Technical Documentation

DPL-Script "Efficiency Ratio Calculation"

v001

Contents

April 24, 2023
Revision 1

1 Cost Benefit Calculations

This chapter describes the DPL script "Efficiency ratio calculation". The script enables the calculation a profitability or rentability index - also denoted as Efficiency ratio (EffR).

The following terminology will be used:

- Q: Cost quantity Q could be: cost of losses, energy interruption costs, user-defined costs or additional costs of expansion stages.

- t_k: Calculation point in time

- $Cost_Q^{noES}$: Cost of quantity Q without any network expansion

- $Cost_Q^{ES}$: Cost of quantity Q with network expansion

- $EffR$: Efficiency ratio

- ES: Expansion stage

- $noES$: No expansion stage

- TEC: Technical Economic Calculation

- EIC: Energy interruption costs

- $EffR_{ES}(t_k)$: the efficiency ratio of an expansion stage with activation time t_k.

The Efficiency ratio expresses the benefits of grid extension with respect to the investment costs - for each expansion stage defining the grid extension process. The cost benefit designated $Cost_Q^{Benefit}(t_k)$ for a cost quantity Q (e.g. energy interruption costs) at a point in time t_k is calculated by eq. 1:

$$Cost_Q^{Benefit}(t_k) = Cost_Q^{noES}(t_k) - Cost_Q^{ES}(t_k) \tag{1}$$

The total benefit is given by the sum of the benefits of each cost quantity. If for example only cost of losses, interruption costs and user defined costs are considered, then the cost benefit is calculated using eq. 2.

$$Cost_{tot}^{Benefit}(t_k) = Cost_{loss}^{Benefit}(t_k) + Cost_{EIC}^{Benefit}(t_k) + Cost_{user}^{Benefit}(t_k) \tag{2}$$

The profitability (or the efficiency ratio) of an expansion stage (eq. 3) expresses the cost benefit of network expansion in % at a certain point in time t_k.

$$EffR_{ES}(t_k) = \frac{Cost_{loss}^{Benefit}(t_k) + Cost_{EIC}^{Benefit}(t_k) + Cost_{user}^{Benefit}(t_k) - (e : AddCosts)}{InvCosts} \tag{3}$$

Where:

- `e:AddCosts`: Additional costs of an expansion stage (this is an input parameter on the "Economical Data" tab of the expansion stage object).

- $InvCosts$: Investment costs of the expansion stage ES (input parameter on the "Economical Data" tab of the expansion stage object).

1.1   Calculation Input parameters

The script has several input parameters, which will be described briefly.

General Selection: If a general set is selected, the EffR will be calculated only for the expansion stages contained in the "General Selection". If no general set is selected, the EffR is calculated for all expansion stages in active variations with an activation time within the study time period.

iStartYear: Starting year of study time period. Only expansion stages with an activation time after (or equal to) the 1st of January at 00:00:00 of this year will be considered for the EffR calculation (default: 2010).

iEndYear: End year of study time period. Only expansion stages with an activation time prior (or equal) to the 31st of December at 23:59:59 of this year will be considered for the EffR calculation (default: 2020)

iAllFeasCalcPoints:

- **0 (default)**: The EffR of a participating expansion stage is calculated only for its defined activation time.

- **1**: The EffR of an expansion stage ES is calculated at the activation time, day and month for all years that are after the closest prior expansion stage of the starting variation (or the starting year of the study period) and before the next closest expansion stage of the starting variation (or the end year of the study period). So only expansion stages of the same variation restrict the calculation times.

iPrintSettingsSec:

- **1 (default)**: A section containing the settings of the EffR calculation is printed to the "Output Window".

- **0**: Settings section is omitted.

iPrintCalcStageSec:

- **1 (default)**: A section containing the expansion stages with its calculation points for which the EffR will be calculated is printed to the "Output Window".

- **0**: Section is omitted.

1.2   Calculation of cost benefits

The TEC command should be pre-configured to calculate at least the costs for losses, expected interruption costs and user-defined costs. To carry out the calculation:

- multi-select the expansion stages (or the variations) for the calculation in the data manager,

- right-click and select "Execute DPL Scripts" in the drop-down menu,

- select the DPL script "Efficiency ratio calculation".

