

CONSIDERATION OF THE INCENTIVE REGULATION REQUIREMENTS FOR COST ANALYSIS BASED ON AGEING MODELS FOR 110-KV EQUIPMENT

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ABSTRACT

Since the incentive regulation has started in January 2009 in Germany, the system operators are subjected to the revenue-cap regulation. Accordingly, the utilities have the incentive to reduce costs, in order to increase their profit. The goal of this paper is to implement cost analysis considering the general conditions of the incentive regulation. The cost evaluation will be accomplished for 110-kV circuit-breakers, by using the simulation software Powersim Studio[®] which is based on system dynamics.

INTRODUCTION

The incentive regulation is the center stage for system operators in many countries. In Germany, the first period of the incentive regulation has started at the beginning of 2009. With the implementation of the incentive regulation, operators of energy distribution networks have to consider strict rules for revenues from system usage charges, quality specifications, obligations to notify and disclosure requirements. Therefore, a new major part of the asset manager's work is to consider the general conditions of the incentive regulation for all future decisions. Thus, it has to be taken into account that for the first two regulation periods, which last five years each, a revenue-cap regulation is specified. The regulatory authority has to determine a maximum revenue limit for the system usage charges for each system operator considering its individual costs. Regarding the predetermined revenue-cap, utilities have the incentive to reduce costs to receive a high profit. The goal of this paper is to implement cost analysis considering the general conditions of the incentive regulation. The cost evaluation will be accomplished for 110-kV circuit-breakers, comprising SF₆, minimum oil and air blast circuit-breakers.

The technical conditions as well as the age of the circuit-breakers have been evaluated and transferred to an ageing model which is based on system dynamics. The age of the circuit-breakers is divided into two parts: the real and artificial age. The real age is the time span since the new installation, and the artificial age shows how old the assets really behave. The optimum is to have corresponding real

and artificial ages, but often the circuit-breakers behave older than their real age. The developed ageing model calculates amongst other things the yearly capital and

operational expenditures (CAPEX and OPEX). Further detailed information about the ageing model can be taken from [1], [2], [3].

Since the beginning of the incentive regulation, the system operators have to prepare two different balance sheets: a trade balance and a balance sheet for the Federal Network Agency. The general conditions for making up the balance are in both cases statutory. As an example the two balances consider different depreciation times and therefore different residual values.

Besides the cost analysis it is furthermore interesting to compare the cost schedules regarding different useful lifetimes for the assets. In this case, a depreciation time of 20 years for the trade balance and a depreciation time of 40 years for the balance sheet for the Federal Network Agency will be assumed, and two scenarios with a useful lifetime of 40 years and 45 years, respectively, will be compared.

Finally, the major goal is to receive the possibility to maximize the profit due to the predetermined revenue-cap. Thus, it is quite important to determine that an optimization due to the revenue-cap will lead to different conclusions compared to an optimization due to the technical condition. Hence, the asset manager has to make his future decisions considering the profitability and not the asset condition.

As already mentioned briefly, the paper will elucidate the requirements of the German incentive regulation in the following chapter, and the third chapter will deal with the explanation and the results of the cost analysis as well as the estimation of the two scenarios.

INCENTIVE REGULATION IN GERMANY

Since 1990 the incentive regulation has been implemented in some countries like Great Britain or Norway. Also the regulation of the German grids is not a new idea as there have been several reports since 2003. The detailed development of the German grids regulation can be seen from Figure 1.

The first two regulation periods have a duration of five years each and furthermore a revenue-cap is predetermined, respectively. That implies that the regulatory authority has to establish a maximum revenue limit of the system usage charges of each network operator considering their individual costs. Therefore, the system operator has the incentive to reduce costs in order to receive a high profit which leads also to a higher efficiency and lower prices for the customers.

For the second regulation period, the revenue-cap will be

adapted to the actual costs at the end of the first regulation period.

