Editorial

CARBON neutrality is a growing important objective for human activities, to prevent climate change. As for computer systems, we are urged to provide sustainability in computing to help mitigate such problems. As such, carbon neutrality shall occupy a critical role in the next-generation digital infrastructure. To this end, we have collected 15 established works towards carbon neutrality in computer systems in the Special Issue on Carbon-Neutral Computing for Next-Generation Digital Infrastructures.

The issue tackle sustainability from three main aspects, namely infrastructure, software/hardware, and applications/models. We start with an overview of data center sustainability. Z. Cao et al. [A1] provide an overview of the sustainability metrics from five aspects and highlight a visualization architecture to simulate data center sustainability with a decision engine. M. Uddin et al. [A3] propose a scheduling methodology to address carbon neutrality challenges through resource management with DVFS technology. P. Cong et al. [A4] propose a state of the art hazard-aware CPS model with a concern on the reliability and sustainability. M. Teng et al. [A5] discuss an energy-aware optimization considering both task offloading and service deployments. W.E. Gnibga et al. [A7] identify the problem on the optimal infrastructure configuration for both renewable production and financial costs and solve it as a multi-objective optimization. S. Pan et al. [A8] discuss an innovative gradient-based algorithm to solve cold-start optimization, thus supporting sustainable serverless computing. L. Cheng et al. [A15] propose to preemptively schedule cloud loads using reinforcement learning techniques.

Many accepted manuscripts also tackle the sustainable issue from software hardware codesign at the edge side. S. Qiu et al. [A2] tackles software sustainability issue via a tree-based encoding technique. O. Huang et al. [A9] focus on the carbon neutrality for Ultra Wide Band. J. Du et al. [A11] propose an interesting approach to improve the energy efficiency via intelligent reflective surface-aided wireless in the aspect of edge computing. A. Alofi et al. [A13] propose a self-adaptive model to minimize blockchain-based systems' energy consumption and carbon emissions while maximizing their decentralization and trustworthiness. G. Jintao et al. [A14] discusses a deepDP, using pruning techniques to optimize query processing in database systems.

Some of papers discuss the models and applications in sustainability. S. Wang et al. [A6] target at the low-carbon route recommendation as a digital system application and propose a novel genetic algorithm on solving these issues. Z. Xu et al. [A10] discuss the computational cost optimization for carbon capture power plants in grid. P. Sun et al. [A12] discuss an LPPCM algorithm for applications like express services.

In all, all reviewers have plead hard works on reviewing these drafts and helping authors to improve their works. We would like to thank these reviewers and our authors for their efforts on carbon-neutral computing for future digital infrastructures, thus collectively summarize current efforts, and beacon a vision to the possible future and beyond.

ZICHEN XU, *Guest Editor*
Department of Computer Science and Engineering
Nanchang University,
China

SHAOLEI REN, *Guest Editor*
Department of Electrical & Computer Engineering (ECE)
University of California,
Riverside, USA

OMER RANA, *Guest Editor*
School of Computer Science and Informatics
Cardiff University, UK

APPENDIX
RELATED ARTICLES

[A1] Z. Cao et al., "Data center sustainability: Revisits and outlooks," *IEEE Trans. Sustain. Comput.*, vol. 9, no. 3, pp. 236–248, May-Jun. 2024.

[A2] S. Qiu, H. Huang, W. Jiang, F. Zhang, and W. Zhou, "Defect prediction via tree-based encoding with hybrid granularity for software sustainability," *IEEE Trans. Sustain. Comput.*, vol. 9, no. 3, pp. 249–260, May-Jun. 2024.

[A3] M. A. Uddin, M. Lin, and L. T. Yang, "Dynamic slack-sharing learning technique with DVFS for real-time systems," *IEEE Trans. Sustain. Comput.*, vol. 9, no. 3, pp. 261–270, May-Jun. 2024.

[A4] P. Cong, J. Zhou, W. Jiang, M. Chen, S. Hu, and K. Li, "Improving reliability and sustainability of hazard-aware cyber-physical systems," *IEEE Trans. Sustain. Comput.*, vol. 9, no. 3, pp. 271–282, May-Jun. 2024.

Digital Object Identifier 10.1109/TSUSC.2023.3336230

[A5] M. Teng, X. Li, and K. Zhu, "Joint optimization of sequential task offloading and service deployment in end-edge-cloud system for energy efficiency," *IEEE Trans. Sustain. Comput.*, vol. 9, no. 3, pp. 283–298, May-Jun. 2024.

[A6] S. Wang, T. Zou, W. Zhao, and L. Liu, "Low-carbon mixed traffic route recommendation for community residents based on multilayer complex traffic network," *IEEE Trans. Sustain. Comput.*, vol. 9, no. 3, pp. 299–314, May-Jun. 2024.

[A7] W. Emmanuel Gnibga, A. Blavette, and A.-C. Orgerie, "Renewable energy in data centers: The dilemma of electrical grid dependency andautonomy costs," *IEEE Trans. Sustain. Comput.*, vol. 9, no. 3, pp. 315–328, May-Jun. 2024.

[A8] S. Pan, H. Zhao, Z. Cai, D. Li, R. Ma, and H. Guan, "Sustainable serverless computing with cold-start optimization and automatic workflow resource scheduling," *IEEE Trans. Sustain. Comput.*, vol. 9, no. 3, pp. 329–340, May-Jun. 2024.

[A9] O. Huang, H. Rao, Z. Zhang, R. Gu, H. Xu, and G. Jia, "Boosting research for carbon neutral on Edge UWB nodes integration communication localization technology of IoV," *IEEE Trans. Sustain. Comput.*, vol. 9, no. 3, pp. 341–353, May-Jun. 2024.

[A10] Z. Xu et al., "Carbon neutrality computational cost optimization for economic dispatch with carbon capture power plants in smart grid," *IEEE Trans. Sustain. Comput.*, vol. 9, no. 3, pp. 354–370, May-Jun. 2024.

[A11] J. Du, M. Xu, S. S. Gill, and H. Wu, "Computation energy efficiency maximization for intelligent reflective surface-aided wireless powered mobile edge computing," *IEEE Trans. Sustain. Comput.*, vol. 9, no. 3, pp. 371–385, May-Jun. 2024.

[A12] P. Sun, L. Li, and J. Wan, "LPPCM: A low-cost package pickup covering mechanism for cooperative express services," *IEEE Trans. Sustain. Comput.*, vol. 9, no. 3, pp. 386–395, May-Jun. 2024.

[A13] A. Alofi, M. A. Bokhari, R. Bahsoon, and R. Hendley, "Self-optimizing the environmental sustainability of blockchain-based systems," *IEEE Trans. Sustain. Comput.*, vol. 9, no. 3, pp. 396–408, May-Jun. 2024.

[A14] G. Jintao, L. Zhanhuai, and S. Jian, "Thorough data pruning for join query in database system," *IEEE Trans. Sustain. Comput.*, vol. 9, no. 3, pp. 409–421, May-Jun. 2024.

[A15] L. Cheng, Y. Wang, F. Cheng, C. Liu, Z. Zhao, and Y. Wang, "A deep reinforcement learning-based preemptive approach for cost-aware cloud job scheduling," *IEEE Trans. Sustain. Comput.*, vol. 9, no. 3, pp. 422–432, May-Jun. 2024.