Increased flexibility in the Swedish Regulation on Continuity of Supply since 2024

Maria Dalheim[1], Malin Kindmark[2], Marcus Tjäder[3] Herlita Bobadilla Robles[4], Carl Johan Wallnerström[5], Albin Emanuelsson[6]

[1-5]The Swedish Energy Markets Inspectorate (Ei), Libergsgatan 6, Eskilstuna, Sweden
**registrator@ei.se*

Keywords: POWER QUALITY, REGULATION, CONTINUITY OF SUPPLY, POWER TRANSMISSION AND DISTRIBUTION

Abstract

Regulating continuity of supply (CoS) is challenging due to varying end-user needs. However, end-users should be able to expect at least a minimum level of CoS. Therefore, the Swedish Electricity Act prohibits outages longer than 24 hours and requires the transmission and distribution of electricity to be of good quality. The Swedish Energy Markets Inspectorate (Ei), is responsible for issuing detailed legislation on what is considered good quality.

Ei's first legislation was issued in 2011 and the latest revision entered in to force on January 1, 2024. A key update is the possibility for distribution system operators (DSO) to be exempt from CoS requirements for certain end-users. These exemptions are intended to address situations where meeting the requirements would lead to excessive costs or other significant challenges.

This paper presents the Swedish regulatory framework for CoS, focusing on the recent changes. The aim is to explain the reasoning behind introducing the possibility for DSOs to not meet the requirements on CoS for certain end-users. The paper outlines the requirements that must be fulfilled for derogations to be granted by Ei and cases handled by Ei so far. It also discusses the impacts of a derogation for both end-users and DSOs.

1 Introduction

The Swedish Electricity Act [1] states that "Electricity supply must be of good quality". Furthermore, the act stipulates that the Swedish regulatory authority, the Swedish Energy Markets Inspectorate (Ei), is responsible for issuing detailed regulation on what is considered good quality [1]. Ei first introduced such regulation in 2011, followed by minor updates in 2013 [2]. To address the emerging challenges posed by the energy transition, Ei issued a revised regulation, EIFS 2023:3 [3], in 2023. The regulation consists of two parts, continuity of supply (CoS) and voltage quality (VQ). While the regulation on VQ is described in a parallel CIRED paper, this paper presents the updated Swedish regulation on CoS, including the reasoning behind its implementation and its practical application.

1.1 Updating the regulation

The process of revising the regulation was both thorough and collaborative. Ei reviewed the previous regulation by analysing CoS statistics and lessons learned from monitoring the requirements. Ei also commissioned an external study to explore how derogations could be designed for requirements on the duration of outages both in the Swedish Electricity Act and in Ei's regulation on CoS.

Additionally, Ei formed a reference group to gather feedback on the potential impacts of the suggested revised CoS requirements. The reference group consisted of around 30 representatives from grid system operators, industries, consulting companies, electricity producers and sector organisations [4]. Moreover, Ei carried out a public consultation on the updated regulation.

1.2 The system operators in Sweden

Sweden has approximately 170 distribution system operators (DSO) and one transmission system operator (TSO). The DSOs are mostly local DSOs with a monopoly within an area up to a given voltage level, while the rest are referred to as regional DSOs. These SOs have different conditions regarding size, ownership, and clime/terrain. Regional DSOs distribute electricity to local DSOs and directly to high-consumption customers, while local DSOs distribute electricity to local customers. There are also local power generators that are directly connected to both regional and local grids.

1.3 Monitoring and incentivising continuity of supply in Sweden

Ei's regulatory framework for CoS includes both minimum requirements on CoS and economic incentives for the SOs to improve CoS. The revenue cap regulation is adjusted based on CoS, which is designed to create economic incentives that encourage an appropriate level of reliability based on average outage frequencies and times [5]. Additionally, the Swedish

Electricity Act entitles customers to compensation for outages longer than 12 hours [1].

To monitor the grid companies' compliance with regulations and for calculating the economic incentive in the revenue cap regulation Ei collects detailed data on power outages per customer from DSOs annually, see article [6].

