Abstract:

During the planning process of a wind farm, an important aspect to be considered is the most efficient use of the available area. However, an increase on the number of wind turbines leads to a smaller distance between each turbine, which may induce a scenario in which one turbine influences negatively another, by means of the *wake effect,* thus reducing the global production of the wind farm.

Wind turbines extract energy from the wind to produce electricity, so that the *downwind* will offer less available energy than the *upwind.* Therefore, the turbine's downwind will have its velocity lowered and the flow will be turbulent, composing the so called wake of the turbine. As the wind flow distances itself from the turbine, this wake commences to dissipate and gradually retains its initial condition of flow. If a wake intercepts the area swept by a downwind turbine, this turbine is said to be "shadowed" by the wake provoking turbine.

In light of the impact of the wake effect on a wind farm's capability of generating electric energy, this work presents the development of a layout optimization algorithm of wind farms. Given the wind's condition, the characteristics and the number of wind turbines, this algorithm determines the optimal position of each turbine, so that the wind farm's efficiency is maximized.

The present work starts off by bringing forward the main models of flow utilized to describe the wake effect – the Ainslie and Jensen's models – and indicating the criteria on which the choice of each of the models is based. The decision of the most adequate model depends on various factors, such as: desired computational time, the precision of the aimed forecast and the available parameters for the wind's modeling.

Thereafter, this work not only presents the genetic algorithm developed, highlighting its main characteristics of functionality, but also the fundamentals of its elaboration and utilization. The developed algorithm was based on validated models and a growing complexity procedure, in a way that the results of each step of the procedure are verified to guarantee the quality of the following step.

The following work also presents the verification of the final algorithm and its comparison with commercial software. This process is structured on layout efficient comparison, capacity factor and annual electric energy generation. The obtained results show the efficiency of the developed algorithm that on account of its low cost and simplicity can be used in a preliminary manner on different works, aiming the optimization of a wind farm's production, showing itself to be a useful tool on initial project estimates for the implantation of wind farms.

As an innovation, the work brings up the use of the modeFRONTIER software as an optimization tool, the implementation of the wake iteration calculation, and the usage of a variable *thrust coefficient*. This is a work on a simple and consistent language, theoretically well-grounded and that presents the optimization tool by genetic algorithm in a clear, simple manner.