Editorial: The green wave in healthcare and bio-research buildings

Zhiqiang Zhai*

Department of Civil, Environmental, and Architectural Engineering,
University of Colorado at Boulder,
ECOT 441, UCB 428, Boulder, CO 80309-0428, USA
E-mail: john.zhai@colorado.edu
*Corresponding author

Dan Watch

Perkins+Will, 1315 Peachtree St. NE,
Atlanta, GA 30309, USA
E-mail: Dan.Watch@perkinswill.com

Walter Vernon

Mazzetti, 530 Bush Street, Suite 300,
San Francisco, CA 94108-3632, USA
E-mail: walterv@mazzetti.com

Biographical notes: Zhiqiang (John) Zhai is an Associate Professor in Architectural Engineering and Environmental Design at the University of Colorado at Boulder. He holds two PhD degrees, one in Fluid Mechanics and the other in Building Technology. His particular research and teaching interests include: experimental and numerical study of building system efficiency, renewable and sustainable building design and optimisation, indoor-outdoor environment quality evaluation. He published over 100 technical papers in reputed journals and conferences and is an active member of several professional societies.

Dan Watch has been responsible for the design of some of the most significant laboratories globally as a leader of the Science+Technology practice at Perkins+Will. Through constant research, he provides the latest trends and design solutions for clients of government, private sector, and academic institutions. He has written three books, two editions of *Research Laboratories* and most recently *Research for the Global Good: Supporting a Better World for All*, which discusses business of research in a global economy. He is a frequent speaker at noteworthy institutions including the NIH, the Academy of Sciences in Beijing, Edinburgh's Science Parks, and Harvard University.

Walt Vernon leads Mazzetti, a company dedicated to making the world a better place by creating better environments. He is deeply involved at a leadership level with many national and international organisations working to improve the environmental footprint of the healthcare industry and its facilities and operations. He is the Principal Author for the WHO Publication '*Healthcare in the Green Economy*', and he chairs the Research Committee for the Facilities Guidelines Institute where he is working to imagine and define the future of healthcare facilities the world needs to create the health we all want and deserve.

Healthcare facilities consume 4% of the total energy used in the USA, including those by industry, transportation and buildings. They are the fourth largest consumer of total energy among all the building types, accounting for 11% of the overall commercial energy consumption (http://www.eia.gov/emeu/consumptionbriefs/cbecs/pbawebsite/health/health_howuseenergy.htm). Hospitals, surgery centres and other biomedical research facilities are among the most energy intensive commercial buildings in the world. Healthcare buildings use an average of 5.3 billion Btu per building and have an energy intensity of 240.4 thousand Btu per square foot, more than 2.5 times over typical commercial office buildings (http://www.betterbricks.com/graphics/assets/documents/Energy_in_Healthcare_Fact_Sheet_FINAL_5.12.10.pdf). This is one of the highest among all building applications.

The most energy used in healthcare facilities is for water heating, followed by space heating and lighting. The miscellaneous category, which accounts for 14% of healthcare energy consumption, consists mostly of energy use by medical equipment (http://www.eia.gov/emeu/consumptionbriefs/cbecs/pbawebsite/health/health_howuseenergy.htm). This equipment energy use can be more substantial for biomedical research facilities due to various research instrumentations. Such high energy use intensity in healthcare and biomedical research facilities imposes pressing needs for proper management and improvement of energy use in these facilities. This includes developing new technologies, adopting new products, promoting best practices in design, construction and operation, and improving standards and regulations.

With the goal of promoting and enhancing energy efficiency in healthcare and biomedical research facilities, this special issue documents several newest developments and technological advances presented by a few active researchers and practioners in the field.

The special issue reviews and criticises the design procedures, methods and regulations for mechanical systems in surgical operating rooms – one of the most critical spaces in healthcare facilities, and indicates further research directions for understanding the role of air distribution patterns in surgical sepsis control, and studying the impact of increasing heat loads in the next generation of surgical procedures. A comprehensive review is also delivered for life-cycle-based green manufacturing – an emerging solution to fulfil practical requirements on sustainable technologies and products. In addition, an innovative conceptual framework and decision-making structure is introduced that can help achieve high energy performance and superior indoor environmental quality with less capital cost. Demonstrations are presented for six most populous and diverse climate regions in the USA.

Papers in this special issue explore several crucial techniques for achieving a better thermal comfort and indoor air quality in healthcare and bio-research facilities. This includes the comparative investigation on the performance of various control techniques for maintaining constant ambient temperature in critical indoor environments; the evaluation of the influence of several conventional and innovative ventilation methods on the transportation and dispersion of exhaled particles and droplets; and the study on the effectiveness of upper-room ultraviolet germicidal irradiation (UR-UVGI) lamps in healthcare facilities using advanced modeling techniques.

Another important energy issue in healthcare and biomedical research facilities is the quantification and reduction of plug loads. This special issue discusses the energy consumption and its carbon footprint from plug load equipment in laboratory facilities, in particular exploring the influence factors of freezer (e.g., ambient temperature and

freezer operating conditions). Methods and challenges for estimating miscellaneous and electronic loads and energy uses in hospitals are investigated, with a new proposal of combining device-level metered data with inventories and usage information. The study also reveals that common and small devices consume a large amount of energy in aggregate and should not be ignored when quantifying hospital energy use.

This special issue collects a small but important fraction of excellent research and practice in the field. It is a great representation of the growing trend and the highlighted aspects in green movement on the healthcare and bio-research facilities. When the world has become more aware of the need to save energy, many institutions have joined the green wave by addressing 'the lowing hanging fruit'. Now, it is time to roll up our sleeves and make more significant commitments to reduce energy, save money and reduce our carbon footprint. In the next 20 years, either through renovation or new construction, we will have 75% updated healthcare and bio-research facilities in the USA. Twenty years is not a long time to make a big difference. The challenge is our responsibility to all generations. Hopefully, ideas in this document will help in this effort.