2 Regulation on continuity of supply

The Swedish Electricity Act states that the system operators (SO) must mitigate the deficiencies in the electricity supply. However, mitigations are not necessary if the costs of improving the power supply quality are deemed unreasonable in relation to the consequences of the supply not being of good quality for the customer. Furthermore, outages longer than 24 hours are not tolerated by the Electricity Act. Ei has been given the right to define additional minimum requirements of CoS. There are requirements regarding both the frequency and duration of outages. Ei's regulation on CoS contains three key components on the following topics:

- **Maximum number of outages for end-users**, thresholds for what is considered good or not good quality.
- **Functional requirements for loads over 2 MW**, stricter requirements on outage durations than the 24 hours in the Swedish Electricity Act.
- **Tree-safe lines for voltages >25 kV**, mandates the protection of power lines against tree interference, enhancing system reliability.

The objective of the regulation is to ensure sufficient CoS for every end-user, while also considering the different needs of the wide variety of users. The goal is to achieve an optimal balance between reliability and reasonable prices. It is important that the requirements align with technological development and the development in society, plus, as far as possible, cover future developments. This includes ensuring that the functional requirements do not hinder market entry or impose unreasonable costs on users.

One of the main challenges in regulating CoS lies in how different end-users value grid reliability. While some end-users are willing to pay more for higher levels of CoS, others are content with a lower level of CoS and should not be forced to bear the cost of investments for improving their own CoS. However, end-users connected to the electricity grid should, by default, be able to expect at least a minimum level of continuity in the electricity supply.

2.1 Maximum number of outages for end-users

In the previous version of the regulation, CoS was considered 'good' if an electricity user had less than four long unnotified outages and 'not good' if there were more than eleven long unnotified outages per calendar year. Other factors were not considered, for example short outages (< 3 minutes) or notified outages. The implication of this was that Ei focused on the twelve long unnotified outages limit in deciding if CoS was of not good quality regarding the number of outages. In the revised regulation it is still not good quality if a customer has more than eleven long unnotified outages, but several factors are considered in determining if CoS is 'good' or 'not good' for less than 12 long unnotified outages. These factors are for example:

- short outages (< 3 minutes),
- notified outages,
- causes of the outages,
- historical outage data,
- voltage quality and
- planned or implemented preventive measures.

Fewer than four long unnotified outages are typically considered 'good' quality. However, for example three long unnotified outages each lasting 23 hours or three long unnotified outages in combination with many notified outages and short outages are no longer automatically considered 'good' quality, as they were by definition in the past.

Additionally, Ei changed the period to a consecutive period of twelve calendar months from a calendar year, acknowledging end-users with plenty of outages around end-of-year.

2.2 Tree-safe lines for voltages >25 kV

The notion of tree-safe lines, along with other regulation on continuity of supply, was introduced in the regulation after a significant portion of the Swedish power system was affected by a massive storm in 2005. The latest revision of the regulation states that for lines with a voltage over 25 kV, the DSO must ensure that users are not subject to outages caused by trees or branches falling across the line. Whilst in the previous regulation the lines with a voltage over 25 kV hade to be tree-safe. The revised regulation allows the DSO to make decisions that are best suited to their specific situation.

Generation capacity and energy storage facilities are exempt from the regulation, provided that they do not play a critical role in the electricity grid. Previously only renewable sources was exempt from the regulation if they did not play a critical role in the electricity grid.

2.3 Functional requirements

The requirement for outage duration varies depending on the power demand of individual end-users. The DSOs are subject to stricter requirements, than the 24-hour-limit set by the Electricity Act, for end-users with a power consumption over 2 MW. It is carried out via a stepwise reduction of allowed outage duration for different increments of power demand shown in Table 1. The shortest outage duration (2 hours) applies to power demands over 20 MW.

Table 1 Functional requirements for individual end-users with power demands over 2 MW

Power demand	Maximum allowed outage duration
> 2 MW ≤ 5 MW	12 hours
> 5 MW ≤ 20 MW	8 hours
> 20 MW	2 hours

2.4 Derogation from the requirements

Not all end-users require the same level of CoS, making the grid investment costs of providing redundancy potentially unjustified. This is especially relevant for certain new end-users connecting to the grid, as they would have to pay for redundant infrastructure that they do not necessarily need. Therefore, Ei's latest legislative revision, effective from January 1, 2024, introduces a more flexible framework for SOs. This includes the possibility for DSOs to apply for derogations not only from the requirements in Ei's legislation on what is considered good quality but also from the 24-hour outage limit in the Swedish Electricity Act for certain end-users, following a mandate granted to Ei by the government in 2022.

In the previous regulation it was only possible with derogations from functional requirements for loads over 2 MW and from tree-safe lines for voltages >25 kV. Furthermore, the derogations were time limited. Whilst it is now possible to get a derogation from all the requirements in the regulation on what is considered good quality, and also from the 24-hour limit in the Electricity act.

