INCENTIVES IN SUPPLY CONTINUITY REGULATION AND SETTING ITS PARAMETERS IN THE CZECH REPUBLIC

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ABSTRACT

The purpose of the incentive quality regulation is to motivate the distribution system operators to improve the quality of power supply to customers. In the Czech Republic this role is played by the so-called quality factor, which is an added part to the regulatory formula increasing or decreasing the allowed revenue of the distribution system operator. Setting of the quality factor parameters is a very important decision to make, which is why an extensive discussion preceded, as well as a number of analyses were made before the beginning of the current regulatory period. The processed supporting documents include calculation of the so-called 'zero borders' of average total value of the quality factor. The core of their calculation is a partial relationship between costs and quality.

This paper presents a method for calculating the 'zero borders', which was the main tool for setting the required values of $SAIFI_Q$ *and* $SAIDI_Q$ *under the incentive regulation. At the same time it summarizes the evolution of incentive regulation of quality in the Czech Republic and lists the parameters that have been set for the current regulatory period.*

INTRODUCTION

Energy regulatory authorities in a number of countries monitor, evaluate and regulate electricity supply quality by using various tools [1]. The implementation of some tools is relatively straightforward. For example, the introduction of compulsory publishing of supply continuity indices (usually *SAIFI* and *SAIDI*) without an economic link, or the introduction of some kinds of customer's standards without an automatic compensation, does not require many analyses and decisions to be made because there are only few parameters. However, an incentive-based (motivational) quality regulation, which is a component of regulatory formula (usually referred to as the quality factor) and links supply continuity indices with the price of distribution services, is an opposite case. The regulator has to choose many parameters with the aim to preserve a motivational character of the whole mechanism.

The set parameters must fit into the overall framework of quality regulation, they must respect certain continuity of their development and must create a predictable environment for operators of distribution networks.

INCENTIVE-BASED REGULATION OF ELECTRICITY SUPPLY QUALITY IN THE CZECH REPUBLIC

Evolution of electricity supply quality regulation

This section describes the historical development of the regulation of electricity supply quality in the Czech Republic.

In 2001, the Energy Regulatory Office (ERO) promulgated its first public notice (i.e. statutory instrument) on the quality of electricity supply. It specified the basics of electricity supply quality standards and related services. However, this public notice did not contain any penalties or repressive measures. Due to the insufficient empowerment in the Energy Act, the issue of the electricity supply quality was not addressed any further during the first regulatory period (2002 to 2004).

In the second regulatory period (2005 to 2009), the ERO promulgated a new public notice, number 540/2005 on the quality of electricity supply and related services in the electricity transmission and distribution, which introduced real standards defining levels of quality that had to be kept in each individual case, i.e., it laid down the minimum level of quality for each of the customers. It also laid down the amounts of compensation for breach of the required standards, the time limits for claiming such compensation, and the procedures for reporting on the keeping of the quality of supply and services. No other requirements for quality were introduced in the second regulatory period.

During the third regulatory period (2010 to 2015), incentive-based quality regulation was introduced in the Czech Republic. The purpose of this mechanism was to improve the quality of electricity supply throughout the system, or in each of the distribution systems, unlike the quality public notice that had primarily focused on each individual customer. The formula for calculating allowed revenue was extended to include a term adjusting the value of allowed revenues by a penalty or bonus for the quality level achieved. At the beginning of the third regulatory period, a sufficiently long time series of continuity indices was not available in the Czech Republic, and the incentive-based quality regulation was therefore only implemented in practice as of 2013. For 2013, 2014 and 2015 the quality factor parameters were set up based on the available historical data only. The required parameters remained the same during those years and no improvements in the achieved values of supply continuity indices were needed.

In the fourth regulatory period (2016 to 2018), the ERO continues to keep in place a combination of the above-stated regulatory mechanisms, i.e. a public notice (standards) and incentive-based regulation. However, a set of changes has been introduced in response to the experience from the previous regulatory period. The most important change is a gradual decrease of the required values of $SAIFI_Q$ and $SAIDI_Q$, which forces the distribution companies to look for improvements. The value of the maximum bonus/penalty has increased, emphasizing the supply continuity. The process during which the supply continuity regulation parameters were set up for the current fourth regulatory period was accompanied with an extensive discussion and many in-depth analyses. An analysis of zero borders of the quality factor was one of them.

Mechanism of incentive-based supply continuity regulation

The Czech Republic's incentive-based quality regulation applies only to electricity distribution and therefore it concerns three regional distribution system operators (DSOs).

