Journal of Engineering for Sustainable Buildings and Cities

Editorial

Inaugural Editorial

This new *ASME Journal of Engineering for Sustainable Buildings and Cities* (JESBC) of the American Society of Mechanical Engineers (ASME) responds to the convergence of growing interests and need to meet our aspirations for sustainable living in the context of a changing society and the natural system. Buildings and cities are at the center of the revolution of low-carbon societies as a key solution to reduce the risks associated with a warming planet and as a source for innovation for productive and healthy human living. The building sector also remains a key component of the global economy. The construction, operation, and maintenance of these spaces represent more than $1T/year in the United States economy alone and more than 40% of the total energy consumed globally while more than 70% in large cities [1–3]. As a result of this surge to achieve sustainable living and the important role that buildings and cities play in reaching this goal, there is a trend for growing groups of engineers and scientists focusing their careers in sustainable buildings, cities, and related technologies, and new business opportunities are emerging in this field. The large number of dissemination forums evidences this trend and the peer-reviewed articles that have resulted over the past ten years in sustainable buildings and systems. A particular set of enabling components for sustainable buildings and cities are mechanical and energy systems, and the related methods and technologies. This refers to energy systems, hydronic systems, and mobility systems within buildings and cities. Traditional energy systems in buildings have been mostly related to heating, ventilating, and air conditioning (HVAC). However, this is rapidly changing as the buildings are becoming active sources of energy production integrating clean energy services such as solar or other renewables, thermal and electrical energy storages, or via energy-efficient conventional generation such as on-site power generation. The trends to provide such energy services with cost-effective low- to zero-carbon options with an integrated approach are demanding new technological contextualization and thinking processes [4].

Furthermore, buildings and cities are rapidly evolving to be key components of interconnected services such as energy, water, transportation, and communications. These interconnections are for the most part two ways where buildings and cities contribute to common services such as energy and water and/or are recipients from other providers of similar services through interconnected grids. Similarly, buildings are expanding the range of services they provide with the electrification of transportation as a key emerging example, where buildings are becoming the primary energy source to the new transportation services. These trends for interconnections and multiservices are also demanding new approaches, designs, technologies, and codes that facilitate such interactions in optimized and secure ways.

At the center of the discussion of sustainability is the resiliency of the interconnected infrastructure to hazards of all types such as frequent and more intense weather storms, extreme heat events, or cyberattacks [5]. In particular, recurrent natural disasters have increased life, property, and economic losses over the last few decades. For instance, the United States alone has experienced during 2017 a record high number of natural disasters resulting in over $300 billion in economic losses [6]. The frequency of natural hazards is expected to increase in part due to the impacts of climate change. In order to reduce the severe impacts of these natural extreme events, it is important to design buildings with enhance resiliency and sustainability.

Resilient buildings should be able to maintain basic functionality either during and/or just after disruptive events. How buildings, cities, and associated services can maintain their key functionalities under these external threats is a challenge to present and future generations of engineers and scientists, perhaps more so now than in the past.

The concept of sustainable buildings and cities will be incomplete without taking into consideration the environmental impacts of buildings both direct and indirect. Direct environmental impacts include modification in outdoor energy and water balances due to the land cover change or emissions of heat, vapor, or chemicals that may change the local climates. A particular related known process is the urban heat island that represents a thermal gradient between the built environment and the neighboring natural environment. Examples of indirect effects are greenhouse gases associated with buildings' activities, a primary source for global warming. It could be argued that buildings and cities are the main indirect sources of global greenhouse gases. As we envision new building-integrated technologies and expand the services that buildings and cities provide to achieve higher levels of sustainability (Fig. 1), the compounded environmental impacts should be taken into account [7]. Moreover, sustainable buildings and cities can have significant economic and social impacts. In particular, energy productivity-based analysis has been proposed to account for the multiple benefits and value added of energy efficiency including economic, environmental, and social. Indeed, the energy productivity framework can include traditional benefits (i.e., reduced energy consumption) as well as nontraditional value added of energy efficiency such as increased asset values, reduced greenhouse gas emissions, and creation of jobs [8]. Thus, new analysis frameworks are needed to evaluate direct and indirect overall benefits of sustainable built environments.

Thus, the concept of sustainable buildings and cities is at the core of modern and future times encompassing a range of variables such as energy efficiencies, low-carbon services, interconnectivity of services, resilient multiservices, low environmental impacts, secure and healthy living, and productivity. The paradigm is compounded by a series of additional factors such as the fact that the majority of the building stocks across the world were built more than 50 years ago, the range of geographical conditions where they operate (whether coastal/inland, low/high elevations, warm/cold climates), and rapidly changing demographics. Thus, advancing the agenda for sustainable buildings and cities presents both grand technical challenges and great opportunities for professions and professionals demanding a new generation of workforce properly trained to