2.4.1 End-user objective determines type of derogation: Ei has decided that DSOs are automatically exempt from the functional requirements for end-users whose main objective is power generation or energy storage as the costs associated with outages for these end-users usually would not justify their otherwise increased grid connection fee. The requirement could therefore pose a barrier to the connection of new generation capacity and energy storage facilities as it may result in costly investments that are disproportionate to the benefits. It also follows from the Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (Electricity Market Directive) that Ei shall facilitate access to the grid for new generation capacity and energy storage facilities. Ei has therefore introduced this exemption to eliminate obstacles for these facilities.

Derogations for other types of end-users must be evaluated on a case-by-case basis by Ei. In those cases, the applying DSO must provide Ei with supporting arguments, including the reason for applying for the derogation.

Even if a DSO is exempt from the requirements or is approved for a derogation from the requirements for an end-user, they are still required to address the deficiencies in the power grid, provided the cost of improving the quality of supply is deemed reasonable in relation to the impact that poor quality has on the customer.

2.4.2 Applying for derogations: The distribution system operators are the responsible party for applying for a derogation after assessing whether there are exceptional circumstances that would raise the need for a derogation. Such exceptional circumstances may be due to new connections or power demand increases, where there is a need for temporary exceptions during the time required to complete necessary grid investments. Another situation could be that the cost of meeting the functional requirements is disproportionate to the benefit for remote or hard-to-reach connection points. Derogations are not applicable where repairs or other temporary solutions could be used to restore the supply quickly. Moreover, any derogations granted must not negatively impact other grid users.

To apply for a derogation, DSOs must clearly specify the nature of the situation and the reasons why they are unable to meet the functional requirements for the user. They should outline any alternative solutions that have been explored or explain why such solutions are not feasible. Alternative solutions could be alternative connection agreements or market-based solutions. The application must demonstrate that the cost of fulfilling the requirement exceeds the benefits, as well as identify any other users who could be affected and describe the potential impacts. Furthermore, the DSO must show that both the DSO and the electricity user agree on the matter, although a finalized agreement is not required. It is also important to note that longer restoration times are already allowed in cases of force majeure, and a derogation is not relevant in those cases.

3 Impact of the updated regulations

Although the regulation aims to improve CoS, there are evidently cases where the requirements may act as disadvantage to the singular end-user and therefore be beneficial with a derogation. For example, a user might be more interested in investing in their own back-up power or risk outages if it means they can connect to the grid quicker. The functional requirements can limit the possibility of connecting energy storage facilities, as the requirements for restoration time from an outage may result in long connection times and high connection costs, potentially leading to unnecessary grid investments. Generation capacity and energy storage facilities are therefore automatically exempted from the requirements.

The goal of the revised regulations and the introduction of derogations is to maintain sufficient CoS while ensuring that connection of new generation capacity, energy storage facilities and various loads can be carried out in an economically justified manner. In practice, allowing derogations may lower the connection fee for new customers or allow them to start operations earlier. If the DSO avoids building unnecessary redundancy, they lower their capital costs, which reduces their revenue cap, leading to lower tariffs for the customer base.

The revisions do not affect the regulations regarding compensation for outages or the revenue cap regulation, ensuring that there are still incentives to minimise outage durations. The incentives on CoS in the Swedish revenue cap regulation aim to maintain or improve the average CoS in each SO’s network.

Residential and commercial users whose CoS has previously been assessed as borderline will find it easier to be classified as having ’not good’ quality under the revised regulations. Derogations regarding small consumers, such as residential users, will only be granted in extraordinary circumstances. Reasons could be that the residential user is located in a remote area where it is not possible to meet the 24-hour-limit with repairs or other temporary solutions under normal restoration conditions. Furthermore, the derogation is not granted if it affects other grid users negatively.

4 Results so far

Since its implementation on January 1, 2024, the influx of requests can be described as a trickle rather than a stream. There has, however, been enough to show a variety of cases.

4.1 Case 1 – Monitoring adequate continuity of supply

The updated regulations state that CoS can be assessed through the amount of unnotified long outages (>3 minutes) experienced during a 12-month period, while also considering the number of notified outages and short outages, among other factors.

