Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

A wind tunnel study on the effects of complex topography on wind turbine performance KEVIN HOWARD, St. Anthony Falls Laboratory, Dep. Civil Engineering, UMN, STEPHEN HU, Aerospace Engineering and Mechanics, UMN, LEONARDO CHAMORRO, MICHELE GUALA, St. Anthony Falls Laboratory, Dep. Civil Engineering, UMN — A set of wind tunnel experiments were conducted to study the response of a wind turbine under flow conditions typically observed at the wind farm scale, in complex terrain. A scale model wind turbine was placed in a fully developed turbulent boundary layer flow obtained in the SAFL Wind Tunnel. Experiments focused on the performance of a turbine model, under the effects induced by a second upwind turbine or a by three-dimensional, sinusoidal hill, peaking at the turbine hub height. High frequency measurements of fluctuating streamwise and wall normal velocities were obtained with a X-wire anemometer simultaneously with the rotor angular velocity and the turbine(s) voltage output. Velocity measurements in the wake of the first turbine and of the hill were used to determine the inflow conditions for the downwind test turbine. Turbine performance was inferred by the mean and fluctuating voltage statistics. Specific experiments were devoted to relate the mean voltage to the mean hub velocity, and the fluctuating voltage to the unsteadiness in the rotor kinematics induced by the perturbed (hill or turbine) or unperturbed (boundary layer) large scales of the incoming turbulent flow. Results show that the voltage signal can be used to assess turbine performance in complex flows.

Michele Guala
St. Anthony Falls Laboratory, Dep. Civil Engineering, UMN

Date submitted: 03 Aug 2012 Electronic form version 1.4