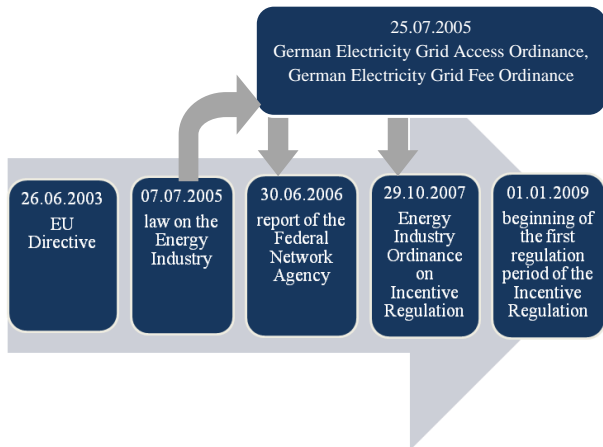


Figure 1: Development of the regulation of the German grids.

PREPARATION OF THE BALANCE SHEETS

To receive a profit increase, two possibilities are available:

- cost reduction or
- revenue increase.

Due to the fact that the incentive regulation has predetermined a revenue-cap, there is no possibility to increase revenues. Thus, the cost reduction is the suggestive possibility to receive a profit increase.

Since the beginning of the incentive regulation in January 2009, the system operators have to prepare two different balance sheets:

- a trade balance and
- a balance sheet for the Federal Network Agency.

The general conditions for making up the balance are in both cases statutory. Table 1 shows the different items of a balance sheet. The liabilities and assets represent the source and application of funds, respectively.

Due to the fact that merely one asset type, in this case 110-kV circuit-breakers, will be considered, it is not possible to present a complete balance sheet with the data of one asset type. Regarding one asset type, only the

- fixed assets,
- current assets,
- stockholder equity and the
- liabilities

can be determined (grey colored rows in Table 1).

The main difference between the trade balance and the balance sheet for the Federal Network Agency are the differing depreciation times and therefore the different residual values.

Table 1: Balance sheet.

balance sheet	
assets	liabilities
A: fixed assets	A: stockholder equity
B: current assets	B: accruals
C: prepayments	C: liabilities
D: active deferred taxes	D: prepayments
	E: passive deferred taxes
balance sheet total	balance sheet total

Every utility has the obligation to prepare a trade balance.

Therefore, the following assumptions were made:

- depreciation time for circuit-breakers is 20 years,
- fixed assets are equal to the yearly residual values of circuit-breakers,
- current assets are 50% of the fixed asset value,
- stockholder equity is equal to 40% of the residual value in the starting year,
- liabilities are the borrowed capital and equal to current values as well as the difference between residual value and stockholder equity.

After preparing the trade balance, the balance for the Federal Network Agency has to be prepared using the following estimations:

- depreciation time for circuit-breakers is 40 years,
- fixed assets are equal to the yearly residual values of circuit-breakers (using a depreciation time of 40 years),
- the values of the fixed assets are the same as in the trade balance,
- liabilities values are taken over from the trade balance,
- stockholder equity is the residual costs less the liabilities.

The stockholder equity has to be divided into two parts which will further be mentioned as equity 1 and equity 2. The value of equity 1 cannot exceed 40% of the sum of the total stockholder equity as well as the liabilities. Equity 2 consists of the remainder, if the total stockholder equity exceed 40%, otherwise equity 2 is equal to zero. This differentiation is necessary for the calculation of the yearly calculative interest on equity capital which can be calculated by multiplying the equity with the interest rate. The interest rate for equity is 9,29% and the one for liabilities 4,23% [4]. As aforementioned up to 40% of the fixed assets can be stockholder equity and therefore merely for this part the interest rate of 9,29% can be used. With the described assumptions and by using the ageing model, the balance sheets can be prepared for different dates which enables the asset manager to forecast the yearly costs over a long time period.

Table 2 shows an example for a balanced balance sheet for the Federal Network Agency after a simulation time of 40

years considering a depreciation time of 40 years.

Table 2: Balance sheet for the Federal Network Agency regarding 110-kV circuit-breakers.

balance sheet	
assets	liabilities
A: fixed assets: 14,046,875 €	A: stockholder equity: 7,994,375 €
B: current assets: 4,023,750 €	C: liabilities: 10,076,250 €
balance sheet total: 18,070,625 €	balance sheet total: 18,070,625 €

RESULTS OF THE COST ANALYSIS

After the simulation time of 40 years, the ageing model delivers the number as well as the age of the circuit-breakers. Therewith, the yearly depreciation and thus the yearly residual values can be calculated which is required for determining the balance sheet items.

