Optimal techno-economic design of small and medium wind turbines

GHENT UNIVERSITY

Simon De Zutter, Jeroen D.M. De Kooning and Lieven Vandevelde

Ghent University (Belgium), Electrical Energy Laboratory (EELAB)
Department of Electrical Energy, Systems and Automation (EESA)

Introduction

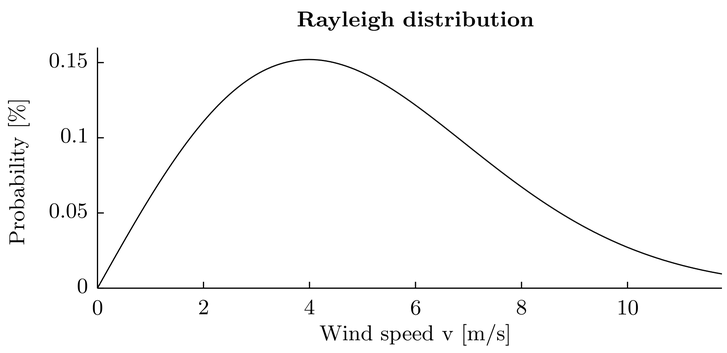
Small and medium wind turbine technology is still immature. This research focusses on enhancing the cost-effectiveness of these turbines. As a first step an algorithm was developed which evaluates economic performance of small and medium wind turbines.

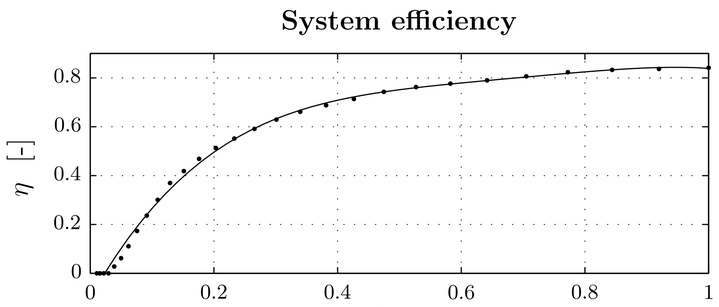
Input

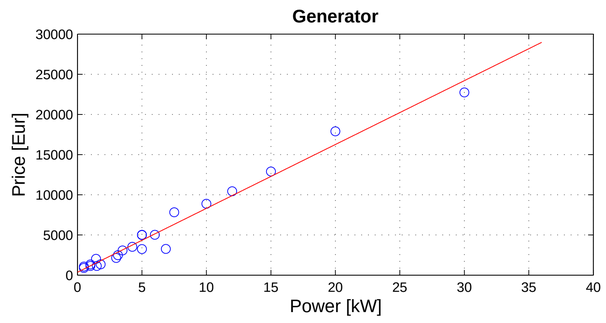
Basic assumptions and input data of the algorithm:

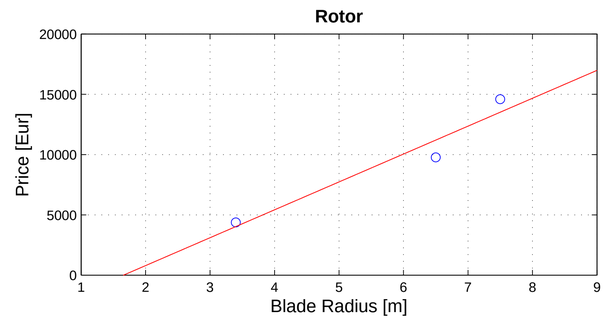
- Wind speed is modelled using a Rayleigh distribution.
- Real price data is used to calculate costs.
- Efficiency of different operating points is taken into account.

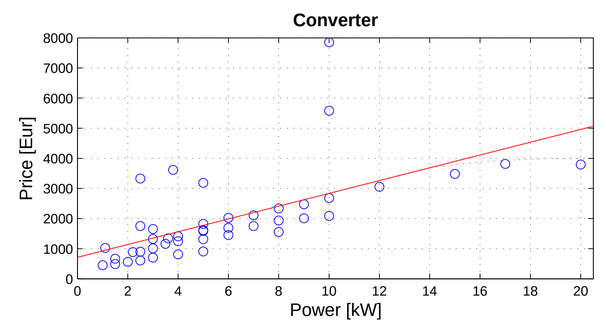
Basic assumptions and input data

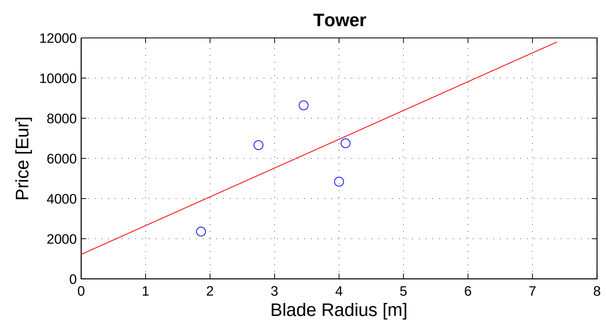












Processing

Annual energy yield:

$$\sum_{u=v_{ci}}^{v_{co}} 8760 \cdot \boldsymbol{R}(u) \cdot \boldsymbol{P}_t(u) \cdot \eta\left(\boldsymbol{P}_t(u)\right)$$