The quality of network services in distribution is evaluated using $SAIFI_Q$ and $SAIDI_Q$ indices.

Individual parameters of the quality indices are set for each of the regional DSOs. The required values of $SAIFI_Q$ and $SAIDI_Q$ are 'whole-system' indices, i.e. indices for the respective system operator's entire distribution system without differentiating among voltage levels. The amount of the penalty or bonus for the quality level achieved in electricity distribution is calculated on the basis of the achieved values of the continuity indices as against the required values set by the ERO. Together with the required quality parameters, upper and lower limits are set, beyond which the maximum value of the bonus or penalty is applied. A 'dead band' is also used, within which no bonuses or penalties are applied. This feature helps to partly eliminate the probable year-to-year fluctuations in the achieved values of continuity indices. The mechanism of incentive-based quality regulation is shown in fig. 1. The shape of the function for the calculation with $SAIFI_Q$ is the same as that with $SAIDI_Q$, but the parameters of these functions are different. For each distribution system operator, there are two functions, whose resulting values are added together.

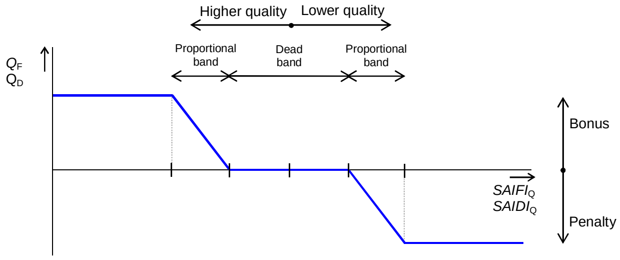

Fig. 1 An illustration of the quality factor components calculation

SETTING THE PARAMETERS OF SUPPLY CONTINUITY INCENTIVE REGULATION

Partial relationship between costs and quality

A partial relationship between costs and quality (more precisely, $SAIFI_Q$ and $SAIDI_Q$ indices) is the cornerstone of calculating the zero border of the quality factor. The method for its calculation is described in [3]. The relationship is calculated for a selected set of feeders (the least reliable feeders) and for a selected set of measures expected to bring about a significant reduction of $SAIFI_Q$ and $SAIDI_Q$ in the particular network. The sequence in which individual feeders (with certain variations in the implementation of measures) enter into this relationship is governed by the MBCA method (Marginal Benefit-to-Cost Analysis) [4]. The benefits of the measures are derived from Monte Carlo reliability simulation. Partial relationship between costs and quality therefore reflects the real possibilities of the given distribution network (it does not work with unit costs and unit benefits). Although a graphic presentation of partial relationship usually shows the course of average changes in $SAIFI_Q$ and $SAIDI_Q$ (for both indices it is non-linear), thanks to Monte Carlo simulation there are also available individual simulated annual values of changes in $SAIFI_Q$ and $SAIDI_Q$ for further calculations.

It is possible to calculate the value of the quality factor (annual average value and the distribution of annual values) for the given setting of quality factor parameters and for each individual point of the relationship.

DSO and ERO scenarios

Each point of the partial relationship corresponds to a set of measures in the network. The partial relationship does not address the implementation of these measures in time - it takes the set as static. The distribution system operator can implement this set of measures:

- in a single shot - to a certain date (in a simplified way - in a certain year) there will be implemented all measures in the network required by the selected point of relationship,
- gradually - the implementation of measures will take place over a longer period of time (in the course of several years) and $SAIFI_Q$ and $SAIDI_Q$ will be decreased gradually.

If this time dimension is added to the selected point of partial relationship, the result will be the selected DSO scenario.

Some scenarios can also be defined for the Energy Regulatory Office. The ERO scenarios define the parameters of the quality factor over time (during the regulatory period).

However, not all quality factor parameters must change over time. In our analyses we took the dead band width and the proportional band width as constants (with values ±5% and 10% respectively - in conformity with the previous regulatory period).

The relative interannual changes of the middles of $SAIFI_Q$ and $SAIDI_Q$ dead bands (shortly 'interannual changes') were considered as variable parameters defining the ERO scenario. The values of the relative interannual changes may vary as to indices, but also as to years. Theoretically, you can get a very wide range of ERO scenarios. The subject of further considerations, however, were only scenarios in which interannual changes were constant during the regulatory period (although they can be asymmetrical - i.e. different for $SAIFI_Q$ and different for $SAIDI_Q$).

