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WIND REPORT

nameWF wind farm

powerWF MW

territorial3, territorial2

dateTime

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Project summary

|  |  |
| --- | --- |
| Name of project | nameWF |
| territorial2Key | territorial2 |
| Territorial3Key | territorial3 |
| ISO | ISOvalue |
| Project Developer | pdName |
| TO manager | TOMname |

Table 1. Main project information.

Wind farm key issues

|  |  |
| --- | --- |
| Average wind speed | windSpeed m/s |
| Turbine model | turbineModel |
| Turbine power | turbinePower MW |
| Total power | powerWF MW |
| Annual production | anualProd MWh |
| Capacity factor | capacityFactor % |
| Equivalent hours | equivalentHours h |

Table 2. Wind farm key details.

# Introduction

The aim of this report is to present the main features of the nameWF wind farm of powerWF MW, located in territorial3, including the site wind resource, the wind farm configuration, and the estimated energy production. This information will allow to assess the technical viability of the wind farm and to draw conclusions about its profitability.

## Methodology

To obtain the wind resource estimation an analysis has been carried out using the software softwareWind.

The starting wind data has been obtained from the climatological reanalysis model modelWind, including wind speed and direction values over numYears years, from yearMinus to currentYear. The modelWind database also provides temperature and pressure records which will be used to build the wind model.

For modelling the site, elevation data has been downloaded the database ASTER and surface roughness values have been estimated using the land uses database GlobCover.

The simulation with softwareWind provides a model of the wind resource at the project site and an estimation of the results of energy production of the wind farm.

# Site analysis

## Site features

The project will be placed at territorial3, territorial2 territorial2Key. The coordinates of the center of the plant are shown in Table 3, in decimal degrees and in UTM coordinates (Zone husoUTM).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Wind Farm | Latitude | Longitude | x UTM | y UTM |
| nameWF | latProj | longProj | longUTMProj m E | latUTMProj m N |

Table 3. Coordinates of the center of the plant.

In Figure 1 a map of the project location is shown, including the mentioned center of the plant:

|  |
| --- |
| aerialCut |

Figure 1. Wind farm location

The mean altitude of the site is around altProj m, making it an appropriate place for the wind resource exploitation.

## Wind farm description

The wind farm described in this report will include numTurbines wind turbines of turbinePower MW each. The wind turbines are the machines which allow the transformation of the wind energy into electricity. The turbine model is selected so its properties best adapt to the wind resource of the site. For this project the turbine model choice is the turbineModel.

An image of the selected turbine model is shown in Figure 2.

Diagrama, Dibujo de ingeniería

Descripción generada automáticamente

Figure 2. Photography of the wind turbine model.

The main features of this turbine are listed in Table 4.

|  |  |
| --- | --- |
| Turbine model | turbineModel |
| Hub height | hubHeight m |
| Rotor diameter | rotorSize m |
| Power | turbinePower MW |

Table 4. Features of the selected wind turbine.

In Figure 3 the power curve of the selected model is shown

|  |
| --- |
| powerCurvePic |

Figure 3. Power curve of turbineModel model.

In Figure 4 the plant layout is presented, showing the outline of the polygonal of the wind farm, and the location of the wind turbines.

|  |
| --- |
| layWFout |

Figure 4. Map of the nameWF wind farm layout.

In Table 5 the characteristics of the layouts are summarized, including for each turbine its coordinates, its altitude, and the distances to the closest turbine.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| flagDf1 | x UTM | y UTM | Altitude | Closest WT | Distance to closest WT |

Table 5. Main features of the wind turbines of nameWF wind farm.

## Wind resource model

Based on the wind and meteorological data downloaded from the mentioned reanalysis database, along with the elevation and roughness maps, softwareWind calculates a prediction of the wind resource at the plant site, which is provided in the form of maps.

In Figure 5 the average wind speed map is shown. This map represents the wind potential in the site, as the energy production will be proportional to the wind speed. As it can be seen, the average wind speed at the wind farm location is windSpeed m/s.

Additionally, the wind rose is displayed in the map, which shows the frequency distribution of the wind directions. The wind directions are also quite relevant, as they will determine the directions of the turbine wakes, which are a source of energy losses.

|  |
| --- |
| windHeatMap |

Figure 5. Map of the average predicted wind speed.

