# Dimensioning of
# Secondary Reserves

October 2020

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## Acronyms

The below table lists acronyms used in this document.

| | |
|---|---|
| DEA | Danish Energy Agency |
| EVN | Electricity of Vietnam |
| ERAV | Electricity Regulatory Authority of Vietnam |
| NLDC | National Load Dispatch Centre (Vietnam) |
| ACE | Area Control Error |
| LFC | Load Frequency Control |

# 1. Introduction

In 2019 in the DEPP cooperation between ERAV, DEA, NLDC and Energinet, methodologies for dimensioning of secondary reserves in Vietnam and Europe respectively were evaluated. This is presented in the Deliverable 2.5 from 2019. Chapter 2 in this present report offers a specific suggestion for how to include both methods in an eventual future revision of the provision ('Decision') that instructs how to dimension reserves in the Vietnamese transmission and distribution system. I.e. the passages given can be inserted into the provision verbatim.

Chapter 3 is a user guide for a tool developed in the cooperation, to calculate the need for secondary reserves in line with the methodology suggested implemented in chapter 2. The methodology is to convert frequency deviations into an imbalance measured in Watt. This imbalance indicates the size of the power deficiency causing the frequency deviation, and hence the reserves theoretically necessary to eliminate it. The tool is developed in excel.

The ACE method for dimensioning and balancing an electricity grid, leans on the principle that subdivisions of the grid balance themselves. If this local balancing meets certain performance criteria, the whole grid will be adequately balanced. The subdivisions will naturally follow borders of typically uncongested areas.

LFC – Load Frequency Control – the term pertains to the frequency containment and frequency restoration processes.

LFC-area is a partitioning principle used in the synchronous area (SA) of continental Europe and the synchronous area of the Nordic European countries. The frequency restoration control error (FRCE – also called Area Control Error (ACE)) is calculated and monitored on LFC-area level.

LFC-block is a level higher in the LFC hierarchy. An LFC-block consist of a number of LFC-areas. In the Nordic synchronous area, there is only one LFC-block, meaning that the Nordic SA is equal to the Nordic LFC-block. The dimensioning of frequency restoration reserves (FRR) and replacement reserves (RR) takes place on the LFC-block level.

| Obligation | Monitoring Area | LFC Area | LFC Block | Synchronous Area |
|---|---|---|---|---|
| Online calculation and monitoring of actual power exchange | MANDATORY | MANDATORY | MANDATORY | MANDATORY |
| Calculation and monitoring of the Frequency Restoration Control Error | NA | MANDATORY | MANDATORY | MANDATORY |
| Frequency Restoration Process | NA | MANDATORY | MANDATORY | MANDATORY |
| Frequency Restoration Quality Target Parameters | NA | MANDATORY) | MANDATORY | MANDATORY |
| FRR Dimensioning | NA | NA | MANDATORY | MANDATORY |
| RR Dimensioning | NA | NA | MANDATORY | MANDATORY |
| Frequency Containment Process | NA | NA | NA | MANDATORY |
| FCR Dimensioning | NA | NA | NA | MANDATORY |
| Frequency Quality Target | NA | NA | NA | MANDATORY |

*Figure 1.  Characteristics of LFC-area versus LFC-block.*

# 2. Proposal to revise Decision 106/QD-DTDL

In order to implement new calculation methodology, Decision 106/QD-DTDL needs to be amended and supplement with some applicable definitions and instructions, specified as below:

  a. **Article 3** shall supplement the definition of Area Control Error (ACE)

"Area Control Error' or 'ACE' means the sum of the power control error ('$\Delta P$'), that is the real-time difference between the measured actual real-time power interchange value ('P') and the Control Program ('P0') of a specific LFC Area or LFC Block and the frequency control error ('$K*\Delta f$'), that is the product of the K-Factor and the Frequency Deviation of that specific LFC Area or LFC Block, where the area con-trol error equals $\Delta P + K*\Delta f$.

b. **Article 13** shall supplement clauses to select a plan to calculate the capacity reserve for primary frequency control and the automatic secondary frequency control reserve, which includes:

