Science, Engineering and Mathematical Challenges in Designing Net Zero Energy Buildings

Ingram Lecture Series

Thursday, April 14, 2:15 – 3:30 pm

103 Engineering Management

JOHN A. BURNS

Hatcher Professor of Mathematics

Technical Director of the Interdisciplinary Center for Applied Mathematics, Virginia Tech

Abstract: Buildings worldwide account for approximately 40% of global energy consumption, and the resulting greenhouse gas emissions significantly exceed those of all transportation combined. In the United States the entire transport sector represents only about 28% of total energy use. This comparison implies that a 50% reduction in buildings' energy usage would be equivalent to taking every passenger vehicle and small truck in the United States off the road and a 70% reduction in buildings' energy usage is equivalent to eliminating the entire energy consumption of the U.S. transportation sector. Reductions of this order are necessary to achieve the International Energy Agency's (IEA) target of a 77% reduction in the global carbon footprint against the 2050 baseline. The larger goal in building energy efficiency is to achieve Net Zero Energy Buildings (NZEBs) which are defined as buildings that average zero consumption of non-renewable energy over a typical year. In order to realize NZEBs, one must be able to achieve around 80% reduction in buildings' energy usage.

Achieving reductions of 70% or greater present several challenges to science, engineering and mathematics. Building systems are the composition of different functioning dynamic subsystems and therefore a highly complex, multi-scale, nonlinear, and uncertain dynamic system. In the report [1] it is noted that the market alone will not produce the necessary progress. Consequently, DOE has established a $122 Million Energy-Efficient Building Systems Design Research Center to address the challenge issued by the U.S. Secretary of Energy, Dr. Steven Chu [2]:

> *We need to do more transformational research at DOE to bring a range of clean energy technologies to the point where the private sector can pick them up, including: Computer design tools for commercial and residential buildings that enable reductions in energy consumption of up to 80% with investments that will pay for themselves in less than 10 years.*

In this presentation we discuss areas in the mathematical and computational sciences which are enabling technologies in the design, optimization and control of high performance energy efficient buildings.

Biographical Sketch: John Burns is the Hatcher Professor of Mathematics at Virginia Tech and the Technical Director of the Interdisciplinary Center for Applied Mathematics. He served as Vice President of SIAM, is the past Chair of the SIAM Activity Group on Systems and Control and is a Fellow of the IEEE. Dr. Burns was recently named as the winner of the 2010 Reid Prize for his fundamental contributions in computational methods for and applications in control, design and optimization of complex systems. Dr. Burns' primary interests concern the development of rigorous and practical computational algorithms for model reduction, design, control and optimization and sensitivity analysis of engineering and biological systems. Dr. Burns has been a consultant and advisor to Booz Allen & Hamilton, NASA Langley Research Center, The Air Force Research Labs, DARPA, The Babcock and Wilcox Company, Solers Inc., United Technologies and has held several visiting positions in the USA, Europe and Asia. Dr. Burns currently is working with United Technologies Research Center on several projects concerning reduced order modeling and control of energy efficient buildings and he is a Co-PI on the recent $122 Million DOE Energy-Efficient Building Systems Design HUB led by Penn State.

Seminar sponsored by: Ingram Lecture Fund, Missouri Institute for Computational and Applied Mathematical Sciences (MICAMS), Department of Mathematics and Statistics, Office of Sponsored Programs

[1] World Business Council on Sustainable Development. Energy Efficiency in Buildings: Facts & Trends. 2008.

[2] Steven Chu: Secretary of Energy. Testimony Before the Committee on Energy and Natural Resources, United States Senate, Washington, D.C. 2009.