Center for Environmental & Applied Fluid Mechanics

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11:00 a.m., 107 Latrobe Hall

"Energy Efficiency: From Fundamental Physics to Power Systems"

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Global warming and security concerns are driving the need to find more efficient and renewable energy sources and systems. In this talk we look at two such energy problems; fuel efficiency in aerodynamic applications and grid integration of renewable energy sources.

Turbulence is undesirable in many applications because it increases drag, which leads to decreased fuel efficiency. We use a 'bottom up' (physics based) approach to understanding energy efficiency through a control theoretic analysis of shear flow turbulence. A 2D/3C model in a robust control framework is used to rigorously connect experimental observations of streamwise coherence to the shape of the mean velocity profile. We demonstrate how this model allows us to isolate mechanisms responsible for profile blunting, which is directly connected to increased drag and decreased fuel efficiency.

In power systems we approach energy efficiency from the opposite direction, using a 'top down' (system level) approach to examine issues associated with integrating renewable sources into a smart electric grid. A couple of case studies are described. The first demonstrates the benefits of grid integrated storage in the current power generation network paradigm. The second looks at how a combination of storage and ancillary services can be used to mitigate the intermittency of renewable sources. In the long term, a combination of physics based and systems level approaches are needed to analyze the technical and market issues that will arise as renewable penetration is increased.

Bio: Dennice Gayme is a postdoctoral scholar in the Computing and Mathematical Sciences Department at the California Institute of Technology. She received her doctorate in Control and Dynamical Systems in 2010 under the supervision of John C. Doyle and Beverley J. McKeon, also at the California Institute of Technology where she was a recipient of the P.E.O. scholar award in 2007 and the James Irvine Foundation Graduate Fellowship in 2003. She received a Masters of Science in Mechanical Engineering from the University of California at Berkeley in 1998. Prior to her doctoral work she was a Senior Research Scientist in the Systems and Control Technology and Vehicle Health Monitoring Groups at Honeywell Laboratories from 1999-2003. Dennice's research interests are in the study of large-scale interconnected systems with an emphasis on renewable and efficient energy systems.