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# Aerodynamic assessment of airfoils for use in small wind turbines

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**Abstract.** A successful blade design must satisfy some criterions which might be in conflict with maximizing annual energy yield for a specified wind speed distribution. These criterions include maximizing power output, more resistance to fatigue loads, reduction of tip deflection, avoid resonance and minimize weight and cost. These criterions can be satisfied by modifying the geometrical parameters of the blade. This study is dedicated to the aerodynamic assessment of a 20 kW horizontal axis wind turbine operating with two possible airfoils; that is Göttingen 413 and NACA 2415 airfoils (the Gottingen airfoil never been used in wind turbines). For this study parameters such as chord (constant, tapered and elliptic), twist angle (constant and linear) are varied and applied to the two airfoils independently in order to determine the most adequate blade configuration that produce the highest annual energy output. A home built numerical code based on the Blade Element Momentum (BEM) method with both Prandtl tip loss correction and Glauert correction, X-Foil and Weibull distribution is developed in Matlab and validated against available numerical and experimental data. The results of the assessment showed that the NACA 2415 airfoil section with elliptic chord and constant twist angle distributions produced the highest annual energy production.

**Keywords:** small wind turbine; blade element momentum; chord distribution; twist angle distribution; horizontal axis wind turbine; annual energy production

## 1. Introduction

Wind energy is a renewable abundant energy source which if adequately tapped can reduce the dependence on fossil fuels. Approximately 10 million MW of wind energy can be continuously harnessed. Large horizontal axis wind turbines are usually installed for electricity generation in sites with optimum wind conditions either on-shore or off-shore. These high capacity wind generators are normally connected to the electricity distribution grids, they are of dominated technology and many of them are installed in wind energy farms in operation around the world. Small wind turbines on the other hand are less efficient and not much popular because of their initial and maintenance costs and poor aerodynamic performance. Usually they are installed in small communities, in isolated and rural areas to produce electricity irrespective of favorable wind

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