COMPENSATION FOR NETWORK BENEFIT – A BENEFIT OF FLEXIBILITY

Erik Blomqvist, Yalin Huang, Martin Nilsson, Karin Alvehag, Carl Johan Wallnerström

Department of Technical Analysis, The Swedish Energy Markets Inspectorate, Eskilstuna, Sweden

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Abstract

Two different methods have been presented by the Inspectorate in 2020. These methods are used by the Inspectorate when there is a disagreement concerning the compensation between the owner of a production facility and the grid company. The reason why there are two different methods being applied in Sweden is that the Electricity act states that the compensation should correspond to the calculated value of the reduction of fees and reduction in costs of losses. Thus, the preferred method calculates both values, using metering values of a periodicity of an hour at the most. The preferred method is currently not possible to apply to many grids due to a lack of hourly metering data for consumption in many grids.

1 Introduction

The Swedish Energy Markets Inspectorate (hereinafter Ei) is the Swedish national regulatory authority which is commissioned to supervise the functioning of the energy markets. It is the responsibility of Ei is to supervise that the distribution system operators (DSOs) comply with the Swedish Electricity Act regarding reliable and effective networks by fulfilling requirements for the costs and compensations for the grids.

The Swedish Electricity Act has a provision that specifies that electricity producers should be compensated if their generated electricity leads to a decrease of costs for the network companies. This compensation should be specific in all ways possible, to compensate fully the degree of usefulness that the generation accounts to in the grid. With the introduction of distributed generation, this provision incentivizes producers to use flexible solutions to increase their revenue. For the distribution system operator (DSO), the cost for this is fully compensated by the revenue cap regulation since it is considered as a “non-controllable cost” (unlike operational controllable costs, these costs do not impose any efficiency requirement). Since the regulation has an incentive scheme for efficient grid utilization including e.g. incentives to reduce losses, it can be a “win-win situation” for the DSO and the producer. The producer receives an extra income for produced electricity, while the DSO gets a better outcome in the incentive scheme (higher regulated return). The customer collective potentially benefits by lower costs if the DSO can decrease the losses, costs for upstream networks and a decrease in capital costs through a reduced need for capacity increasing investments. This paper will elaborate on two different methods of calculating the compensation that Ei have put into use in 2020.

2 Background

The owner of a production facility is entitled to compensation when feeding in to the grid, in correlation to the cost reduction for the network company where the production facility is connected to. The compensation should be differentiated by e.g. the structure of the specific grid that the production facility is connected to. This also means that for example different load situations or technical bottlenecks or other technical specifics of the connecting grid affect the amount of compensation. Another aspect is that a change in other production facilities, such as the wind or solar situation affects the compensation in a grid with such production facilities.

The specifics of the compensation are also dependent on the Swedish tariff system, and the way that the tariffs economically affect the production facilities. The tariffs should be modelled so that all tariffs are decided on fair and non-discriminatory criteria of the tariff setup in relation to the geographical location of the production facility. A geographical signal in the tariff design is not allowed.

The objective of the compensation is to be fair and give economic incentives for establishing production facilities at the socio-economically most favourable locations. The challenge concerning the compensation is when it comes to calculating a production facility’s individual and actual contribution to the connecting grid. The compensation should be determined by the network company’s costs when the production facility is connected to the grid in comparison to the production facility not being connected to the grid. On the one hand, what the actual costs have been during a previous period are relatively easy to determine. On the other hand, a calculation based on hypothetical costs for the network company, if the production facility was not connected during a previous period when the production facility in reality has been connected to the grid, presents a greater challenge.

The difficulty in the calculation of the network company's costs if the production facility was not connected can differ between different cases depending on the topology of the grid, the production facility's dynamic impact on the grid and missing the essential data that is necessary to perform accurate calculations.

The structural build of the grid is, to a great extent individual to each grid area or network company, and can be a challenge to describe, to get a correct picture of the circumstances concerning each production facility. A grid with more transmission lines calls for more advanced calculation than a grid with single transmission line to calculate correct and precise network losses. In addition to this the comprehension of the structure of the grid calculation of the network losses can require a lot of work depending on the topology of the grid.

The production facility's dynamic contribution affects the reduction of network losses and tariff fees. Regarding grids with large variations in consumption from an upstream network and/or feed in, to an upstream network, the production facility's contribution will vary greatly over time. To describe this there is a need for high resolution calculation as well as time-differentiated calculations.

