User Guide

I. Requirements

Before start using the tool, please consider if all requirements are accomplished to run simulations without problems:

1. Input files

Before running the tool it is necessary to put all required files in the "Input" folder inside the root folder of the tool. Those files have to be in the same format and directory according to example files. Please consider that the tutorial files use reference Cartesians coordinates from Portugal – ETRS89. However, different coordinates can be used in custom-made case-studies. For a better GUI presentation, the data presented in case-studies shall be in neighboring locations.

a. File "Dados_Input.xlsx":

All simulations need this file which has the features of each segment between vertex towers. Every region under study has its own file, so, it only should be changed in the case of a need to modify the number of segments or lines under study.

b. File "caracteristicas_condutores.xlsx":

To perform simulations, the features of all types of cables presented in file "Dados_Input.xlsx" of each region have to be in this file, which are in the directory "root\Input\Others\". In case of a need to introduce new types of cables, those should be added to this file considering the data format of the other cables.

Every cable type has its own code from 1 to n, being n, the number of different types of cables. These cables' codes have to be the same code of the ones presented in files "Dados_Input.xlsx".

c. Weather data files:

These files must have the same format and features of the files provided as exemple. Depending on the initial day and temporal horizon under simulation (Day-ahead, Real-time, Historical) these input files must be at "root\Input\"region"\"day"\"temporal horizon"\". Also, to be automatically loaded by the program they need to have an exact name format: "DLR_CaseStudy"region""segmentnumber"_"discretization".mat". The discretization considers the distance between segments, which in all case-studies is 3000m.

To run simulation there is a need of at least 24 hours of weather data (wind speed (m/s) and direction (^{O}), ambient temperature (^{O}K) and irradiance (W/m^2)). In case of having historical yearly data in directory "root\Input\"region"\"01-01-yyyy"\Historical\" , this data can be used instead of putting the data in the respective folder of the day under simulation.

The quality of the data depends on the user. To simulate "Day-ahead" DLR, should be used adequate forecasts and in "Real-time" observed data. "Historical" simulations may

consider both forecasted and observed data, since the consistency is guaranteed along the simulation, i.e., only using forecasts or observed data on each simulation

d. File “Altitude”discretization”.xlsx”

This file contains the altitude (m) of each line segment. It has to be in the same directory of the “Dados_Input” file. Because different segment discretization can be used to simulate the same region, the discretization has to be part of the file name, to be automatically selected by the tool.

e. File “borders.txt”:

This file has the ETRS89 coordinates of the border between Portugal and Spain in directory “root\Input\Others”. It can have different type of coordinates and can be adapted to other case-studies. This file is very important to define the GUI limits of the case-study.

f. File “stations.xlsx”:

This file has the ETRS89 coordinates of the wind parks, hydropower plants, PV, substations and other geographic locations that users want to add, with codes “Wind Park”, “Hydro”, “Wind Park”, “PV” and “Labels” in the first column of the file. The “Labels” can be the name, number or both that users want to present in the interface. The second and third columns have the ETRS89 coordinates of the requires geographic locations.

2. Output Files

The tool creates folders considering the simulation set-up. So, before running the tool the user does not have to consider the necessary folders. It creates the output files in the directory “root\Output\”. The output files are saved in the folder considering the simulation set-up with the following structure “root\Output\”region”\”day”\”model”\”defined name”.xlsx”

In case of repeating the same simulation set-up and choosing the same name for the input file, the program will ask if the user wants to rewrite the file or rename the new file.

II. Installing the tool

The executable files “MyAppInstaller_web” or “MyAppInstaller_mcr” have to be installed in your machine and all supplied input files may be left in the root file of the “OptiRESLinesOA.exe” runner or be replaced by alternative files produced by the users. This file will install the Matlab runtime, which is necessary to run the tool. It is possible to run the tool without a Matlab license.

