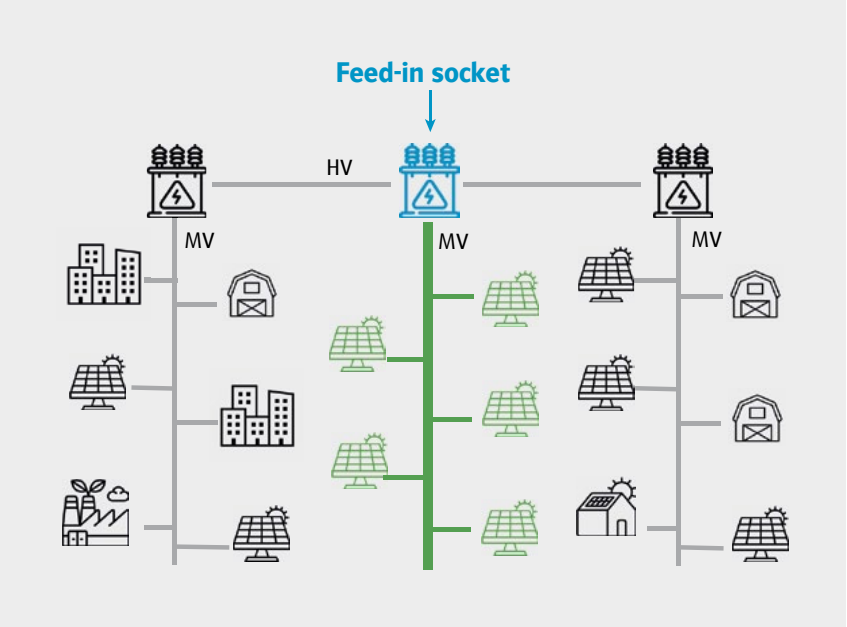

Figure 2: Example of a feed-in socket as a high voltage (HV) / medium voltage (MV) substation

ZThe aim is for the preliminary coordination to lead to faster authorisation procedures for the plant operators and the installation of the feed-in socket. A transparent procedure has been developed for the selection of possible locations for feed-in sockets. Data at municipal level on the following aspects is incorporated into the site selection process in equal proportions:

- Ratio of installed RE capacity to maximum consumption load as an indicator for grids that are already designed for feed-in and for which it is not expedient to expand them further in an n-1-safe manner
- Distance of committed grid connection points in relation to the capacity for feed-in requests from the previous year as an indicator of available connection capacities
- Potential areas for ground-mounted PV systems - combined from study values and grid connection enquiries received for ground-mounted PV systems
- Another exclusion criterion for a municipality is whether it is located in the vicinity of existing high-voltage lines that still have free transmission capacity.

2. Clustering of generation plants instead of individual enquiries:
In the target scenario of the feed-in socket, grid operators should be entitled to include other grid connection requests and expected feed-ins in accordance with Section 14d (3) EnWG (Energy Industry Act) in the sense of an overall assessment when examining the technically and economically more favourable connection point - an overall efficient grid structure should be established, whereby the focus moves away from the individual determination of the grid connection point and towards a target grid expansion by the DSO. A clustered consideration of several systems in a region and the overall connection of these systems to the electricity grid via a feed-in socket proves to be more favourable overall in economic terms and is also advantageous for optimum grid utilisation. In addition, the grid operator can create higher feed-in capacities at an early stage in the sense of a forward-looking expansion if its expansion scenarios forecast additional feed-in.

Publication of grid connection points with available capacities

By proactively expanding grid connection capacities, the grid operator can send location signals for the expansion of renewable energies and thus utilise available capacity in the distribution grid. This can result in additional densification and increase the utilisation of the existing grid. It also reduces redispatch costs, which totalled €4.2 billion in Germany in 2022 [1].

For feed-in sockets, available connection capacities are proactively published at the planned location of the feed-in socket. This enables system operators to tap into feed-in potential in these regions with greater planning certainty. The publication of connection capacities enables system operators to select locations where a simple, cost-effective and fast grid connection can be expected. On the DSO side, the grid compatibility check of these enquiries can be greatly simplified and the processing time thus reduced. In the target scenario, it should be possible to make connection commitments at the feed-in socket via a 'fast track'.

In addition to the proactively built feed-in sockets, it is of course also possible to publish existing, still free capacities. Bayernwerk and Lechwerke have already taken the first step towards publishing available grid capacities with the SNAP tool for a quick, non-binding connection check.

Implementation path

Enabling the clustering of generation plants
According to Section 8 of the Renewable Energy Sources Act, the DSO is obliged to individually determine the technically and economically most favourable grid connection point for each grid connection request above 30 kW. A clustering and joint consideration of different grid connection requests as well as the consideration of the future expansion of feed-in systems in accordance with Section 14d (3) EnWG (Energy Industry Act) therefore require further legal development.

Avoid negative effects when comparing efficiency
The proactive construction of feed-in sockets and thus of grid operating resources has a negative effect on the efficiency comparison of the grid operators and thus on the revenue cap. The reason for this lies in the comparison of current structural parameters with costs incurred for a sustainable future task. The proactive positioning and efficient economic integration of renewable energies into the distribution grid can therefore have a negative economic impact on the grid operator. This inhibiting effect fundamentally affects forward-looking grid expansion and must be taken into account by the regulatory authority (Bundesnetzagentur).

Utilise the opportunity to redistribute costs according to causation
A clustered connection of renewable energy systems to the electricity grid has economic benefits when analysed as a whole. In several exemplary large connection enquiries in the Lechwerke grid area, it was found that the economic costs can be reduced by around 30 % with clustering. At the same time, however, this shifts costs from the operator of a renewable energy plant to the grid operator. The grid operator builds and operates grid operating equipment to connect the plants, which in most cases 'counteracts' the renewable energy plants, for example by building a new substation.

This gives the majority of renewable energy plants a closer grid connection point and thus saves them the costs that they would have to bear under the current logic. On the other hand, the grid operator incurs costs that it would not have to bear under the current legal situation. This in turn tends to increase the grid fees.

The concept of the feed-in socket therefore raises questions about cost distribution that need to be clarified in this context. There are various ways in which the costs could be distributed in line with the polluter-pays principle, which are already the subject of public debate [2]. One approach could be that renewable energy systems are connected to the electricity grid in a similar way to the procedure used for residential customers and would have to bear the same cost components.

Conclusion

The feed-in socket concept is a proactive approach by Bayernwerk and Lechwerke to accelerate the efficient connection of renewable energy systems to the grid.

The grid connection point for renewable energy systems is currently determined on a case-by-case basis by the grid operator on request. This leads to complex calculation procedures, reactive grid expansion and potentially high connection costs for the system operator.

A proactive approach is necessary in order to accelerate grid connection, enable more cost-efficient, forward-looking grid expansion and develop a steering effect for the expansion of renewable energies.

A feed-in socket is a grid technology concept that integrates renewable energies into the electricity grid in a quick, simplified (N-0-safe) and bundled manner.

The feed-in socket pursues the following objectives:

- safely plannable locations fo renewable energy plants due to existing grid capacity
- Simplification and acceleration of grid connection processes
- Locating renewable energy plants close to the feed-in socket.

This is associated with a more cost-effective and forward-looking grid expansion as well as an orientation of the expansion of renewable energies towards free capacities in the electricity grid.

Literature

[1] Bundesnetzagentur: Marktbeobachtung Netzengpassmanagement 2022. 2023.

[2] Brückl, O.: Hemmnisse im Verteilnetzausbau und deren Überwindung, Gutachten. 2023.

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