International Summit on

CONVENTIONAL & SUSTAINABLE ENERGIES

March 30-31, 2018 | Orlando, USA

Ramesh K Agarwal

Washington University, USA

Aerodynamic optimization of wind turbine blades and wind energy

Wind has been used as a source of power by human society centuries before the dawn of industrial revolution. Since the beginning of the industrial age, the fossil fuels have dominated as a source of energy. Only in last couple of decade or so, because of concerns about global warming, there has been increased emphasis on using wind as a source of clean, renewable and sustainable energy source. This talk will describe the potential of wind as an important source of energy since it is available around the globe at sufficient velocities to generate significant amount of power. It is well established that the power generated by a Horizontal-Axis Wind Turbine (HAWT) is a function of the number of blades B, the tip speed ratio λ (blade tip speed/wind free stream velocity) and the lift to drag ratio (CL/CD) of the airfoil sections of the blade. The airfoil sections used in HAWT are generally thick airfoils such as the S, DU, FX, Flat-back and NACA 6-series of airfoils. These airfoils vary in (CL / CD) for a given B and λ, and therefore the power generated by HAWT for different blade airfoil sections will vary. This lecture will show the effect of different airfoil sections on HAWT performance using the Blade Element Momentum (BEM) theory. The relatively thick airfoils DU 91-W2-250, FX 66-S196-V1, NACA 64421, and Flat-back series of airfoils (FB-3500-0050, FB-3500-0875, and FB-3500-1750), both original and optimized, are considered and their performance is compared with S809 airfoil used in NREL Phase II and III wind turbines; the lift and drag coefficient data for these airfoils sections are available. The output power of the turbine is calculated using these airfoil section blades for a given B and λ and is compared with the original NREL Phase II and Phase III turbines using S809 airfoil section. It is shown that by a suitable choice of airfoil section of HAWT blade, the power generated by the turbine can be significantly increased. Calculations are presented both for uniform wind velocity and variable wind velocity by including the dynamic inflow. We also consider the wind farm layout optimization problem using a genetic algorithm. Both the Horizontal–Axis Wind Turbines (HAWT) and Vertical-Axis Wind Turbines (VAWT) of various sizes in diameter and height are considered. The goal of the optimization problem is to optimally position the turbines within the wind farm such that the wake effects are minimized, and the power production is maximized. The reasonably accurate modeling of the turbine wake is critical in determination of the optimal layout of the turbines and the power generated. For HAWT, two wake models are considered; both are found to give similar answers. For VAWT, a very simple wake model is employed. In addition, the technologies related to windmill control will be briefly discussed. The issue of intermittency of wind generated power and its integration into the grid will be discussed. The environmental concerns and cost-effectiveness issues will also be addressed.

Biography

Ramesh Agarwal has received his PhD from Stanford University in 1975 and Post-doctoral training at NASA Ames Research Center in 1976. From 1976 to 1994, he was the Program Director and McDonnell Douglas Fellow at McDonnell Douglas Research Laboratories in St. Louis. From 1994 to 2001, he was the Sam Bloomfield Distinguished Professor and Executive Director of National Institute for Aviation Research at Wichita State University in Wichita, KS. He is currently the William Palm Professor of Engineering at Washington University in St. Louis. He is the author/co-author of nearly 250 archival papers and over 500 conference papers. He is on the editorial board of 20+ journals. He is a Fellow of 18 societies including AIAA, ASME, ASEE, SAE, IEEE, APS, and AAAS among others. He is the recipient of many honors and awards.

rka@wustl.edu

Journal of Fundamentals of Renewable Energy and Applications
ISSN: 2090-4541

Sustainable Energies 2018
March 30-31, 2018

Volume 8

Page 33