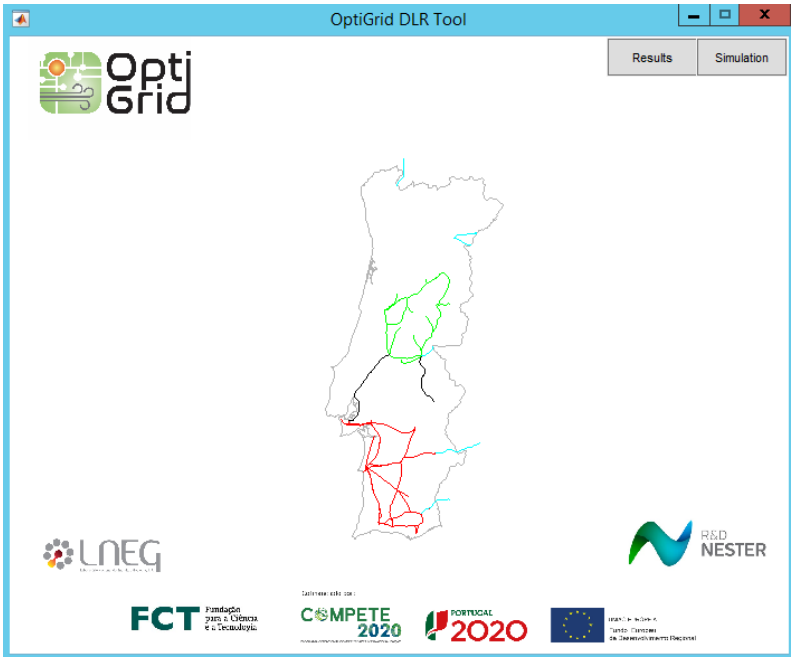
PS: Users may create a shortcut or put the tool runner in the directory they want, but all required files have to be located in the root folder of the shortcut runner.

III. Using the tool

After installing the tool and complying with all requirements, users can start using the tool.

The tool starts presenting the interface where is possible to run a simulation or to present past results.

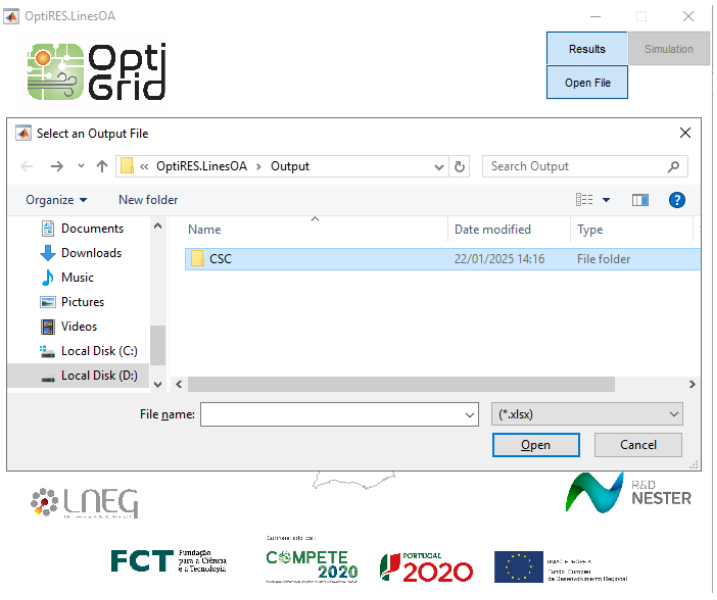
1. Initial interface:



