

JUWAN HA

College of Design, North Carolina State University, Raleigh, NC, USA

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Education

North Carolina State University

Raleigh, NC, USA

Ph.D. in Design (Design for Energy and Sustainability)

Aug. 2022 – Present

- Advisor: Prof. Soolyeon Cho
- Dissertation: *NC STATE Energy Hub* - Developing a Virtual Testbed for Implementing Control Strategies in Grid-Interactive Smart Campus Buildings- (Ongoing)

Gyeongsang National University

Jinju, South Korea

M.E. in Architectural Engineering

Aug. 2017 – Aug. 2019

- Advisor: Prof. Young-hak Song
- Thesis: A Study on Circulation Pump Configuration and Cooling Tower Control for Improving the Efficiency of Cooling Source System in Buildings “**Outstanding Master's Thesis Award (AIK)**”

Gyeongsang National University

Jinju, South Korea

B.S. in Architectural Engineering

Mar. 2011 – Aug. 2017

- Thesis: A Study on the Quantitative Understanding of Cost-saving Effects of Thermal Storage Operations
- Completion of Accreditation Board for Engineering Education of Korea (ABEEK)

Interests and Skills

Interests

- Grid-Interactive Connected Community for Supporting Microgrid
- Grid-edge resource (Grid-Interactive Efficient Building (GEB), Vehicle to Building (V2B))
- Coordinated or Cooperative energy management from building level up to urban level.
- Energy efficiency improvement of Building HVAC&R systems.
- Building HVAC&R system control for robustness and stability.

Modelling	Model-based (Data-driven (Physics-informed, Black-box) Physics-based), Model-free.
Control	Coordinated Control, Deep Reinforcement Learning (DRL), Multi-agent Reinforcement Learning (MARL), Model Predictive control (MPC), Robust control
Etc.	Smart Buildings, Zero Energy Buildings (ZEB), Retrofit, District Cooling Plant, Data Center, Combined Heat and Power (CHP), Distributed Energy Resources (DERs: Electric Vehicle, Battery Energy Storage System (BESS), Thermal Energy Storage (TES), Building Envelope as Virtual Battery), Fault Detection and Diagnosis (FDD), Convex Optimization.

Skills

Programming Language	Python (PyTorch, Gym, CVXPY, SALib, Eppy), MATLAB (Simulink).
Software	Modelica Building Library, EnergyPlus & Openstudio, DesignBuilder, JEPlus, BCVTB, FlowMaster, ArcGIS.

Research Experience

Synthetic study on the energy potential of solar power systems at community level using AI and spatiotemporal data (Next-Generation Science & Technology (S&T) Leaders NET, Korean Federation of Science & Technology Societies (KOFST))

Principal Investigator (PI)

NCSU., Raleigh, NC, USA.

Apr. 2024 – Dec. 2024

- Wrote the proposal and lead the project with 2 Ph.D. students in NCSU.
- Target Community: NCSU Campus / Tool: ArcGIS and Pytorch

Development of EMS with Optimal Control Algorithm for Energy Efficiency Improvement in Commercial Building Using AI and Digital Twin Technology (MOTIE of Korea, No.20014154)

Graduate Research Assistant

BET Lab., NCSU., Raleigh, NC, USA.

Aug. 2022 – Dec. 2024

- Real-time Model predictive control (MPC) using machine learning.
- Experience with building automation system and protocols (BACNet using BACpypes)
- Target building: Fitts-Woolard Hall (Office, Class, Laboratory; NCSU), Home manufacturing factory building (Columbia, SC)
- Target system: Packaged air conditioning system (rooftop unit (RTU), ground mounted unit (GMU)), VRF system (Heat pump), Chiller, Boiler, Dedicated Outdoor Unit system (DOAS)

A Development of One-day Build-up Modular Airborne Infection Isolation Ward based on Free-plan (MOHW of Korea, No. HG22C0044)

Graduate Research Assistant

BEL Lab., Gyeongsang National Univ., Jinju, Korea.

Apr. 2022 – Aug. 2022

- Mechanical, Electrical, and Plumbing (MEP) system development of Modular Negative Pressure Isolation rooms (NPIR)
- Contributed to full proposal writing and concept development

Green remodeling(retrofit) regional hub platform project. - Gyeongsang Province- (MOLIT of Korea)

Graduate Research Assistant

BEL Lab., Gyeongsang National Univ., Jinju, Korea.