Zero borders of the quality factor

When setting the quality factor parameters (i.e. when selecting a suitable ERO scenario), it is not the expected value of the quality factor in a single year which is so important, but it is the fact whether the sum of annual values of the quality factor during the regulatory period will be positive or negative (i.e. whether it will have the character of a bonus or a penalty). The 'zero border' of average total value of the quality factor for the given period Q_{sum} corresponds to this very consideration.

A zero border is the connecting line between the points for which the interannual change of the middle of the $SAIFI_Q$ dead band and the interannual change of the middle of the $SAIDI_Q$ dead band means an average total value of the quality factor for a given period of time (e.g. regulatory period) equals nil. The DSO scenario (or other variables/versions of ERO scenario) is the parameter of the zero border.

Fig. 2 shows the zero border in a graph. The *x* axis shows a relative interannual change of $SAIDI_Q$, the *y* axis shows a relative interannual change of $SAIFI_Q$. Combinations of interannual changes that lie below the zero border have the $Q_{sum} > 0$ and it can therefore be assumed that the total in the whole regulatory period will represent a bonus quality factor for the DSO. Combinations of interannual changes that lie above the zero border have the $Q_{sum} < 0$ and they can therefore be regarded as a penalty (from the DSO perspective), thus being non-motivating.

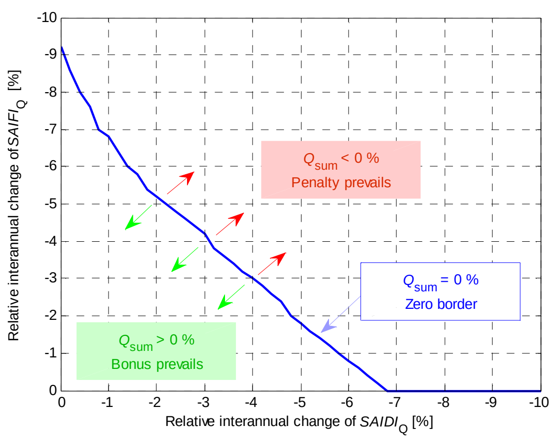

Fig. 2 A graphic interpretation of the zero border of the average total value of the quality factor for the given period

In order to maintain the motivational character of the incentive regulation, ERO should select a combination of interannual changes of supply continuity indices that lie below the zero border.

The average total value of the quality factor is calculated from simulated annual values of $SAIFI_Q$ and $SAIDI_Q$. It is therefore a numerical calculation for which intervals of interannual changes (e.g. 0% to -10%) and a calculation step (e.g. 0.1%) are selected. For each combination of interannual changes a Q_{sum} is calculated. The zero border is then made up of points for which $|Q_{sum}|$ is less than the selected value (e.g. 0.2% of the regulated profit).

Fig. 3 gives an example of the zero borders graph. One point of the partial relationship has been selected from a segment of the relationship just before its saturation phase. This point represents a certain set of measures and the corresponding costs. Two variants of the implementation of the measures have been taken into account:

- an implementation during one year (a single shot investment),
- an implementation during three subsequent years (a gradual investment).

A wide range of the interannual changes of supply continuity indices has been analysed (0% to -10%), and they could follow a geometric or an arithmetic series. Other parameters of the quality factor correspond with the values promulgated for the third regulatory period.

Fig. 4 shows directly the average total values of the quality factor for two cases - in the first case the maximum bonus/penalty equals 3% and in the second it equals 5%. The zero border is located in the intersection of the plotted surfaces. In this way, the graph illustrates that the selection of the maximum bonus/penalty does not affect the course of the zero border (assuming that the maximum bonus is the same as the maximum penalty - see the symmetric function in fig. 1).

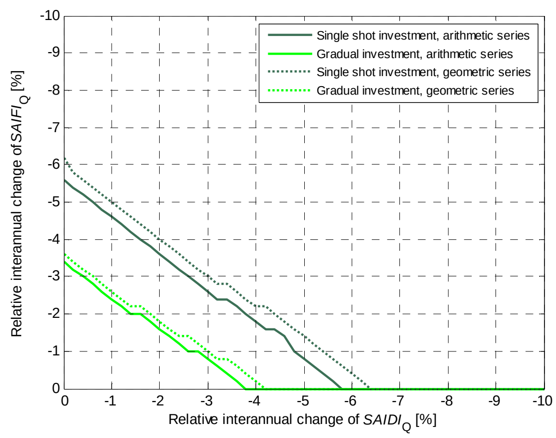

Fig. 3 The zero borders of the average total value of the quality factor in a three-year period (the negative values of the relative interannual change correspond to a gradual decrease of the middle of the dead band, i.e. they correspond to the stricter requirements)