For the cost analysis the following two different scenarios have been investigated:

- Scenario 1: Depreciation time of 20 years for the trade balance and of 40 years for the balance for the Federal Network Agency and a maximum useful lifetime of 40 years for each circuit-breaker and
- Scenario 2: Depreciation time of 20 years for the trade balance and of 40 years for the balance of the Federal Network Agency and a maximum useful lifetime of 45 years for each circuit-breaker.

Figure 2 shows the shapes of the trade balance items during the whole simulation period regarding a useful circuit-breaker lifetime of 40 years. As aforementioned, the stockholder equity is constant during the whole time and the other three items vary with the number and age of the circuit-breakers. The shape of the capital expenditures (CAPEX) which mirror the number of the yearly new-installations due to replacement as well as the yearly operational expenditures (OPEX), can be seen in Figure 3 for both scenarios. The shape of CAPEX shows two investment peaks in both scenarios. The first peak occurs because of many old air blast and minimum oil circuit-breakers which have to be replaced in the first simulation year. The second peak occurs 11 years later in scenario 1 and 16 years later in scenario 2, due to the fact that most of the evaluated minimum oil circuit-breakers are between 25 and 30 years old, therefore, they have to be replaced approximately 11 (16) years later. The shapes of CAPEX illustrate the difference between the two scenarios. It is evident that a longer lifetime allows investments at a later time and leads to lower investment peaks. To avoid high investment peak values, it is also possible to introduce a limit for the maximum budget and to distribute the delay

of investment to the following years.

Considering the shape of CAPEX, the shapes of the three non constant trade balance sheet items become obvious, because new circuit-breakers have a high residual value which leads to an increase of the fixed and current assets as well as the liabilities with one year delay.

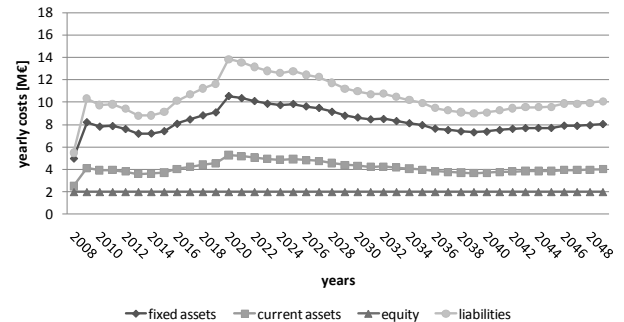


Figure 2: Shape of the trade balance sheet items regarding a useful circuit-breaker lifetime of 40 years.

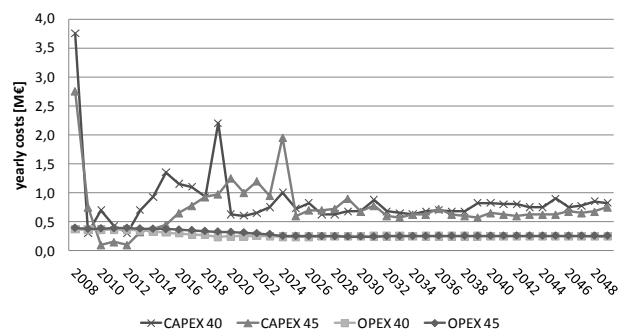


Figure 3: Yearly CAPEX and OPEX values for the two scenarios.

Figure 4 shows the shape of the items of the balance sheet which is required for the Federal Network Agency. Comparing Figure 2 and Figure 4, the corresponding current asset values as well as liability values can be seen. The values of the fixed assets are noticeably higher compared to the trade balance, due to longer depreciation time and therefore higher residual value.