The capacity reserve for primary frequency control for the next year, next month, and next week cycle is calculated by two methods: simulate the initial operating state of the power system (specified in Appendix 2 of this procedure) or ACE method (specified in Appendix 5 of this procedure).
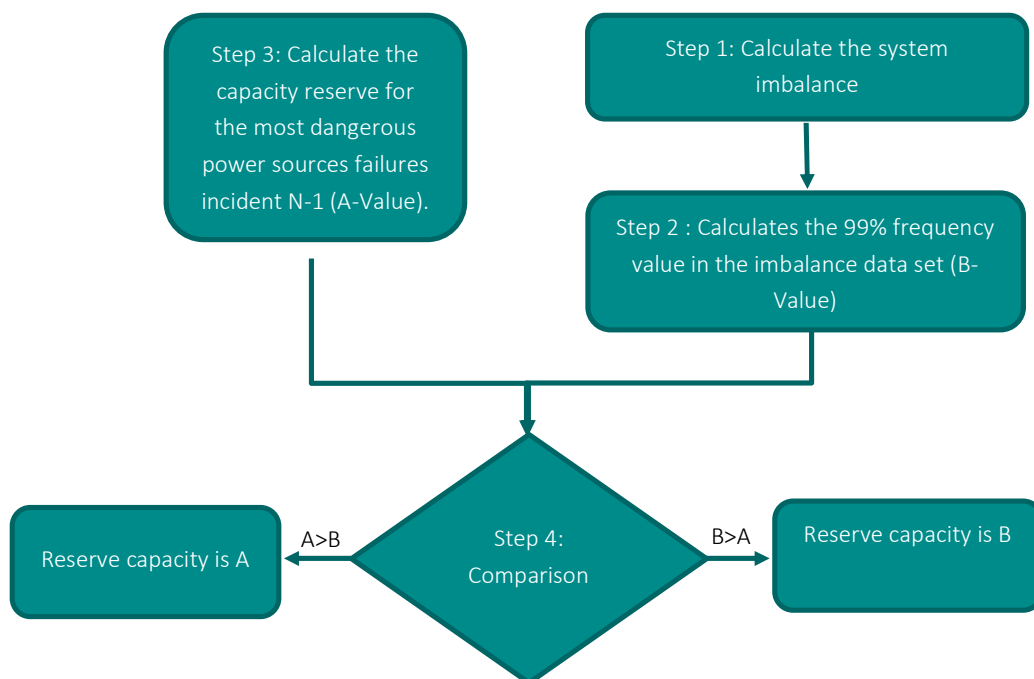
c. **Annex 5**:
- Step 1: Calculate the system imbalance.
  Collect high resolution (<10 sec) data on the imbalance and frequency deviation value.
- Step 2: Calculates the 99% frequency value in the imbalance data set (B-Value)
  Filter and sort to find the 1% and 99% frequency value. Then, determine the value of the capacity guarantee 99% probability.
  Step 3: Determine the capacity reserve for the most dangerous power sources failures incident N-1 (A-Value). This problem is usually identified as the largest power supply problem in the system.
- Step 4: Compare the values in steps 2 and 3.
  Then, determine the need to adjust the applicable frequency as the larger value between the two above values.

Methodology to calculate frequency adjustment capacity reserve applied for Area Control Error (ACE) is specified as below:
   i)    The capacity reserve calculation is based on historical parameters of the imbalance over a one-year period for the yearly plan and the previous one month for the monthly plan.
   ii)   Calculate the system capacity reserve in case of the most dangerous N-1 incident (A-value)
   iii)  Calculate the imbalance of the system according to the frequency deviation of each data point collected and static characteristic of the system.
   iv)   Calculate the guaranteed 99% of imbalance values of the system in the 1-year or 1-month data set at c) less than or equal to this value (frequency 99%) (B-value )
         The applicable frequency adjustment capacity reserve is the larger of the two values A and B

Annex: Methodology to determine reserve capacity

## 3. Imbalance Calculation tool

The imbalance calculation tool has ability to open all CSV files and calculate imbalance data automatically. Next, it would return all the calculated data to "master file" or Version 2.1.2.xlsm and draw imbalance chart. From the imbalance calculation results, NLDC will determine the need for frequency modulation backup.

