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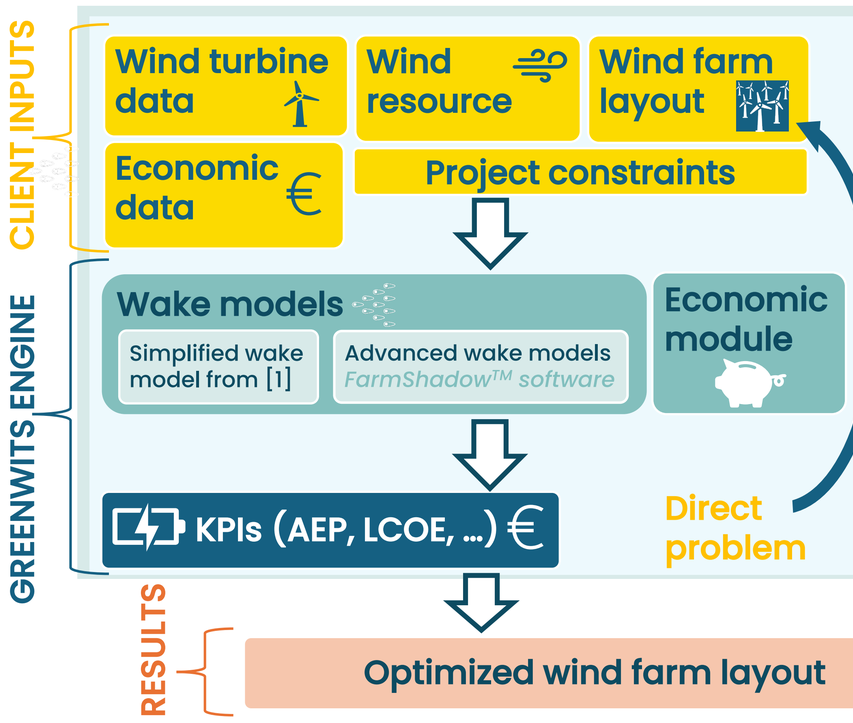
OptiWITS: a smart solution for wind farm layout design

G. Coppin[1], P. Bozonnet[1], D.Rahon[1], P. Malisani[2], T. Bartement[2]
[1]GreenWITS, [2]IFP Energies Nouvelles, contact: Gisele.coppin@greenwits.com

More details available online

Concept

OptiWITS is a digital solution to quickly get the best wind farm layouts based on advanced algorithms optimizing relevant KPIs.



Optimization problem

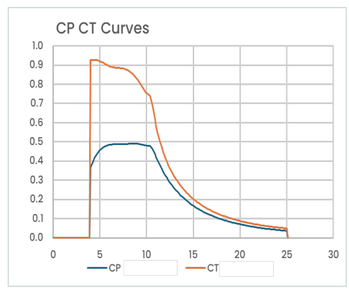
Optimization algorithms

- Suited to complex zones and alignment constraints
- Ranked #1 in IEA-Wind benchmark [1]
- Proprietary and patented algorithms

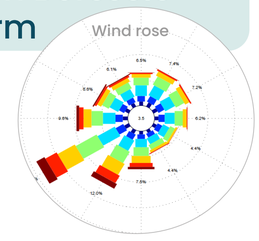
Use Case

Based on Borssele wind farm and on IEA Wind study [1].

Input data



- Turbine: IEA 10 MW[1]
- Wind rose from [2]
- Baseline layout: based on Borssele wind farm



Optimization constraints

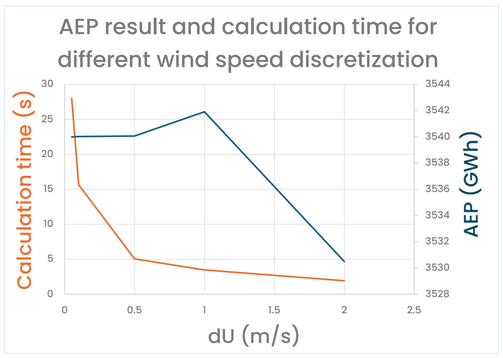
Optimization constraints:

- 77 wind turbines
- Boundaries from [1]
- Minimum inter-distance: 2 diameters
- Alignment constraints

Optimization

Wake model and optimization tuning to efficiently get the best layout.

Wake model tuning

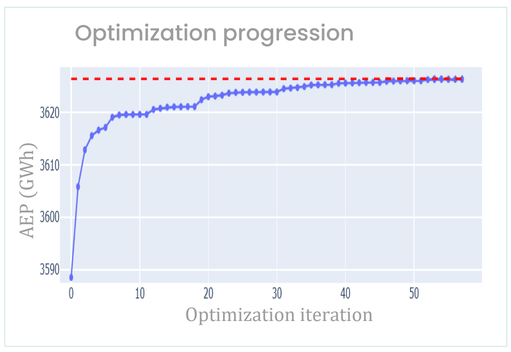


The wake model is tuned to get the best trade-off between accuracy of the AEP and calculation time.

Tuned parameters:

- Discretization of wind direction and speed bins
- Rotor discretization
- Influence zone of the wake

Optimization tuning



1 iteration = all the turbines are successively moved in an exploration grid

The optimization parameters are tuned to minimize the calculation time while ensuring a large exploration of space.

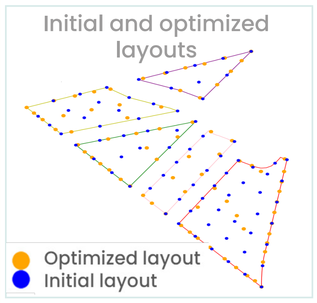
Tuned parameters:

- Initial exploration distance
- Decay rate for this distance
- Exploration grid Discretization

Results

Optimization is run without and with alignment constraints.

Non-aligned optimization

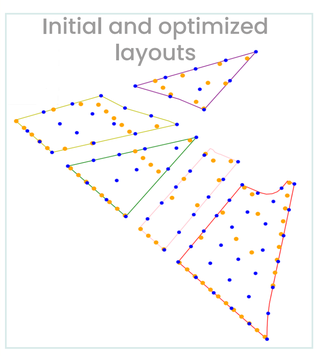


Optimization performed for 2 levels of wake model accuracy:

- **Simplified wake model**
  → Run time: 10 s → AEP Gains*: +2 %
- **Advanced wake models**
  → Run time: 28 h → AEP Gains*: +2.4 %

**Computed with advanced wake models*

Aligned optimization



2-step algorithm:
1. Definition of grid parameters (grid orientation angles, grid spacing)
2. The 77 turbines are optimally located among the grid intersections

Optimization run with **simplified wake model** only (calculation time challenge)
→Run time: 8 min → AEP Gains*: +1.6 %

➔ Optimizer converges on a fine grid, allowing a lot of possible turbine locations

Conclusion

Non-aligned optimization is fully operational: wake model choice allows trade-off between computation time and optimization performance. Aligned optimization is operational for simple wake model.

Perspectives

- Solution currently available as a service ➔ software solution under development
- On-going work to enable aligned optimization with advanced wake models

References:

1. Thomas, J. J., et al. A comparison of eight optimization methods applied to a wind farm layout optimization problem, Wind Energ. Sci., 8, 865–891, https://doi.org/10.5194/wes-8-865-2023, 2023.
2. Site studies wind farm zone Borssele, Metocean study for the Borssele Wind Farm Zone Site III, Netherlands Entreprise Agency, 2015.