The fact that a lot of the metered values that are needed for correct calculation of the compensation are not available in the Swedish grids is troublesome. This has however been the situation, and even more so in a historical perspective. A great deal of network companies in Sweden do not have hourly metering values available concerning their customers' consumption due to there not being any legislation enforcing this. Because the network losses of a grid are calculated using values of production, consumption, and feed in or consumption concerning in the connection to an upstream network, the missing hourly metering values affect the calculation of the compensation concerning network losses. Calculation based on monthly metered values can result in the calculated compensation not corresponding to the benefit of the grid, from a production facility supplying intermittent production to the grid. This is due to the network losses varying in relation to the consumption in the grid.

3 Methods to calculate the compensation

The calculation of the compensation for network benefits can be split up into three different components. The sum of these components is equal to the compensation that the owner of a production facility should be entitled to. The three components are reduced costs corresponding to the savings in:

Energy-based tariffs (A)

Power-based tariffs (B)

Network losses (C)

Each of these components can only be greater than or equal to zero. Hence, the production facility can not be liable for any payments to the network company as a result of the calculation of compensation for network benefits, but the compensation can may well be zero under circumstances where there is no benefit to the grid.

The calculations of the reduced costs from energy tariffs (A) and power tariffs (B) are relatively simple, but the accuracy can vary depending on the chosen method. The calculation requires at least the tariffs of the upstream network, the metering values of the connecting production facility and the metering values for energy received from the upstream network for each time period. The accuracy can be enhanced, by including the power of the production facility on the network losses. If the tariffs are non-symmetrical and there is both feed in and consumption towards the upstream network, the energy delivered from the production facility should be put in relation to the energy delivered from other production facilities in the same grid to increase the accuracy of the calculation.

The calculation of reduced costs corresponding to the savings in network losses (C) is more complicated than the other components and is difficult to simplify, due to the amount of losses having relation to the consumption in the grid. Even when the calculation is simplified, the calculation has a degree of complexity as we will demonstrate henceforth. The calculation basically includes the delivered energy per production facility, feed in and consumption towards to upstream network and the consumption in the grid in each time period. The time period should be as short as possible, an hour at most, so that the calculation can have some degree of accuracy, and to consider the dynamics of the grid. For the reasons hereby given there is a difficulty in having only one methodology that will work for all grids and network companies in Sweden.

Another challenge is the available data concerning consumption and network losses. All electricity production fed to the grid and all energy transferred to and from the upstream networks in Sweden must be hourly metered. Consumption however is often metered and settled monthly. Network losses for each time period should be calculated based on metering values for the metering points mentioned above concerning the same time period. This means that the network losses cannot be calculated with a higher resolution than the metering values for consumption, which often is monthly. The network companies are not obliged to have implemented hourly metering for consumption before the year 2025.

Furthermore, a challenge for calculating the compensation for network benefits is the modelling of grids. The full-scale modelling of a grid in these calculations requires data on the hourly operation situations in the grid, apart from metering values, one has to take into account for example which lines are in operation, and all of the flows of energy during the time period used for the calculation. This also means that the compensation concerning network losses can differ between two consecutive hours of production for a production facility independent of the production facility itself or even the consumption in the grid, so there is a lot of data required from the network companies to be able to calculate the compensation concerning network losses.

To address these challenges, the Ei has formerly used a method that uses estimates to calculate the compensation. The estimations have not given accurate results but have been historically useful in the absence of any hourly metering values and been able to apply reasonably well in grids where the energy produced within the grid is consumed within the same grid.

In 2020 the Ei has published two new methods for calculating the compensation for network benefit.[1] The substantial difference between these methods that the detailed method does require hourly metering of consumption and the simplified method of 2020 does not. The simplified method will hereinafter be shortly described in the calculations of the three components,

For energy tariffs (A), hourly metering values of the production facility and connection to the upstream network are used, and, where applicable also a time-related energy tariff of the upstream network, that in that case affects the network benefits.

The detailed method uses energy-based tariffs as well as changes in the network losses in the calculation of the network benefit. In the simplified method, we assume that the reduced energy delivered from the upstream network is equal to the produced energy within the grid if the production is less than the consumption. In the detailed model, the energy delivered from the upstream network when the production facility is not connected is calculated from the network and load data. After this step, the energy delivered from the upstream network without the metered production is compared with the metering values with the production.

For power tariffs (B), hourly metering values of the production facility and connection to the upstream network are used. The production facility's contribution during the hours that are of relevance for the power tariff can thus be identified and quantified. This means that every production facility in the grid is entitled to compensation regarding the contribution made during these relevant hours relating to the reduction in power tariffs towards the upstream network.