Oct. 2020 – Aug. 2022

- Finding ways to improve the aging of public and medical facilities mainly used by the socially disadvantaged and to improve indoor air quality and energy performance
- Promotion of regional industrial ecosystem creation and capacity strengthening of public building green remodeling project, which is one of the core projects of the Korean New Deal

A study on primary system retrofit methods for high energy performance. (NRF of Korea, No. 2017R1A2B2006424)

Graduate Research Assistant

BEL Lab., Gyeongsang National Univ., Jinju, Korea.

Mar. 2020 – Feb. 2022

- Development of a method to efficiency improvement of central chilled water system
- Energy cut-off evaluation with low liquid to gas ratio operation of cooling tower
- Development control algorithm of cooling tower for low-approach temperature on Python EMS
- Verification of low-temperature condenser water and operation time in HVAC&R system

Development of THI chart for each type of livestock and poultry and THI internal cage prediction model (RDA of Korea, No. PJ013446)

Graduate Research Assistant

BEL Lab., Gyeongsang National Univ., Jinju, Korea.

Jan. 2018 – Dec. 2019

- Development of the heat-wave notification system for layer chicken
- CFD simulation analysis on windowless laying hen houses which employing a cross or tunnel -type ventilation system
- Verification of thermal environment and development THI Index prediction model of laying hen house
- Measurement and Verification (M&V) of actual laying hen house

A study on economic analysis of altitude tracking PV systems. (Gyeongsang National Univ., UNIC-Lab program)

Graduate Research Assistant

BEL Lab., Gyeongsang National Univ., Jinju, Korea.

Jul. 2017 – Nov. 2017

- Technology proposal of PV systems according to the altitude tracking of the sun
- Energy savings and economic analysis of altitude tracking PV systems

Publications

Journals

- J16** **J.W. Ha**, S.M. Lee, S.Y. Cho., "Practical VRF Heat Pump Modeling using Physics-Informed Neural Networks (PINNs) with Multi-Fidelity Data sets for Model Predictive Control (MPC). (In-Progress)
- J15** K.H. Kim, Y.J. Kim, **J.W. Ha**, Y.H. Song "Development of Integrated Loop Control Algorithm for Improvement of Water-side Economizer Efficiency and Expansion", International Journal of Refrigeration (I.F. 3.5), submitted (under review).
- J14** **B.M. Seo, J. W. Ha**, Y. B. Yoon, S. Y. Cho "Energy Consumption in Office Building using ANN based AHU-DAT Control with Cooling Load-interval Division Methods", Journal of Building Engineering (I.F. 7.144), submitted (under review).
- J13** Y.J. Kim, K.H. Kim, **J.W. Ha**, Y.H. Song "Research on a Plan of Free Cooling Operation Control for the Efficiency Improvement of Water-side Economizer", Energies (I.F. 3.2), 2024, 17(12), 2804.
- J12** **J. W. Ha**, Y. J. Kim, Y. H. Song "Energy Saving Evaluation with Low Liquid to Gas Ratio Operation in HVAC&R system", Energies (I.F. 3.252), 2022, 15, 7327.
- J11** Y. J. Kim, **J. W. Ha**, Y. H. Song "Energy Efficiency Analysis on Free Cooling Operation Mode with Water-side Economizer System in Data Center", Journal of KIAEBS, Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS), Vol. 16, No. 1, pp. 1-13, Feb. 2022.
- J10** **J. W. Ha**, Y. J. Kim, H. Y. Kim, Y. H. Song "Development of Control Algorithm for Cooling Tower Low-Approach Temperature", Journal of KIAEBS, Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS), Vol. 15, No. 5, pp.431-442, Oct. 2021.
- J9** S. C. Park, **J. W. Ha**, K. S. Park, Y. H. Song "Sensitivity Analysis and Bayesian MCMC based on Artificial Neural Network Surrogate Model for Input Variable Uncertainty Calibration", Journal of KIAEBS, Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS), Vol. 15, No. 4, pp.326-337, Aug. 2021. "**Annual Best Paper**"
- J8** Y. J. Kim, **J. W. Ha**, K. S. Park, Y. H. Song "A Study on the Energy Reduction Measures of Data Centers through Chilled Water Temperature Control and Water-side Economizer", Energies (I.F. 3.004), 2021, 14(12), 3575.