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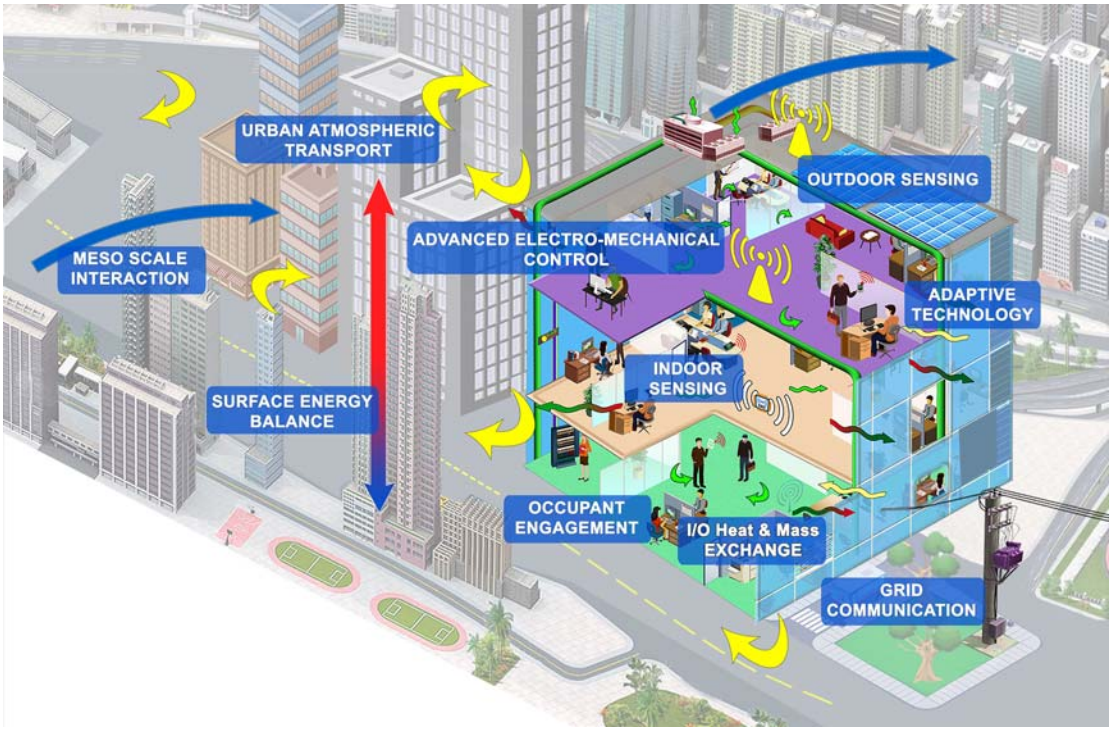

Fig. 1 Vision of sustainable community of buildings using highly integrated and interactive systems

address these challenges, new research directions, and investments to create associated businesses.

The above elements are the primary source for motivating this new *ASME Journal of Engineering for Sustainable Buildings and Cities (JESBC)* within the American Society of Mechanical Engineers (ASME). The main aims of this journal are multifold, namely to inspire discussions to address the above challenges and to serve as a prime dissemination source for engineering-centered solutions and approaches for sustainable buildings and cities, something that is currently lacking in the many emerging peer-reviewed dissemination forums. The range of multidisciplinary technical problems that are required to enable sustainable buildings and cities are wide to include, but not limited to, integrated energy systems; sensors systems; efficient HVAC systems; cyber infrastructure for building systems; materials sciences and engineering for new buildings envelopes; new architectural designs; multiscale fluid mechanics and heat transfer analysis for buildings components, whole buildings, or cities; control theory and practice for building systems; theory and practice of sustainability and resiliency for buildings and cities; multiservice buildings and cities; and human health and productivity, among many other topics. This journal aspires to motivate high-quality discussions in these range of multidisciplinary topics in local and global contexts.

This new journal also represents an evolution of ASME that dates back to the year of 2013 as part of an initiative on Integrated/Sustainable Building Equipment and Systems (ISBES), which had the objectives of filling voids in the literature and to motivate advances on integrated mechanical systems in buildings. A strategic workshop was convened on April 24, 2013, at the ASME Center for Research and Technology Development (CRTD) and ASME Emerging Technologies (ET) at the ASME offices in Washington, D.C. in order to identify and evaluate challenges and opportunities in topical areas related to ISBES. National technical experts and thought leaders from industry, government, and academia came together for a detailed one-day discussion of each of the four proposed ISBES topical areas namely integrating renewable energy generation into buildings and building systems; integrating power generation systems into building heating and cooling systems; and integrating energy strategies at a neighborhood and city-scale. The workshop was proceeded by several technical sessions at the ASME International Conference and Exposition and at the International Energy Sustainability Conferences. These efforts resulted in a wealth of knowledge that was first summarized in a special issue in *ASME Journal of Solar Energy Engineering* [9] and further expanded in the *Handbook of Integrated and Sustainable Buildings Equipment and Systems: Volume I: Energy Systems* [10,11]. *ASME Journal of Engineering for Sustainable Buildings and Cities* is a natural continuation of this evolutionary interest of the mechanical engineering profession as represented by ASME. We hope that this new journal will cover most aspects of these engineering systems for sustainable buildings and cities. Most importantly, we hope that this *journal* provides a point of encounter for continuous dialog in the very relevant subject of sustainable buildings and cities.

We would like to thank the contributors at the initial workshop in 2013, to all authors that presented their works at the follow-up technical conferences and journal publications, and the contributors of the Handbook, an effort that span six years from the inception of the ISBES initiative. Our special thanks to ASME production staff, Tara Smith and Mary Grace Stefanchik, for their encouragement and patience throughout this editorial process.

We hope the readers and contributors find the contents of the new journal useful to their practices and insightful to inspire unique contributions for new developments that advance the agenda of engineering systems for sustainable buildings and cities.

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