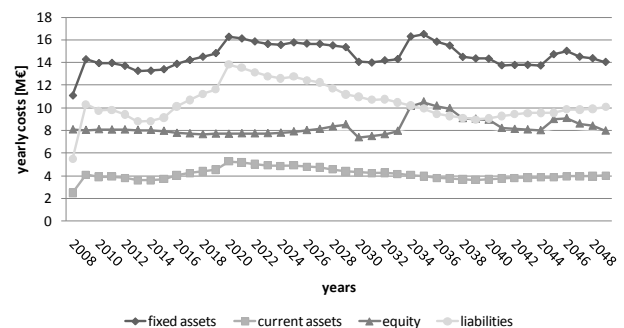


Figure 4: Shape of the items of the balance sheet for the Federal Network Agency regarding a useful circuit-breaker lifetime of 40 years.

It can also be seen, from Figure 4, that high liability values lead to lower equity values and vice versa, because the values of fixed and current assets have to be covered by these two values. The equity of the Federal Network

Agency balance sheet is a fictive value compared to the stockholder equity of the trade balance which is permanently available in the utility.

Another interesting point is to evaluate the values of the return, due to the fact that this amount is the real profit of the utility. Figure 5 shows the standardized return values of the two scenarios which are related to the value of the fixed assets. Comparing these shapes with the shapes of Figure 6 which shows the residual values it can be seen that decreasing residual values may lead to higher return values and vice versa. Therefore the return values of the second scenario are mostly higher than those of the first one due to lower residual values.

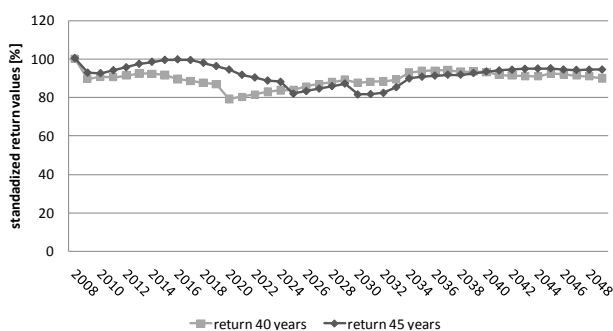


Figure 5: Shape of the standardized return for the scenarios.

Furthermore, the two scenarios will be compared while investigating the grid fees (Figure 7).

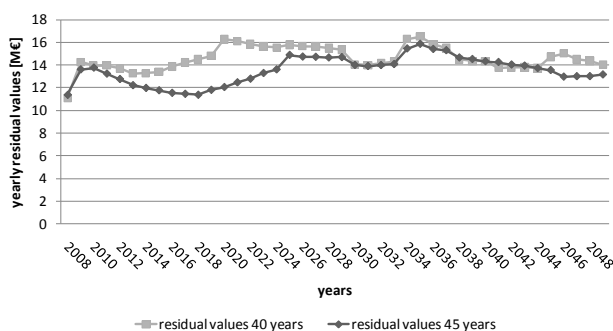


Figure 6: Comparison of the two scenarios regarding the yearly residual values.

Figure 6 and Figure 7 show that scenario 1, which considers corresponding depreciation time and maximum lifetime, has mostly higher residual as well as grid fee values.

The grid fees consist of

- depreciation value,
- interest on equity capital and
- basic costs comprising OPEX and the borrowed costs.

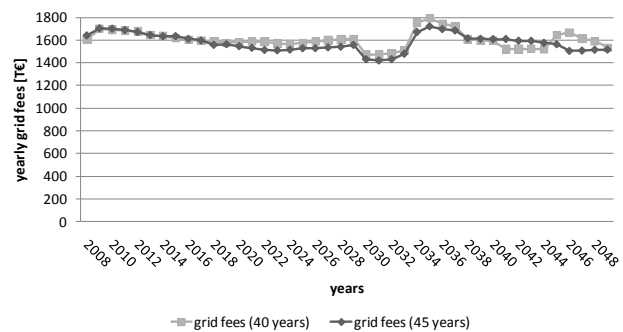


Figure 7: Comparison of the two scenarios regarding the grid fees.

CONCLUSIONS

In Germany system operators have to prepare two different balances, the trade balance and the balance for the Federal Network Agency.

The analyses have shown that from the technical point of view a longer useful lifetime is recommendable due to the fact that it leads to later investments and lower investment peaks.

Regarding the results of the cost analysis a longer useful lifetime is not in any case advisable because it may lead to lower grid fees but to higher return values. Therefore the asset manager has to decide which scenario is the best for its utility.

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