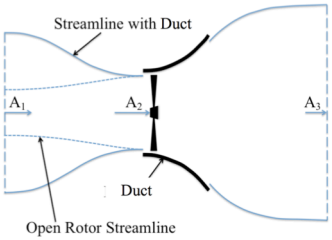
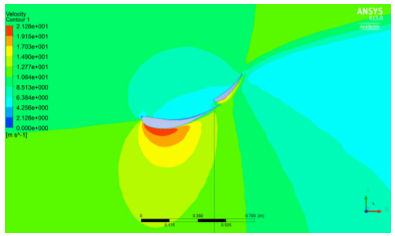
Queen's University

# The Department of Mechanical and Materials Engineering

invites you to a research seminar entitled:

# Ducted Wind Turbines: Towards Increased Energy Extraction



Dr. Ken Visser Clarkson University, Potsdam, NY, USA

Ducted wind turbines (DWTs) are created by enclosing a conventional horizontal axis wind turbine with an airfoil geometry revolved around the rotor axis. The presence of the duct increases the mass flow rate and, consequently, the power output of the turbine. The duct captures a larger stream tube than an open rotor and a substantial increase in velocity, exceeding even the free stream, is observed at the rotor face.

Recent computational studies have been conducted to optimize the design variables of a DWT and provide guidance for a full-scale prototype. A single-slotted duct geometry, using high lift airfoils designed at Clarkson, is the basis for the design. CFD simulations were conducted with FLUENT using a κ-ε turbulence model and an actuator disk to represent the rotor. Seven variables were investigated: duct and flap angles of attack, gap ratio, rotor position, pressure drop across the rotor, flap gap and flap overlap.

Two significant observations have been made. First, the optimum rotor placement that yields the highest power output for the rotor is towards the aft region edge of the duct, not in the narrowest cross-sectional area, or highest velocity position, as is often surmised. The second, and perhaps most interesting result comes about if the turbine performance is examined, not in terms of the swept rotor area, as is conventionally done, but instead using the projected frontal area (PFA). By defining the power coefficient in terms of the PFA, an equivalent ideal open rotor performance coefficient, or “Betz coefficient”, for a ducted turbine can be determined and compared directly to an open rotor turbine. To date, the current design has reached a value of 0.705, almost 20% above that of the open rotor theoretical maximum of 0.593. A short review of the history of ducted turbines will be presented, followed by recent results here at Clarkson and a discussion of where things are headed on further optimization and the construction of a prototype.

***11am in McLaughlin Room 312 on Friday, December 11, 2015***