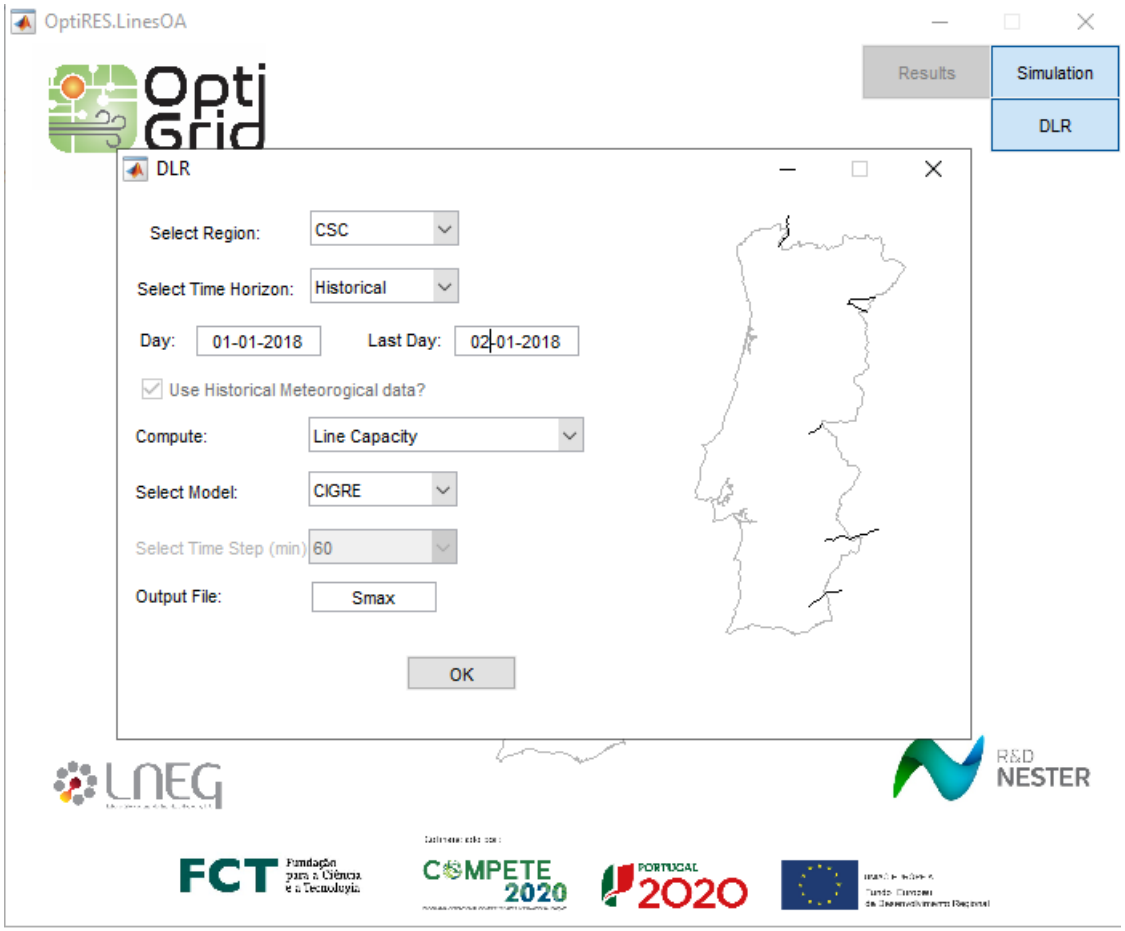
In the initial interface the users have two options, or present past results by clicking in "Results" and then in "Open File". To perform simulation user may click first in "Simulation" and then in "DLR".

2. "Results->Open File"

The tool automatically indicates users to select files in the directory with folders of different regions/case-studies with historical results. Users should select an excel file obtained using the tool or a created file with exactly the same structure of the tool files, otherwise, some errors may avoid opening, manipulating and presenting the results of the selected file. The results are dynamically presented and georeferenced as can be illustrated in the next section of this manual.



3. “Simulation->DLR”:



The users may set-up the simulation considering the following options:

i. “Select Region”:

Users may select the region to simulate considering the following options: “CSA”, “CSB” and “CSC”.

ii. “Select Time Horizon”:

Users may select the time horizon that want to simulate between “Day-ahead”, “Real-time” and “Historical” and have the required input files in the respective input folders.

When putting the day to simulate it should have the format “dd-mm-yyyy”.

In case of selecting a “Historical” simulation users have to indicate a “Last Day” after the initial “Day” with the previous format.

If selecting the option “Use Historical Meteorogical data” the tool instead reading the meteorological data from the folder of the selected day to simulate, it will read the tha data of this day of the respective yearly data in the directory “root\Input\”Region”\01-01-yyyy\Historical”

This option allows users to use one single folder with annual data instead of several folders with daily data.

iii. “Select Model”:

Users may choose between the DLR reference “CIGRE” and “SLR” (TSO design) that uses static and seasonal weather conditions. The “SLR” model is obtained from the “Dados Input” file and all the other models are compared with this TSO design. The DLR models need meteorological data as input while the other models run without this data.

iv. “Output File”:

The user may select the required name for the output file. In case of existing a file with the same name in the same output folder, the tool asks the used to select between rewrite the file or rename the new file.

v. Data in the Output file

The format of the excel file change according to the selected model, between SLR and DLR models.

The first sheet of the excel file contains the information about the simulation set-up.

In case of selecting a SLR model, the second sheet has the static/seasonal maximum capacity of each line.

In case of selecting a DLR model, more sheets are added with: i) the maximum ampacity, ii) the “DLR Sector”, which is the line segment that defined the DLR of the line, iii) the “DLR Upgrade (%)”, which is the relative difference between the DLR and the TSO’s designed capacity of the line (SLR), iv) the “Critical Sector”, which presented the sectors when DLR<SLR, v) “DLRk (%)” which presents the relative difference between the DLR and SLR per line segment. In case of a high number of line segments the information of their DLR Upgrade is saved in a “.mat” file. The lines are presented by their code and the name of substations they connect.

vi. Dynamic presentation of results

All results are dynamically presented in a georeferenced interface.

