Zhe WANG
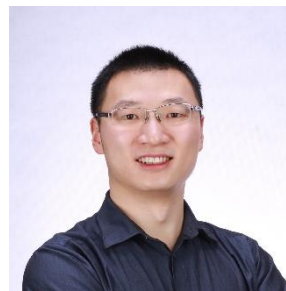
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INTRO

I am an Assistant Professor working with the Department of Civil and Environmental Engineering at The Hong Kong University of Science and Technology. My current research is about the application of artificial intelligence in smart building and low carbon city, majorly from two aspects. First, I am looking at how to leverage advanced control techniques (e.g. Reinforcement Learning, Model Predictive Control, etc.) to enhance building performance and building-grid interaction. Second, I am interested in how machine learning techniques could help to inform decision making on buildings and cities.

Prior to joining HKUST, I was a scientist in Lawrence Berkeley National Laboratory working on smart building control; a Postdoctoral Scholar in UC Berkeley working on data-driven personal comfort models and devices; and an Energy Consultant in World Bank working on Urban Scale Building Energy Efficiency and Renewable Energy in China.

I published 83 articles in SCI journals, among which 23 as the first author, 5 as the co-first author, 9 as corresponding author. I have published 5 ESI highly cited papers so far, among which 3 as the first author. I have been named as the World's Top 2% Scientists by Stanford University & Elsevier since 2021. I was awarded the **National Science Fund for Excellent Young Scholars** (2023), **Hong Kong Collaborative Research Fund** (PC, 2023), **Second Class Award of State Science and Technology Prize** (2019); and was selected as a Schwarzman Scholar (2016, covered by the New York Times). I am now serving as an Section Editor for Energy and Buildings, and Subject Editor for Building Simulation (SCI journal), and is a Fellow of the George H. W. Bush Foundation for U.S.-China Relations. I have obtained **13.2 million HKD** (**1.7 million USD**) external research funding as the PC or PI since I joined HKUST. I have won the first prize in the **2022 Global AI Challenge for Building E&M Facilities** hosted by Hong Kong Electrical & Mechanical Services Department, and the second prize in the **NeurIPS CityLearn Challenge 2023** (Leaderboard here). I was invited to give a speech on the Seventh-Round High-level Consultation on U.S.-China People to People Exchange, chaired by U.S. Secretary of States John Kerry and Chinese Vice-Premier Yandong Liu, as the ***only representative of Chinese young scholar*** (news coverage).

EMPLOYMENT

2021.11 till now   **Hong Kong University of Science and Technology, Assistant Professor**   **Hong Kong**

- ➢ PC, Toward 2060 Carbon Neutrality: Life-cycle Planning and Design of Photovoltaic Integrated Green Roof (PVIGR) Systems for Hong Kong and the Greater Bay Area (3.46M HKD, Hong Kong Research Grant Committee, Collaborative Research Fund, C6003-22Y), 2023-2026
- ➢ PI, Advanced building control for energy efficiency and load flexibility (2M RMB, the National Science Fund for Excellent Young Scholars by NSFC, 52322813), 2024-2026
- ➢ PI, Model Predictive Control in Hong Kong's Residential Buildings for Energy Efficiency and Load Flexibility (804k HKD, Hong Kong Research Grant Committee, Early Career Scheme, 26209323), 2023-2026
- ➢ PI, Key technologies for the efficient building-grid interaction and building load flexibility in hot and humid area (2M RMB, National Key R&D Program of China), 2024-2028
- ➢ PI, Cabin thermal management for electrical vehicles (300k RMB, the National Science Fund for Young Scholars by NSFC, 52306028), 2024-2026
- ➢ PI, Fault detection and control optimization for air-conditioning system of commercial buildings (800k RMB, Shenzhen Sustainable Development Research Grant, KCXST20221021111403009), 2023-2026
- ➢ PI，An AI-assisted solution for low-cost high-resolution urban scale environmental simulation (360k