- J7** Y. J. Kim, **J. W. Ha**, K. S. Park, K.H. Lee, Y. H. Song "Energy Evaluation of Data Center with Low Cooling Water Temperature and Free Cooling", Journal of KIAEBS, Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS), Vol. 14, No. 5, pp.427-438, Oct. 2020. "**Annual Best Paper**"
- J6** **J. W. Ha**, Y. J. Kim, H. Y. Kim, Y. H. Song "Verification of Low-temperature Condenser Water and Operation Time considering Climate Zones", Journal of KIAEBS, Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS), Vol. 14, No. 3, pp.298-309, Jun. 2020.
- J5** **J. W. Ha**, H. H. Chang, K. J. Cha, Y. H. Song "Verification of Thermal Environment and THI Prediction Equation of Hen House by Field Measurement and Model-based Simulation", Journal of KIAEBS, Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS), Vol. 14, No. 2, pp.208-219, Apr. 2020.
- J4** **J. W. Ha**, S. Y. Cho, H. Y. Kim, Y. H. Song, "Annual Energy Consumption Cut-off with Cooling System Design Parameter Changes in Large Office Buildings", Energies (I.F. 2.707), 2020, 13(8), 2034.
- J3** **J. W. Ha**, K. S. Park, H. Y. Kim, Y. H. Song "A Study on Annual Cooling Energy Consumption Cut-off with Cooling Tower Control Change", Journal of KIAEBS, Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS), Vol.13, No.6, pp.503-514, Dec. 2019.
- J2** S. C. Park, **J. W. Ha**, H. Y. Kim, Y. H. Song, "An Operation Status of Library Building using BEMS Data -Energy Performance Evaluation on Initial Stage of Completion-", Journal of KIAEBS, Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS), Vol. 12, No. 6, pp.669-679, Dec. 2018.
- J1** **J. W. Ha**, K. S. Park, H. Y. Kim, Y. H. Song "A Study of Zero Energy Building Verification with Measuring and Model-based Simulation in Exhibition Building", ARCHITECTURAL RESEARCH, Architectural Institute of Korea (AIK), Vol. 20, No. 3, pp.93-102, Sep. 2018. "**Annual Best Paper**"

Conferences

- C14** **J.W. Ha**, S.M. Lee, S.Y. Cho, "Automated Energy Retrofit Potential Analysis of Building using Large Language Model-Based Energyplus (LLM-Based Energyplus)", 2025 Architectural Research Centers Consortium (ARCC) International Conference, College Park, MD & Washington DC, USA, April 2-5, 2025., (In-Progress).
- C13** S.W. Ham, S.J. Lee, **J.W. Ha**, D.H. Kim, "Development of the AI-tech assistant to transfer research outcome knowledge for accelerating low-cost MPC technology deployment", 2025 ASHRAE Winter Conference, Orlando, FL, USA, February 10-12, 2025., submitted (under review).
- C12** S.M. Lee, **J. W. Ha**, S.Y. Cho "A Review of Federated Learning Applications in Building Energy Management", US-KOREA Conference on Science, Technology and Entrepreneurship (UKC) 2024, San Francisco, California, USA, August 21-24, 2024.
- C11** **J. W. Ha**, S.M. Lee, S.Y. Cho "Development of Heat pump prediction model based on limited experimental data in Factory Building", US-KOREA Conference on Science, Technology and Entrepreneurship (UKC) 2024, San Francisco, California, USA, August 21-24, 2024. (Poster)
- C10** **J.W. Ha**, S.M. Lee, S.Y. Cho, "Development of Roof Top Unit (RTU) Prediction Model Based on Limited Experimental Data", Graduate Student Research Symposium, NC STATE, NC, USA, April 3, 2024. (Poster)
- C9** S.M. Lee, **J. W. Ha**, J.H. Kim, S.Y. Cho "An Empirical Analysis of Korean Household Appliance Use Patterns: using a national Time Use survey dataset", US-KOREA Conference on Science, Technology and Entrepreneurship (UKC) 2023, Dallas, Texas, USA, August 2-5, 2023.
- C8** **J. W. Ha**, B.M. Seo, S.M. Lee, S.Y. Cho "Fast Load Prediction Model of Chiller Using Bayesian Optimization", US-KOREA Conference on Science, Technology and Entrepreneurship (UKC) 2023, Dallas, Texas, USA, August 2-5, 2023.

