Journal of Engineering for Sustainable Buildings and Cities

Guest Editorial

Special Issue: Electrification of the Building Heating Sector

Human society is at a defining moment to take actions to avoid the most significant health, environmental, and economic impacts resulting from global climate change. To meet the goal set by the United Nations Framework Convention on Climate Change (UNFCCC) to limit global average temperature rise below 2 °C above pre-industrial levels requires very large decreases in greenhouse gas (GHG) emissions, often referred to as deep decarbonization. Approximately 40% of the US population (about 50 million households) lives in the cold-climate regions and intensive space heating and domestic hot water heating dominates total energy consumption. As cities and communities strive for deep decarbonization, meeting heating demand sustainably has become a challenge and an opportunity as most heating infrastructure is based on fossil fuels. For example, in the Northeastern US, over 80% of the heating-related energy consumption come from onsite combustion of fossil fuels dominated by natural gas and fuel oil.

As such, electrification of the building heating sector, together with effective thermal insulation of the building envelopes, is an emerging technological field where electrical energy maybe provided by low carbon sources such as solar or wind. Intrinsic challenges for transitioning from carbon-based heating to electrically based heating include efficient electrically based systems such as air or ground based heat pumps, use of low global warming refrigerants, cost effective technologies, retrofit processes, power system integration, building integrated approaches, environmental and energy infrastructure impacts, public policies, and economic incentives for large-scale transitions.

In this special issue, we are pleased to present a series of peer-reviewed articles on electrification of the building heating sector.

- The first paper included in this issue is titled "Potential of utilizing energy storage integrated ground source heat pump system to reshape electricity demand in the United States." [1] The authors introduced a novel ground source heat pumps systems integrated with underground thermal energy storage an evaluated the impact on the electricity demand in multiple electricity markets in the US. The integrated system has a potential to manage the peak in electricity consumption while serving the thermal demand.
- In the second paper titled "Sustainable energy solutions for thermal load in buildings—Role of heat pumps, solar thermal, and hydrogen-based cogeneration systems," the authors conducted a performance assessment of heat pumps, solar thermal collectors, non-fossil fuel-based cogeneration systems, and their hybrid configurations [2]. As there are no established technological pathways in heating electrification, the assessment is valuable to inform policy makers and the public of the impact from different heating options.
- The third and fourth papers are a two-part series that provides a comprehensive review of the design aspects of ground-source heat pumps utilizing shallow geothermal energy. Part I focuses on designs of ground heat exchangers [3] and Part II on hybrid ground source heat pumps that adopt various supplemental heat sources and sinks [4]. The review incorporated the latest development in this area and identified the research gaps for future studies.

We are most thankful to the contributing authors of those high quality articles. Beyond this special issue, the *ASME Journal of Engineering for Sustainable Buildings and Cities* (JESBC) will continue encouraging submissions on this critical and emerging topic.

Sincerely,
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