HKD, Fei Chi En Education and Research Fund), 2023-2025

- ➢ PI, Modeling and optimization for building energy system, (300k RMB, Shui On Sustainable Research Fund), 2023-2025
- ➢ PI, Autonomous Cruise UVC Disinfection and Microclimate Air-conditioning Robot (720k RMB, SHCIRI-FSNH-2203), 2022-2024
- ➢ PI, Optimizing Variable Refrigerant Flow (VRF) Systems for efficient Demand Response (600k RMB, Midea Group), 2022-2023
- ➢ PI, Smart Platform for Demand Response of Commercial Buildings (600k RMB, Midea Group), 2022-2023
- ➢ PI, Model Predictive Control for Energy Efficient Data Center (300k RMB, Tencent Young Faculty Open Research Fund), 2022-2023

2018.07 – 2021.10   **Lawrence Berkeley National Lab, Project Scientist**   **Berkeley**

- ➢ Co-PI, AlphaBuilding – Reinforcement Learning for Building Control (0.2M USD, LBNL LDRD: BU21-036)
  - Develop virtual testbeds to train and benchmark RL controllers for buildings
  - Design and implement multi-agent RL structure to enhance the scalability of RL controllers
- ➢ Leading researcher, Sensor Data Integration - Integrating Sensor Data with Physics-Based Models (1.5M USD, US Department of Energy: EE-5B37579)
  - Infer building thermal dynamics using connected smart thermostat data
  - Estimate demand response potential of US residential building stock
- ➢ Key researcher, Hierarchical Occupancy Responsive Model Predictive Control at Room, Building and Campus Levels (3.0M USD, US Department of Energy: EE-5B24502)
  - Develop, deploy, and test Model Predictive Control for buildings
  - Develop toolkits to simplify MPC controller development process
- ➢ Key researcher, End-Use Load Profiles for the U.S. Building Stock (1.2M USD, US Department of Energy: EE-5B35033)
  - Develop occupant behavior modelling toolkits to generate realistic building load shape
  - Develop and validate data-driven approach to generate building load using GAN

2017.10-2018.06   **UC Berkeley, Postdoc Researcher**   **Berkeley**

- ➢ Key researcher, Data-driven personal comfort models and wearable comfort devices (0.3M USD, US National Science Foundation)
  - Develop data-driven models to predict individual comfort demands
  - Develop and test energy-efficient personal comfort wearables to address individualized demands

2016.12-2018.06   **World Bank, Energy Consultant**   **Beijing/Berkeley**

- ➢ Joint research with Ministry of Housing, Urban and Rural Development: Urban Scale Building Energy Efficiency and Renewable Energy Project
  - Assist the project manager by overseeing the technical progress
  - Provide technical supports to the sub-contractors

EDUCATION

2011.08-2017.07   **Tsinghua University**   *Ph.D. in Building Science*

- ➢ Visiting scholar in *Harvard University*, 2015
- ➢ Recipient of the *National Scholarship* (2012), *Boeing Scholarship* (2015), *Outstanding Graduate of Beijing* (2017)

2016.08-2017.07   **Schwarzman College, Tsinghua University**   *Master in Public Policy*

- ➢ Invited to give a speech on the Seventh-Round High-level Consultation on U.S.-China People to People Exchange (Chaired by Chinese Vice Premier Yandong Liu and U.S. Secretary of State John Kerry), as

the *ONLY* representative of Chinese young scholar

➤ Selected as a Student Council Member (12 out of 110)

2013.10-2014.09	**University of Cambridge**	***M.Phil. in Energy Technology***

➤ Recipient of the *Wing Yip Scholarship, Cambridge Overseas Trust* (*2013*)

2008.09-2011.07	**Tsinghua University**	***Bachelor in Economics***

➤ Cumulative GPA 92.8/100, **ranking 1st /126**

2007.09-2011.07	**Tsinghua University**	***Bachelor in Civil Engineering***

➤ Cumulative GPA 91.3/100, **ranking 1st /29**

➤ Recipient of the *National Scholarship* (2009, 2010), *Boeing Scholarship* (2011)

➤ Recipient of the *Outstanding Undergraduate of Beijing* (2011)

OPEN-SOURCE TOOL

MPCPy	Python-based open-source platform for model predictive control in buildings
	https://github.com/lbl-srg/MPCPy
Modelica Buildings Library	Dynamic simulation models for building energy and control systems
	https://github.com/lbl-srg/modelica-buildings