IV. Presenting the results in the tool interface

When running the DLR simulation besides saving the results in an excel file, the tool presents an interface with the results of the simulation. When presenting this interface exists the option to load and compare past results by clicking on “Open File” and the select “Compare Results”. These results have to be in the format created by the tool, such as the files it saves in the directory “root\Output\”. The tool indicates to the user to select a file in this folder.

a. Georreferenced data:

In the left side of the interface is possible to see a figure with the type and location of the lines in the region under study (indicated in the top of the figure) with the critical sectors obtained for the simulation set-up (presented with black crosses). By selecting the options on the bottom of the figure “Wind Parks”, “Solar”, “Hydro”, “Substations” and “Labels” is possible to load and present the geographical location of these items saved in the “station.xlsx” file for the region under study. In case of selecting the “DLR

Gain" option it opens the color map on the right side of the figure and presents the georeferenced DLR gain of each segment in the figure. In case of selecting to compute SLR models, the "DLR Gain" options will not be available.

Is also possible to do a left click with the mouse in a specific segment and present its line code, the substations it connects, the line capacity and the DLR gain of both the line and the selected segment (cursor mode).

In case of selecting a "Historical" time horizon, only the critical sectors with the highest incidence taxes per line are presented per each hour under study.

PS: The cursor mode is incompatible the other features that can be used with the mouse, such as zoom in or zoom out. The other feature can be selected by doing a right click with the mouse, disabling the cursor model.

b. Results presented in the right table and figure of the interface:

In case of simulating SLR models it is only presented the maximum capacity of the lines power hour in the table. In the figure it is only presented the maximum capacity per line, since it is constant along the day.

In case of simulating DLR models it is presented in the table per line and hour the maximum capacities and ampacities, the sector which defines the DLR, the relative "DLR Gain (%)" between the computed DLR and the SLR, and the weather conditions that defined the DLR of each line. These options can be selected in the top of the table, which is also reflected in the information presented in the figure bellow. If all options are selected is presented the maximum capacity and the DLR Gain per hour of each line or only one hour/average hourly values of all line. These results and the maximum ampacity are the only ones presents in this figure.

In case of doing a "Historical" simulation instead of presenting the critical zones in the table, it will be presented the most critical zone per hour and line, their frequency of occurrence and their weights in relation to other critical zones. These critic zones may be presented in the figure bellow in the case the "DLR Gain" option is not selected but the "Critic Zone" is.

In the bottom of this figure is possible to open a file by clicking on "Open File". The selected file need to have the same format of the files created by the tool and exactly the same number of lines and segments of the performed simulation. The results of the saved file will be compared with the simulated results with exception to the weather data and each segment DLR gain. These options are available for "Day-ahead" and "Real-time" simulations.

c. Results opened when clicking "Results->Open File"

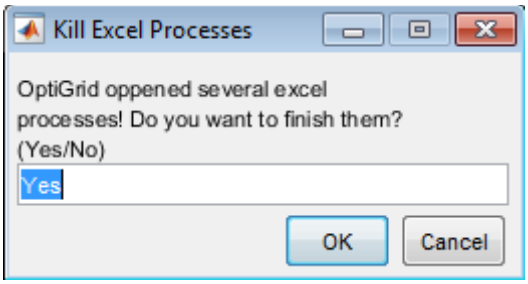
When opening files is possible to present all the results presented in the simulations with exception to the weather conditions.

V. Errors and closing the program

Missing data and closing menus will lead to diverse messages advising for the possibility or not of using all resources of the tool

When using the tool, several “Excel” processes can be opened and let the machine running slow. So, the tool asks the user to close all excel processes, which is advisable in the case all open excel files have been saved.

PS: Do not accept this suggestion in case of having an excel file open because the work performed in not saved excel files may be lost.



NOTE: If the tool is open and performing write and read operations in excel files, may be difficult to open new excel file. However, users may not have any problem in excel files previously opened.

VI. Tutorial

All data required to run the “CSC region during the first two days of 2018 is available considering the tie lines connected between Portugal and Spain.

When the program asks to select a file with the data from “CSA”, “CSB” or “Custom” click cancel if you do not have the data, because the data is not provided in this Tutorial.

Please check the organization of the tutorial data to create custom-made case-studies in the “Custom” folder.

NOTE: For a better GUI presentation, if the custom-made data is not on the neighboring of CSC, please replace file “Dados_Input.xlsx” of CSC