The developed tool calculates the active power imbalance (MW) by using the formula provided in Deliverable 2.5 (2019) as below:

$$\Delta P = (f - f_n) \times K$$

Where:

$\Delta P$: active power imbalance (MW)

$f$: measured frequency (Hz)

$f_n$: Nominal frequency (50 Hz)

$K$: Frequency dependent load (MW/Hz), assuming K = 100MW/0.1Hz based on historical incidents.

aFRR requirements are calculated for both side (up regulation and down regulation), being the lower limit and upper limit respectively. The upper limit and lower limit are the values that have an accumulated probability of 99% in the imbalance samples (calculated from provided historical frequency bias).

Open tool, the file was named as Version 2.2.2.xlsm, the user interface might be not started yet, please press Crtl + R to run it again. User interface of the tool as the figure below:
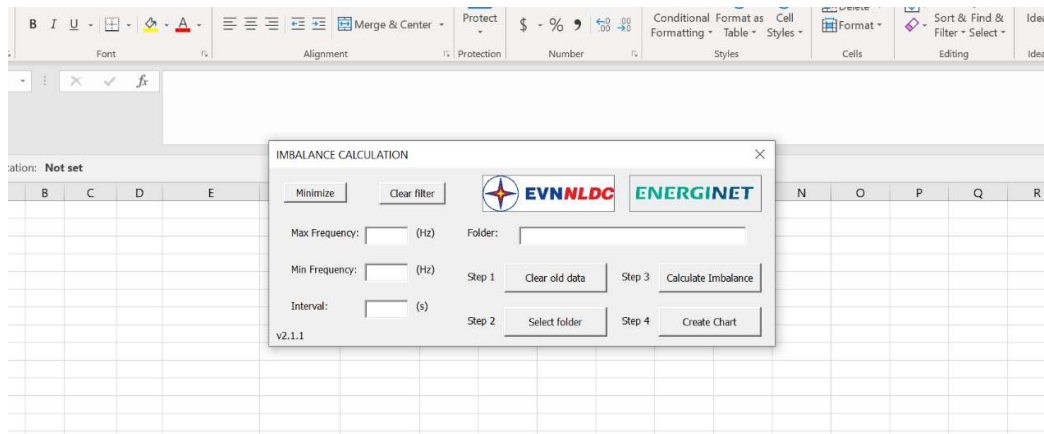


*Figure 2.  User interface*

Functional buttons with the detailed description as below:

- **Minimize/maximize**: the button has ability of minimize the User interface, which allow user is more convenient to handle data cells and charts
- **Clear filter**: click button to clear all input data including max frequency, min frequency, interval and folder location.
- **Max frequency**: fill up to set the maximum value of frequency, the tool would delete all higher value
- **Min frequency**: fill up to set the minimum value of frequency, the tool would delete all lower value
- **Interval**: the lagged time value, all lagged time data would be deleted by the tool before calculating
- **Folder**: the address of source data

*Step 0:* Fill in all required input value.

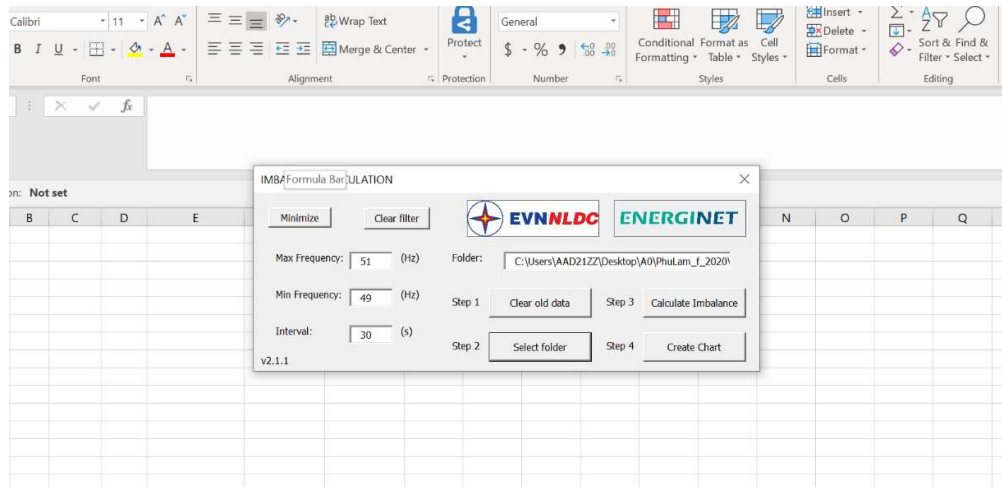*Step 1:* Click **"Clear old data"** to clear all old results before start to perform the tool.