ACADEMIC SERVICE

Journal Editor	*Energy and Buildings,* **Section Editor** *in Intelligent Building and Smart Control*
	Building Simulation, **Subject Editor** in *Building Control*
	Frontiers in Built Environment，**Associate Editor**
	Building Energy Conservation, **Editorial Board Member**
Grant Proposal Reviewer	*The Dunhill Medical Trust, UK, 2020*
	MTR Research Funding Scheme, HK, 2023
Conference Organizing	Chair, *Jiangsu-Hong Kong-Macao University Alliance Seminar on Smart City and Green Building*, 2023
	Member of Technical Program Committee, *International Workshop on Reinforcement Learning for Energy Management in Buildings & Cities (RLEM)*, https://rlem-workshop.net/, 2020, 2021, 2023
	Member of Scientific Committee, *the 13th International Symposium on Heating, Ventilation and Air-conditioning*, 2023
Journal Reviewer	*Nature Energy, Applied Energy, Energy, Building and Environment, Energy and Building, Journal of Building Engineering, Building Simulation, Environmental Science and Pollution Research, Science and Technology for the Built Environment, SoftwareX, Journal of Building Performance Simulation, Applied Thermal Engineering, Advanced Engineering Informatics, Frontiers in Built Environment, International Journal of Biometeorology, Journal of Asian Architecture and Building Engineering, Journal of the Taiwan Institute of Chemical Engineer, Sustainable Cities and Society, Engineering*

AWARD

1. Key Technology for the Environmental and Energy-Efficient Design of Green Building, Second Class Award of 2019 Chinese State Science and Technology Prize, Award Number: 2019-J-22101-2-01-R09

2. First Prize, 2022 Global AI Challenge for Building E&M Facilities, hosted by Hong Kong Electrical and Mechanical Services Department (EMSD)

3. Second Prize, 2023 NeurIPS CityLearn Challenge, control track, hosted by AIcrowd, UT Austin, and NeurIPS

4. Key Technology for the Environmental and Energy-Efficient Design of Green Building, First Class Award of 2018 Beijing Science and Technology Prize

5. Environment Monitoring and Energy Conservation Technology of Large Commercial Buildings, First Class Award of 2020 Huaxia Construction Prize

PATENT

1. **Wang, Z.**, A Smart Thermostat for Demand Response in Residential Buildings. Chinese Patent Application Number: 202210667572.X
2. Lin, BR., Zhao, HT., and **Wang, Z.**, A Waste Heat Recovery System Designed for Dishwasher. Chinese Patent Number: ZL 201320328067.9

PUBLICATION

Google Scholar Citation: 4901; h-index: 39; i10-index: 68; ESI Highly Cited papers: 5

(#: contribute equally; *: corresponding author)