There is no difference in calculating power-based tariff in these two methods.

Lastly, regarding network losses (C) the network losses that the production facility helps to reduce are estimated to be one third of the energy delivered for production facilities connected at 1000V or more and all the energy delivered for production facilities connected at less than 1000V. The delivered energy is then multiplied by the specific network loss coefficient of the grid. The production facility is not entitled to any compensation if the network company can prove that the production facility does not reduce the network losses e.g. if there is no consumption connected to the grid.

The difference between the simplified method and the detailed method in calculating network losses lies in considering productions individual contribution to the reduction. In the detailed method, the reduction of network losses is based on the losses when there is production in the network and that when the production is not in the network. In order to calculate the losses when the production is not connected to the network, the network model which considers network data and topology is needed. This model then is used to calculate the contribution from each production location. The contribution for each production is dependent on their location, the time them produce and the consumption. If a production facility shows that its contribution to loss reduction is zero, it will not be compensated even if the losses reduced when all production facilities are connected.

The detailed method calculates the compensation more exactly than the simplified method. The detailed method uses technical data, such as resistance in sections of the grid, having effect on the network losses. The method also compares hourly metered values for both production and consumption in the grid that the production facility is connected to. When the compensation relating to energy tariffs (A) is calculated, all the metering values of production and of consumption in the grid are used to obtain a correct calculation of the network benefit of reducing energy tariffs.

As to the calculation of network losses (C) the metered network losses for the grid (actually reduced losses) in each time period are used in the detailed method, which takes into account the grid topology. This also considers the physical entities of the grid, such as the resistance between the production facility and a connected consuming connection point in the grid in the time period. Thus, the topology of the grid in the time period affects the network benefit, and thus also the compensation.

4 Calculations

4.1 Compensation for energy-based tariffs (A)

The reduced energy tariff to the upstream network is calculated based on the specific hours that the production facility reduces the energy delivered from the upstream network. In each hour that the production in the network is less than the consumption in the network:

$$A = E_a * P_a \quad (1)$$

where E_a is the reduced energy from the upstream network, which is the production of DG, and P_a is the energy tariff of the upstream network.

4.2 Compensation for power-based tariffs (B)

The reduced power-based tariff to the upstream network is calculated based on the hours that the production facility reduces the peak power. As described earlier, this step depends on the tariff design of the upstream network. Here we assume that the power-based tariff from the upstream network is based on the actual peak power in a year.

$$B = E_b * P_b \quad (2)$$

Where E_b is the production during the hour that the power consumption from the upstream network is the highest and P_b is the power-based tariff from the upstream network.

4.3 Compensation for network losses (C)

The reduced network losses in the network is **calculated** based on an approximate loss factor. Since the relation between the loss and the consumption in the network is dependent on the voltage levels, the loss factor is also used differently in low voltage networks and high voltage networks. In this step we assume that consumption is not metered per hour as this is the most likely case in Sweden now.

$$\text{For low voltage network: } C = E_m * K * P_c \quad (3)$$

$$\text{For high voltage network: } C = E_m * K/3 * P_c \quad (4)$$

Where K is the difference, in percent between losses and the total consumption and production in the network in a month, E_m is the production from DG in a month, and P_c is the cost of the network losses.

5 Concluding remarks

This paper was a brief description of two methods that the Ei has developed to accommodate the need for the authority to settle disputes on the compensation for network benefit between production facility owners and network companies. With the increase in variable renewable energy production, and the introduction of high resolution metering, the complexity of the calculations has increased.

To further conclude the discussion, the Ei is expecting to be using both methods for calculating the compensation of network benefit (depending on the availability of data) until the year 2025, when only the detailed method will be used, since the necessary data should be available in all Swedish grids at that time. To shortly also elaborate on the relevance of the methods to calculate the compensation of network benefit in Sweden, one could argue that the calculations are ‘much a do about nothing’, given that the compensation is commonly 0.003 to 0.007 euros per kWh. On the other hand, electricity prices are in a global context very low in Sweden, and the lower the electricity price, the more relevant this compensation can be to a production facility, because the compensation is in part dependant on the costs related to the grid tariffs. The compensation is also greater, in both methods generally when the production facility is a prosumer or a small scale producer, which in general is a small scale solar or wind producer that the transition of the energy system is in need of, and totally in line with the Clean Energy Package of the European Union.

6 References

Authority publication

[1] The Swedish Energy Markets Inspectorate 'Ellagens bestämmelser om ersättning vid inmatning av el',
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