Design Specific Computational Tools for Energy Efficient Buildings

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Abstract

The Energy Independence and Security Act of 2007 (EISA) was passed with the goal "*To move the United States toward greater energy independence and security.*" Energy security and independence cannot be achieved unless the United States addresses the issue of energy consumption in the building sector and significantly reduces energy consumption in buildings. Moreover, energy efficiency is a national problem that transcends the Department of Energy (DOE) and achieving energy efficiency in Federal facilities and especially the Department of Defense (DOD) facilities is critical to national security and energy independence.

The US must invest in new areas of computational and mathematical sciences required to enable the development of computer tools to design, control and optimize energy efficient buildings. The challenge has been issued by the U.S. Secretary of Energy, Dr. Steven Chu (emphasis added):

> "*We need to do more transformational research at DOE … including* ***computer design tools*** *for commercial and residential buildings that enable reductions in energy consumption of up to 80 percent with investments that will pay for themselves in less than 10 years.*[1]

It is important to note that the challenge is to produce computational tools **specifically** for design, control and optimization of energy efficient building systems. Although forward simulation is an important component of this task and provides a basis for simulation based design, what is needed is a new set of computational tools that are developed expressly to enable rapid design, optimization and real time control of the multi-scale dynamical systems typical of whole building systems. The concept of developing mathematical and computational algorithms to produce design and control specific computational tools is a new idea for the energy industry, but the potential payoffs in terms of design cycle times, performance optimization and control to obtain and maintain energy savings are huge. Moreover, recent advances in computational power, computer science, and mathematical algorithms offer the foundations to address the control problems presented by the complex dynamics of whole building systems. However, these challenges cannot be overcome by "raw computational power" alone and require the development of new algorithms, a better understanding of the building dynamics and new mathematical approaches to optimization and control of large multi-scale systems. Several barriers remain before one can deliver design specific tools. We will discuss these issues and suggest possible roles for HPC in the design and control of energy efficient building systems.

[1] Secretary of Energy Dr. Steven Chu, House Science Committee Testimony, March 17, 2009