1. **Wang, Z.*** and He, Y., 2023. AlphaHydrogen: A virtual platform for simulating and evaluating station-based regional hydrogen-electricity networks with distributed renewables, buildings, and fuel-cell vehicles. Energy Conversion and Management, 280, p.116802.
2. **Wang, Z.***, 2022. How frequent should we measure the indoor thermal environment. Building and Environment, 222, p.109464.
3. **Wang, Z.**, Chen, B., Li, H. and Hong, T., 2021. AlphaBuilding ResCommunity: A multi-agent virtual testbed for community-level load coordination. Advances in Applied Energy, 4, p.100061.
4. **Wang, Z.**, Hong, T. and Li, H., 2021. Informing the planning of rotating power outages in heat waves through data analytics of connected smart thermostats for residential buildings. Environmental Research Letters, 16(7), p.074003.
5. **Wang, Z.**, Hong, T., Li, H. and Piette, M.A., 2021. Predicting city-scale daily electricity consumption using data-driven models. Advances in Applied Energy, 2, p.100025.
6. **Wang, Z.** and Hong, T., 2020. Reinforcement Learning for Building Controls: The opportunities and challenges. Applied Energy, 269, p.115036. (highly cited paper)
7. **Wang, Z.**, Hong, T. and Piette, M.A., 2020. Building thermal load prediction through shallow machine learning and deep learning. Applied Energy, 263, p.114683. (highly cited paper)
8. **Wang, Z.** and Hong, T., 2020. Learning occupants' indoor comfort temperature through a Bayesian inference approach for office buildings in United States. Renewable and Sustainable Energy Reviews, 119, p.109593.
9. **Wang, Z.** and Hong, T., 2020. Generating realistic building electrical load profiles through the Generative Adversarial Network (GAN). Energy and Buildings, p.110299.
10. **Wang, Z.**, Hong, T., Piette, M.A. and Pritoni, M. 2019, Inferring occupant counts from Wi-Fi data in buildings through machine learning, Building and Environment, 158, pp. 281-294.
11. **Wang, Z.**, Parkinson, T., Li, P., Lin, B. and Hong, T., 2019. The Squeaky wheel: Machine learning for anomaly detection in subjective thermal comfort votes. Building and Environment, 151, pp.219-227.
12. **Wang, Z.**, Zhang, H., He, Y., Luo, M., Li, Z., Hong, T. and Lin, B., 2020. Revisiting individual and group differences in thermal comfort based on ASHRAE database. Energy and Buildings, 219, p.110017.
13. **Wang, Z.**, Wang, J., He, Y., Liu, Y., Lin, B. and Hong, T., 2020. Dimension analysis of subjective thermal comfort metrics based on ASHRAE Global Thermal Comfort Database using machine learning. Journal of Building Engineering, 29, p.101120.
14. **Wang, Z.**, Hong, T. and Piette, M.A., 2019. Predicting plug loads with occupant count data through a deep learning approach. Energy, 181, pp.29-42.
15. **Wang, Z.**, Warren, K., Luo, M., He, X., Zhang, H., Arens, E., Chen, W., He, Y., Hu, Y., Jin, L. and Liu, S., 2019. Evaluating the comfort of thermally dynamic wearable devices. Building and Environment, p.106443.
16. **Wang, Z.**, Hong, T. and Piette, M.A., 2019. Data fusion in predicting internal heat gains for office buildings through a deep learning approach. Applied Energy, 240, pp.386-398.
17. **Wang, Z.**, Hong, T. and Jia, R., 2018. Buildings. Occupants: a Modelica package for modelling occupant behaviour in buildings. Journal of Building Performance Simulation, pp.1-12.
18. **Wang, Z.**, Luo, M., Geng, Y., Lin, B. and Zhu, Y., 2018. A model to compare convective and radiant heating systems for intermittent space heating. Applied Energy, 215, pp.211-226.
19. **Wang, Z.**, de Dear, R., Luo, M., Lin, B., He, Y., Ghahramani, A. and Zhu, Y., 2018. Individual difference in thermal

comfort: A literature review. Building and Environment, 138, pp. 181-193 (highly cited paper)

20. **Wang, Z.**, Zhao, Z., Lin, B., Zhu, Y. and Ouyang, Q., 2015. Residential heating energy consumption modeling through a bottom-up approach for China's Hot Summer–Cold Winter climatic region. Energy and Buildings, 109, pp.65-74.

21. **Wang, Z.**, Zhao, H., Lin, B., Zhu, Y., Ouyang, Q. and Yu, J., 2015. Investigation of indoor environment quality of Chinese large-hub airport terminal buildings through longitudinal field measurement and subjective survey. Building and Environment, 94, pp.593-605.

22. **Wang, Z.**, de Dear, R., Lin, B., Zhu, Y. and Ouyang, Q., 2015. Rational selection of heating temperature set points for China's hot summer–Cold winter climatic region. Building and Environment, 93, pp.63-70.

23. **Wang, Z.**, Lin, B. and Zhu, Y., 2015. Modeling and measurement study on an intermittent heating system of a residence in Cambridgeshire. Building and Environment, 92, pp.380-386.

24. Liu, S.*,#, **Wang, Z.***,#, Schiavon, S., He, Y., Luo, M., Zhang, H. and Arens, E., 2020. Predicted percentage dissatisfied with vertical temperature gradient. Energy and Buildings, p.110085.

25. Wang, J.#, **Wang, Z.**#, Zhou, D. and Sun, K., 2019. Key issues and novel optimization approaches of industrial waste heat recovery in district heating systems. Energy, p.116005.