*Figure 3. Clear all data*

**Step 2:** Click **"Select folder"** to select folder address which be used to calculate imbalance data.

**Step 3**: Click **"Calculate imbalance"** to start the calculating of imbalance values. The result would be exported to master file as below.
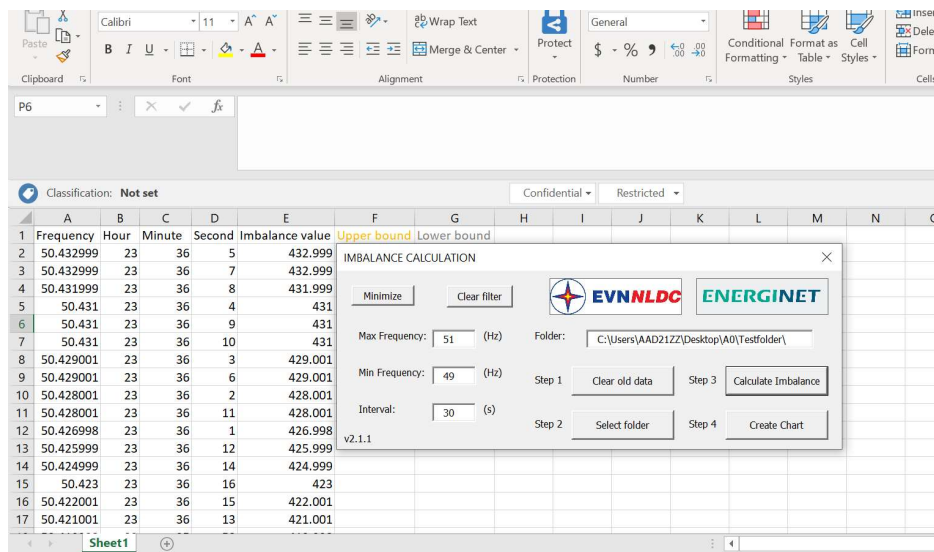


*Figure 4. Calculate imbalance*

**Step 4**: Click **"Create chart"** to start the drawing of imbalance chart. The result would be exported to master file as below.
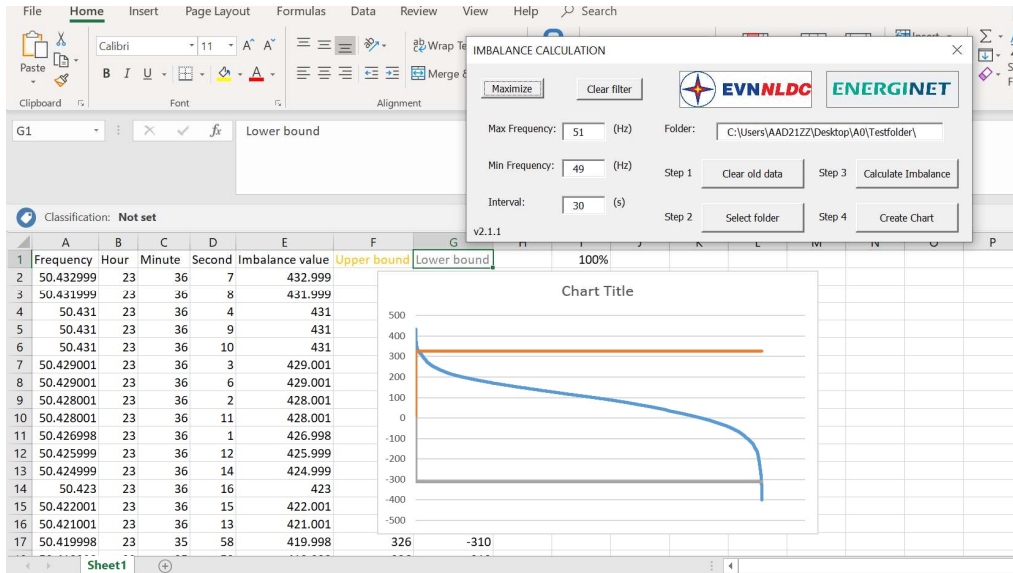
*Figure 5. Create chart*