In one case, a customer complaint to Ei indicated that the CoS was ‘not good’, resulting in a monitoring investigation of the relevant DSO. The investigation revealed a total of 57 outages, including one long unnotified outage (with a duration of 1 hour and 53 minutes), seven notified outages (amounting to a total duration of 26 hours) and 49 short outages (< 3 minutes). Initially, the causes of the short outages were unknown, but further inspection identified misconfigurations as the issue. The DSO implemented several measures to improve the CoS so that the quality of supply could be considered ‘good’ going forward.

Without the updated regulation, it would not have been possible to classify the CoS as ‘not good’ in this situation, since the number of long unnotified outages were below four.

4.2 Case 2 – Industrial user increases capacity

A derogation has been granted to a DSO concerning an industrial user that wanted to increase their capacity. The user had not experienced any issues with their electricity supply. The higher capacity meant a stricter functional requirement since they would now fall under another capacity tier in Tabel 1, which the user did not consider necessary. After a dialog with the DSO and reviewing the available options, it was concluded that meeting these requirements would be very expensive. The cost of providing a backup supply far exceeded the benefits, as the customer did not require it.

The derogation resulted in the customer remaining at the same capacity tier as before the increase in capacity as the DSO assessed that they could address any outages within 12 hours, but not within the 8 hours otherwise mandated by the regulation for the higher capacity. The derogation is conditional and will be revoked if the special circumstances justifying it no longer exist.

4.3 Case 3 – Derogation during construction

An industrial user wanted to increase its power demand from 1,5 to 5 MW. To support this higher load, the DSO planned to connect the user with two power lines and transformers to ensure redundancy. However, as soon as one line and transformer were completed, the user wanted to start its seasonally dependent operations. This created a risk of months long outages during construction of the second transformer if the only available transformer failed.

Ei granted a time-limited derogation from the 24-hour outage limit (and consequently from the functional requirements for individual end-users with power demands over 2 MW). The derogation applied for the duration of the construction period for the second transformer.

4 Conclusion

The revised regulation on CoS introduces a more nuanced and flexible approach to defining and addressing what constitutes ‘not good’ CoS.

For the requirement on number of outages there is now clearer assessment criteria to determine if an end-user has ‘good’ or ‘not good’ quality for less than 12 long unnotified outages (over 11 long unnotified outages is considered ‘not good’ quality). There is now an assessment based on several factors. For example, a few long unnotified outages in combination with poor voltage quality or a high frequency of short outages is no longer automatically considered ’good’ quality. Furthermore, changing the period to a 12-month assessment period allows for improvements of CoS, particularly benefiting for customers experiencing the worst conditions during winter.

The new derogations from the requirements on the duration of outages for certain end-users create conditions to remove barriers to access the electricity grid. The derogations can help avoid costly and unnecessary investments, provided that flexibility or market-based solutions have already been explored. Fully exempting generation capacity and energy storage facilities from the requirements on the duration of outages ensures that Ei does not hinder new connections or demand investments where costs exceed benefits. It is also in line with the EU Electricity Market Directive.

Lastly, the revised regulation offers more options for DSOs to meet the requirements on tree-safe lines, emphasising that grid companies can have different tools to accomplish tree-safe lines. This flexibility ensures that grid companies can implement the most suitable solutions while maintaining reliability.

6 References

[1] SFS 1997:857, Ellag, (legislation from the Swedish government, in Swedish)

[2] EIFS 2013:1 Energimarknadsinspektionens föreskrifter och allmänna råd om krav som ska vara uppfyllda för att överföringen av el ska vara av god kvalitet, (Swedish regulation, in Swedish)

[3] EIFS 2023:3, Energimarknadsinspektionens föreskrifter och allmänna råd om krav som ska vara uppfyllda för att överföringen av el ska vara av god kvalitet, (Swedish regulation, in Swedish)

[4] Sweco., 'Förslag till undantag från ellagens funktionskrav' (Published 2022)

[5] Wallnerström, C. J., Huang, Y., Wigenborg, G., Ström, L., Johansson, T.: 'Incentive Scheme for Continuity of Supply in the Swedish Revenue Cap Regulation from 2020'. 25th International Conference on Electricity Distribution (CIRED), Madrid, Spain, 2019

[6] Wallnerström, C. J., Dalheim, M., Seratelius, M., Johansson, T.: 'Power outage related statistics in Sweden since the early 2000s and evaluation of reliability trends'. 2020 International Conference on Probabilistic Methods Applied to Power Systems (PMAPS), Liege, Belgium, 2020