26. Wang, J.#, **Wang, Z. ***,#, de Dear, R., Luo, M., Ghahramani, A. and Lin, B., 2018. The uncertainty of subjective thermal comfort measurement. Energy and Buildings, 181, pp.38-49.

27. Liu, Y.#, **Wang, Z.**#, Lin, B., Hong, J. and Zhu, Y., 2018. Occupant satisfaction in Three-Star-certified office buildings based on comparative study using LEED and BREEAM. Building and Environment, 132, pp.1-10.

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29. Ju, Y., **Wang, Z.***, Ju, X., Cao, B., Chen, C. and Lin, B., 2023. Understanding occupancy patterns of university libraries in the post-pandemic era. Energy and Buildings, 291, p.113138.

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31. Zhong, H., Guo, M., Wang, Y. and **Wang, Z.***, 2023. Quantify the magnitude and energy impact of overcooling in a sub-tropical campus building. Building and Environment, p.110033.

32. Wang, D., Zheng, W., **Wang, Z.***, Wang, Y., Pang, X. and Wang, W., 2023. Comparison of reinforcement learning and model predictive control for building energy system optimization. Applied Thermal Engineering, 228, p.120430.

33. Zhou, Q., Zhong, H., Li, L. and **Wang, Z.***, 2023, February. AlphaMobileSensing: A virtual testbed for mobile environmental monitoring. In Building Simulation (pp. 1-14). Beijing: Tsinghua University Press.

34. Wang, Y., Wang, X., Zheng, L., Gao, X., **Wang, Z.***, You, S., Zhang, H. and Wei, S., 2023. Thermo-hydraulic coupled analysis of long-distance district heating systems based on a fully-dynamic model. Applied Thermal Engineering, 222, p.119912.

35. Wang, D., Chen, Y., Wang, W., Gao, C. and **Wang, Z.***, 2023. Field test of Model Predictive Control in residential buildings for utility cost savings. Energy and Buildings, 288, p.113026.

36. Wang, D., Li, M., Guo, M., Shi, Q., Zheng, C., Li, D., Li, S. and **Wang, Z.***, 2023. Modelling Variable Refrigerant Flow System for Control Purpose. Energy and Buildings, p.113163.

37. Luo, M., **Wang, Z.***, Ke, K., Cao, B., Zhai, Y. and Zhou, X., 2018. Human metabolic rate and thermal comfort in buildings: The problem and challenge. Building and Environment, 131, pp. 44-52

38. Jung, W., **Wang, Z.**, Hong, T. and Jazizadeh, F., 2023. Smart thermostat data-driven US residential occupancy schedules and development of a US residential occupancy schedule simulator. Building and Environment, p.110628.

39. Blum, D., **Wang, Z.**, Weyandt, C., Kim, D., Wetter, M., Hong, T. and Piette, M.A., 2022. Field demonstration and implementation analysis of model predictive control in an office HVAC system. Applied Energy, 318, p.119104.

40. Kim, D., **Wang, Z.**, Brugger, J., Blum, D., Wetter, M., Hong, T. and Piette, M.A., 2022. Site demonstration and performance evaluation of MPC for a large chiller plant with TES for renewable energy integration and grid decarbonization. Applied Energy, 321, p.119343.

41. Luo, N., **Wang, Z.**, Blum, D., Weyandt, C., Bourassa, N., Piette, M.A. and Hong, T., 2022. A three-year dataset supporting research on building energy management and occupancy analytics. Scientific Data, 9(1), p.156.

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44. Li, H., **Wang, Z.** and Hong, T., 2021. A synthetic building operation dataset. Scientific data, 8(1), pp.1-13.

45. Li, H., **Wang, Z.**, Hong, T. and Piette, M.A., 2021. Energy Flexibility of Residential Buildings: A Systematic Review of Characterization and Quantification Methods and Applications. Advances in Applied Energy, p.100054.

46. Li, H., **Wang, Z.**, Hong, T., Parker, A. and Neukomm, M., 2021. Characterizing patterns and variability of building electric load profiles in time and frequency domains. Applied Energy, 291, p.116721.