In Figure 6 the average turbulence intensity map is shown. This magnitude will also affect the wake effects at the windfarm, and thus the losses concerned. The average turbulence intensity at the wind farm location is turbulenceIntensity %.

|  |
| --- |
| turbulenceHeatMap |

Figure 6. Map of the average predicted turbulence intensity.

# Energy production

The software softwareWind provides an estimation of the wind farm yearly production based on the predicted wind resource at the site and the mentioned wind farm features.

In order to obtain the final production, several losses have been taken into account, which are summarized in Table 6. These losses will be considered constant for all the turbines, as most of them are set to generic values.

| Loss | Description | Estimated value |
| --- | --- | --- |
| Wind turbine unavailability | Losses due to wind farm stops for preventive and corrective maintenance. Often low wind seasons are used for these works allowing to reduce the resulting losses. Manufacturers guarantee a 97% of technical availability. | 3% |
| Collection system unavailability | These losses refer to the possible faults of the internal electrical system which connects the turbines. | 0.25% |
| Substation unavailability | These losses refer to the substation non-working periods due to maintenance works or repair of possible faults. | 0.25% |
| Utility grid unavailability | Losses related to the connection line which carries the generated power to the grid. | 0.25% |
| **Unaviailability losses** | | **3.73%** |
| **Electrical losses** | | **3.26%** |
| Power curve fitting | Losses due to wrong fitting of the wind turbine power curve. | 1% |
| High wind hysteresis | These losses refer to the turbine shutdown due to high wind gusts. | 0.1% |
| Wind shear | Wind shear refers to the change of wind direction with height along the rotor disk. | 0.1% |
| Yaw misalignment | Losses that appear when there are fast changes of wind flow direction, and the alignment system cannot adapt the yaw angle. | 0.1% |
| Inflow angle | Losses that appear when the inflow angle increases reducing the aerodynamic performance. | 0.1% |
| **Turbine performance losses** | | **1.49%** |
| Blade degradation | Losses due to blade degradation which limits aerodynamic performance. | 1% |
| Blade icing | Losses due to ice formation on rotor blades, which reduce aerodynamic efficiency. | 0.1% |
| Low temperature shutdown | When the temperature goes beyond the operating range of the turbine the system shuts down. | 0.1% |
| High temperature shutdown | 0.1% |
| **Environmental losses** | | **1.30%** |

Table 6. Summary of main wind farm losses.

Also, the losses due to wake effects are considered, which are caused by the interaction between the turbine wakes. These effects are calculated during the softwareWind simulation. The result is a decrease of the average wind speed at the turbine positions to a value of wakeSpeed m/s. This leads to an energy loss of the wakeLoss %.

Finally, the net yearly energy production of the wind farm is anualProd MWh. This implies a capacity factor of capacityFactor % and a specific production of equivalentHours h. In the table below a summary of the energy production of the wind farm is shown.

|  |  |
| --- | --- |
| Capacity of the wind farm | powerWF |
| Number of turbines | numTurbines |
| Gross yearly production | anualProdGross MWh |
| Wake losses | wakeLoss % |
| Unavailability losses | 3.73% |
| Electrical losses | 3.26% |
| Turbine performance losses | 1.49% |
| Environmental losses | 1.30% |
| Net yearly production | anualProd MWh |
| Capacity factor | capacityFactor % |
| Equivalent hours | equivalentHours h |

Table 7. Energy production results of the windfarm.

Additionally, in table 8 the energy production results for each wind turbine are displayed:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| flagDf2 | Power (MW) | Mean wind speed (m/s) | Gross energy (MW) | Wake losses (%) | Net energy (MWh) | Net capacity factor (%) | Net eq. hours (h) |

Table 8. Energy production results of each wind turbine.

# Conclusions

In this document the nameWF wind farm project has been developed, including the description of the project site, the wind farm configuration, the main features of the wind resource, the different energy losses involved, and the yearly energy production results. For that purpose, a wind study using softwareWind has been carried out which has allowed to characterize the wind resource at the project location and model the behavior of the wind farm.

The wind farm features are gathered in Table 9.

|  |  |
| --- | --- |
| Location | territorial3 |
| territorial2Key | territorial2 |
| Turbine model | turbineModel |
| Number of turbines | numTurbines |
| Total capacity | powerWF MW |
| Average wind speed at turbine positions | wakeSpeed m/s |
| Net yearly production | anualProd MWh |
| Net capacity factor | capacityFactor % |
| Net equivalent hours | equivalentHours h |

Table 9. Summary of wind farm features and results.