Investment costs:

$$\boldsymbol{f}(\boldsymbol{P}_n, \boldsymbol{R}) = \boldsymbol{\alpha}_{ex}(\boldsymbol{a} \cdot \boldsymbol{P}_n + \boldsymbol{b} \cdot \boldsymbol{R} + \boldsymbol{c})$$

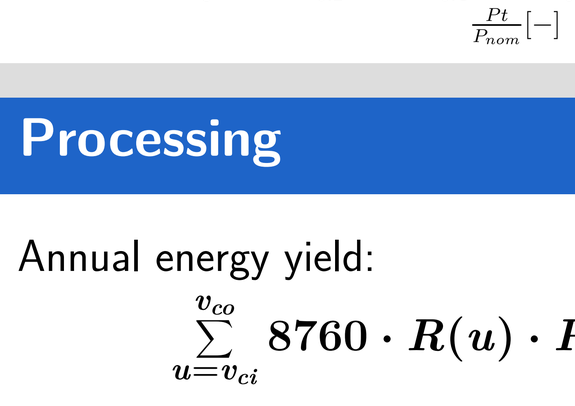
Cost function uses linear fits of data. Additional factor $\boldsymbol{\alpha}_{ex}$ for extra costs.

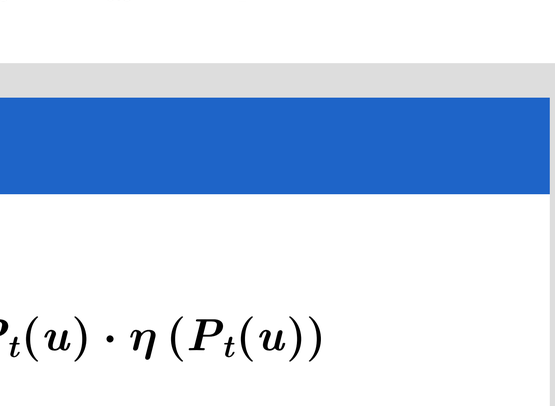
Output

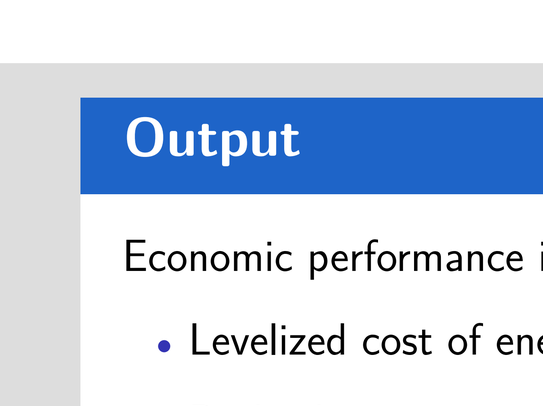
Economic performance is given by:

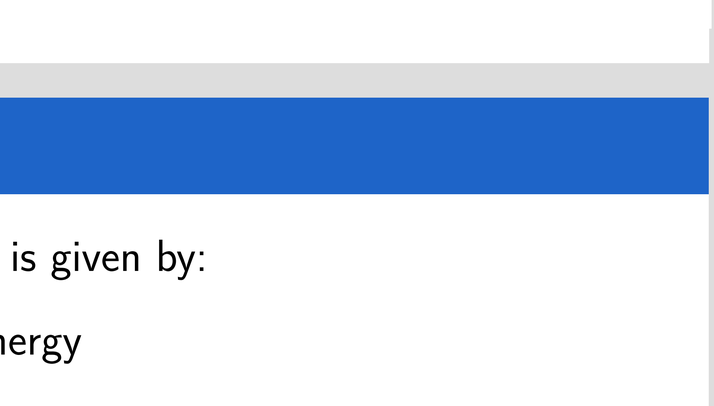
- Levelized cost of energy
- Payback time
- Internal rate of return
- Capacity factor

Results









Conclusion

There is room for economic improvement of small and medium wind turbines when different design choices are made. The next step in the research is to explore certain new design choices which render good results in the economic assessment algorithm.