47. Li, H., **Wang, Z.** and Hong, T., 2021. Occupant-Centric key performance indicators to inform building design and operations. Journal of Building Performance Simulation, pp.1-29.

48. Hong, T., **Wang, Z.**, Luo, X. and Zhang, W., 2020. State-of-the-art on research and applications of machine learning in the building life cycle. Energy and Buildings, p.109831. (highly cited paper)

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51. Luo, M., **Wang, Z.**, Zhang, H., Arens, E., Filingeri, D., Jin, L., Ghahramani, A., Chen, W., He, Y. and Si, B., 2020. High-density thermal sensitivity maps of the human body. Building and Environment, 167, p.106435.

52. Luo, M., **Wang, Z.**, Brager, G., Cao, B. and Zhu, Y., 2018. Indoor climate experience, migration, and thermal comfort expectation in buildings. Building and Environment, 141, pp. 262-272

53. Lin, B., **Wang, Z.**, Sun, H., Zhu, Y. and Ouyang, Q., 2016. Evaluation and comparison of thermal comfort of convective and radiant heating terminals in office buildings. Building and Environment, 106, pp.91-102.

54. Lin, B., **Wang, Z.**, Liu, Y., Zhu, Y. and Ouyang, Q., 2016. Investigation of winter indoor thermal environment and heating demand of urban residential buildings in China's hot summer–Cold winter climate region. Building and Environment, 101, pp.9-18.

55. Perera, A.T.D., Zhao, B., **Wang, Z.**, Soga, K. and Hong, T., 2023. Optimal design of microgrids to improve wildfire resilience for vulnerable communities at the wildland-urban interface. Applied Energy, 335, p.120744.

56. Yuan, Y., Chen, Z., **Wang, Z.**, Sun, Y. and Chen, Y., 2023. Attention mechanism-based transfer learning model for day-ahead energy demand forecasting of shopping mall buildings. Energy, 270, p.126878.

57. Su, Y., Cheng, H., **Wang, Z.**, Yan, J., Miao, Z. and Gong, A., 2023. Analysis and prediction of carbon emission in the large green commercial building: A case study in Dalian, China. Journal of Building Engineering, 68, p.106147.

58. Su, Y., Cheng, H., **Wang, Z.** and Wang, L., 2022. Impacts of the COVID-19 lockdown on building energy consumption and indoor environment: A case study in Dalian, China. Energy and Buildings, 263, p.112055.

59. Guo, X., Lee, K., **Wang, Z.** and Liu, S., 2021. Occupants' satisfaction with LEED-and non-LEED-certified apartments using social media data. Building and Environment, p.108288.

60. He, Y., Zhou, Y., **Wang, Z.**, Liu, J., Liu, Z. and Zhang, G., 2021. Quantification on fuel cell degradation and techno-economic analysis of a hydrogen-based grid-interactive residential energy sharing network with fuel-cell-powered vehicles. Applied Energy, 303, p.117444.

61. Chen, B., Jin, M., **Wang, Z.**, Hong, T. and Bergés, M., 2020, November. Towards Off-policy Evaluation as a Prerequisite for Real-world Reinforcement Learning in Building Control. In Proceedings of the 1st International Workshop on Reinforcement Learning for Energy Management in Buildings & Cities (pp. 52-56).

62. Hong, T., Chen, C.F., **Wang, Z.** and Xu, X., 2020. Linking human-building interactions in shared offices with personality traits. Building and Environment, 170, p.106602.

63. Jiang, Y., Luo, Z., **Wang, Z.** and Lin, B., 2019. Review of thermal comfort infused with the latest big data and modeling progresses in public health. Building and Environment, 164, p.106336.

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65. Geng, Y., Ji, W., **Wang, Z.**, Lin, B. and Zhu, Y., 2018. A review of operating performance in green buildings: Energy use,

indoor environmental quality and occupant satisfaction. Energy and Buildings. 183, pp.500-514. (highly cited paper)

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67. Cho, B., Dayrit, T., Gao, Y., **Wang, Z.**, Hong, T., Sim, A. and Wu, K., 2020, December. Effective Missing Value Imputation Methods for Building Monitoring Data. In 2020 IEEE International Conference on Big Data (Big Data) (pp. 2866-2875). IEEE.

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