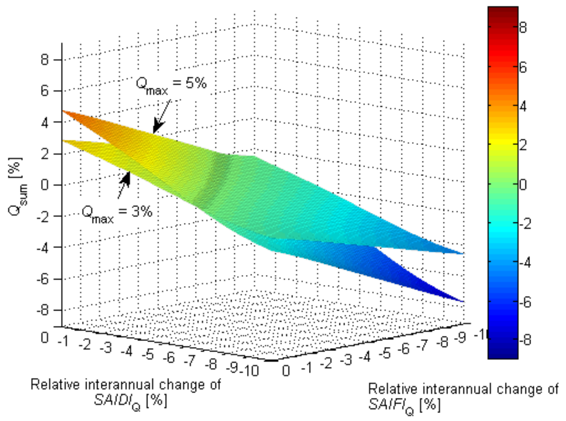

Fig. 4 The influence of the bonus/penalties maximum on the average total value of the quality factor in a three-year period and the zero border

The zero borders graphs carried out for particular distribution system operators in the Czech Republic have served (together with other analyses) as a basis for the ERO decision making on the setting of regulation parameters for the regulatory period currently under way.

Parameters selected for the fourth regulatory period in the Czech Republic

The required values for 2015 were the starting point for the fourth regulatory period. In both indices ($SAIFI_Q$ and $SAIDI_Q$) some improvement is required for the years 2016-2018.

Parameters for DSOs operating networks with predominantly outdoor lines, which cover most of the territory of the Czech Republic, were set like this:

- relative interannual change for $SAIFI_Q$: 1.25%, or 0.75% (annually),
- relative interannual change for $SAIDI_Q$: 2.5%, or 5% (annually),
- the width of the dead band: ±5%,
- the width of the proportional band: 10% (equally for the bonus and the penalty).

The maximum amount of the bonus/penalty has been increased from ±3% (in the third regulatory period) to ±4% of the regulated profit. By making this step, ERO increased emphasis on supply continuity within the whole regulatory mechanism.

Unlike the third regulatory period, the $SAIFI_Q$ and $SAIDI_Q$ indices enter the calculation of quality as two-year averages, which should reduce interannual fluctuations.

CONCLUSION

Setting the quality factor parameters will determine the behaviour of distribution networks operators for a relatively long time (at least for one regulatory period). It is therefore an important and sensitive task. The Energy Regulatory Office is from the essence of its position at a disadvantage, as it lacks full knowledge of the distribution network. It doesn´t know all possible measures to improve the continuity of distribution either, nor their impact. Naturally, ERO is not even an entity that should decide what measures should be taken. However, it creates an environment in which the DSOs operate, and determines the level of quality that should be provided to individual customers. At the same time ERO has one of few possibilities - by means of an incentive-based quality regulation - how to ‘force’ the network operators to effectively invest into their networks. Yet it must also specify the required level of quality at a reasonable price for the end customers, since the whole mechanism will be reflected in the final price of electricity.

In order to ensure a truly motivational character of the quality factor it is appropriate to establish a partial relationship between the costs and the quality ($SAIFI_Q$ and $SAIDI_Q$ indices) and calculate on their basis an expected total value of the quality factor for the whole regulatory period for various degrees of intended tightening up of $SAIFI_Q$ a $SAIDI_Q$. The impact of a wider spectrum of possible combinations of interannual changes of the $SAIFI_Q$ and $SAIDI_Q$ can be transparently visualized by means of the zero border graph of the average total value of the quality factor.

This procedure was used when supporting documents were being created for setting the parameters of incentive regulation for the fourth regulatory period in the Czech Republic. In particular the working out of the partial relationship for each DSO is a time-consuming step, which requires processing a large amount of data from a real network. What is also essential is mutual cooperation with DSOs in preparing the necessary supporting documents.

REFERENCES

[1] MOOG at al. *6th CEER benchmarking report on the quality of electricity and gas supply 2016*. Council of European Energy Regulators CEER.Brussels, 2016.

[2] MOOG at al. *5th CEER benchmarking report on the quality of electricity supply 2011*. Council of European Energy Regulators CEER.Brussels, 2012.

[3] P. Skala, V. Dětřich, J. Šefránek, 2015, ‘A partial relationship between costs and quality as a basis for setting regulation parameters of supply continuity’, *The 23th International Conference and Exhibition on Electricity Distribution*, CIRED, Lyon, June 15-18 2015. ISSN: 2032-9644.

[4] R.E. Brown, *Electric Power Distribution Reliability*. Second Edition. CRC Press. 2009. ISBN 978-0-8493-7567-5.