If no expansion stages are selected, all active expansion stages are considered, then the first step of the calculation of the efficiency ratio is to determine the expansion stages for which the EffR will be calculated. Generally, only the expansion stages:

- in active variations,

- that are not excluded from activation,

- whose investment costs are greater than zero,

- whose activation time lies after the start of the study time period determined by the input parameter $iStartYear$,

- whose activation time lies before the end of the study time period determined by the input parameter $iEndYear$, are considered.

If a "General Selection" with set of expansion stages or variations is selected, then the only participating expansion stages are those satisfying the above criteria and contained in the general selection of the DPL script. In case an inactive variations is selected, then its expansion stages are considered for the calculation of efficiency ratio. The expansion stages are activated for during calculation and deactivated at the end.

The participating expansion stages are calculated one after the other. The rest of this section describes the steps for the calculation of the EffR of one of such an expansion stage.

Determination of calculation points

The EffR of an expansion stage denoted by ES is calculated for all calculation points $t_1, t_2, ..., t_n$ (where n is th number of calculation time points) determined as follows using the input parameter "iAllFeasCalcPoints":

- If $iAllFeasCalcPoints = 0$ then the EffR is calculated only for the activation time of the expansion stage. This means that n=1 and t_1 is given by the activation time of ES .

- If $iAllFeasCalcPoints = 1$ then the activation times t_{Prior} and t_{Next} of those expansion stages of the same variation as for ES with the closest activation times to the one of ES are found (only expansion stages that are not excluded from activation are considered). If ES has no prior expansion stages in the variation then t_{Prior} is given by the start of the study period. If ES has no follow-up expansion stages in the variation then t_{Next} is given by the end of the study period
The 1st calculation point t_1 is given by the activation -month, -day and -time of ES in the first year after t_{Prior}.

  The 2nd calculation point t_2 is exactly one year after t_1. This date determines a calculation point only if $t_2 \leq t_{Next}$

  ...
  The nth calculation point t_n is exactly n-1 years after t_1. This date determines a calculation point only if $t_n \leq t_{Next}$.

Calculation of benefits for calculation point t_k

To calculate the benefits in costs for losses, expected interruption costs and user-defined costs of an expansion stage ES at a calculation point t_k the following steps are executed:

1. The expansion stage ES is excluded from the TEC calculation.

2. TEC is executed with the setting: *Calculate → "for user-defined dates"*. The table used for calculation time points has two dates, t_k and $t_k + 1$ year.

3. After TEC (without the participation of ES) the following costs are available in the result file of the TEC command (calculated according to the settings of the TEC command)
   - Cost for losses are stored in the parameter $Cost_{Loss}^{noES}(t_k)$.
   - Expected interruption costs of this calculation are stored in the parameter $EIC^{noES}(t_k)$.
   - The user-defined costs are stored in the parameter

4. The ES is enabled - flag "Exclude from Activation" disabled and its activation time is set to t_k. The technical economical calculation is executed again with the same settings as in 2.

   This yields costs for losses $Cost_{Loss}^{ES}(t_k)$, expected interruption costs $EIC^{ES}(t_k)$ and user-defined costs $Cost_{user}^{ES}(t_k)$ with the expansion stage ES participating.

5. The benefits in costs for losses, expected interruption costs and user-defined costs at time t_k are calculated using equation 2.

6. The efficiency ratio EffR in % of expansion stage ES for calculation point t_k is calculated using equation 3.

1.3 Efficiency Ratio Calculation Results

The result report for the Efficiency Ratio Calculation is divided in the following sections:

- Calculation steps.

- DPL script settings for the calculation.

- Table of participating expansion stages with the corresponding variations and calculation points.

- Table with calculated values of efficiency ratios in % for the expansion stages.

The table with calculated values of efficiency ratios has results for each expansion stage and these include:

- the calculation points,

- the investment costs,

- the benefits due to:
  - load and no load losses
  - interruption cost
  - user defined costs
  - and additional costs

- the efficiency ratios.

Negative values of the efficiency ratio indicate that there are absolutely no cost benefits due corresponding expansion stages. If there is some benefit the values are positive. The higher these values are, the more preferable an investment should be carried out and this is also an indication that such an investment could be carried out earlier as planned.