- C7** **J. W. Ha**, Y. J. Kim, Y. H. Song "A Study on the Verification Approach Temperature of Cooling Tower according to the Change L/G Ratio", Autumn Conference for Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS), Chungju, Republic of Korea, Nov. 2020.
- C6** Y. J. Kim, **J. W. Ha**, Y. H. Song "A Study on the Cooling Performance of Water-side Economizer System on The Chilled Water Return-side Applying Partial Operation", Autumn Conference for Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS), Chungju, Republic of Korea, Nov. 2020. **"Best Paper Award of Fall Conference"**
- C5** Y. J. Kim, **J. W. Ha**, Y. H. Song "A Study on the Cooling Energy Consumption Cut-off in the Intermediate Season of the Data Center" Summer Conference for The Society of Air-conditioning and Refrigerating Engineers of Korea (SAREK), Pyeongchang, Republic of Korea, Jun. 2020.
- C4** S. C. Park, **J. W. Ha**, Y. J. Kim, Y. H. Song "A Study on the Thermal Storage Loss Rate for the Geothermal Storage System", Autumn Annual Conference of Architectural Institute of Korea (AIK), Daejeon, Republic of Korea, Oct. 2019.
- C3** **J. W. Ha**, Y. H. Song "Comparison Analysis of Temperature and Humidity Index (THI) according to Ventilation Type of laying house", Autumn Conference for Busan-Ulsan-Gyeongnam Chapter of Architectural Institute of Korea (AIK), Jinju, Republic of Korea, Nov. 2018.
- C2** **J. W. Ha**, Y. H. Song "THI Index within Laying house according to the Predicted Outside Temperature", Autumn Conference for Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS), Incheon, Republic of Korea, Nov. 2018.
- C1** **J. W. Ha**, Y. H. Song "A Study on Economic Analysis for Adapting Ice Thermal Storage System to Retrofit of Heat Source System", Autumn Conference for Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS), Seoul, Republic of Korea, Nov. 2017.

Honors and Awards

Awards

- 2024 Next-Generation Science & Technology (S&T) Leaders NET, Korean Federation of Science & Technology Societies (KOFST).
- 2022 Annual Best Paper Award, Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS).
- 2021 Annual Best Paper Award, Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS).
- 2020 Best Paper Award of Fall Conference, Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS).
- 2020 GNU Young Pioneer Researcher Award, Gyeongsang National University.
- 2020 Outstanding Master's Thesis Award, Architectural Institute of Korea (AIK).
- 2019 GNU Young Pioneer Researcher Award, Gyeongsang National University.
- 2019 Annual Best Paper Award, Architectural Institute of Korea (AIK).
- 2018 Excellence Award, Waryong Mountain sustainable design competition (\$1,000), Samcheonpo Headquarters of Korean South-East power Co. (KOEN).
- 2017 Bronze Prize, Portfolio contest, Accreditation Board for Engineering Education of Korea (ABEEK)
- 2017 Excellence Award, LINC-GPP, Gyeongsang National University.
- 2017 Best Award, Portfolio contest, Pusan National University (South Gyeongsang province chapter)
- 2017 Golden Prize, Portfolio contest (\$300), Gyeongsang National University.

Scholarships

2024	US-Korea Conference (UKC) 2024 Travel Support, Korean-American Scientists and Engineers Association (KSEA) <ul style="list-style-type: none"> 37th US-Korea Conference on Science, Technology, and Entrepreneurship (Aug. 21-24) Venue: San Francisco, CA, USA
2024	IIBEC Travel Fellowship (\$2,500) <ul style="list-style-type: none"> 2024 International Convention and Trade show (Mar. 8-11) Venue: Phoenix, AZ, USA
2024	Ph.D. Travel Scholarship (\$1,000), North Carolina State University <ul style="list-style-type: none"> 2024 ASHRAE WINTER CONFERENCE (Jan. 20-24) Venue: Chicago, Illinois, USA
Jan 2024 - Dec 2024	Kennan Institute for Engineering, Technology, and Science (KIETS) Climate Leaders Program Scholarship, North Carolina State University (\$13,000) <ul style="list-style-type: none"> The KIETS Climate Leaders Program focuses on mitigating or reversing the negative effects of climate change via technical, managerial, political, or economic approaches that, if adopted, will help humanity deal with this existential threat. Scholar's work with their faculty mentors to grow their leadership capacities through presentations held by industry leaders and professional internships with sustainably-focused ventures.
2023	US-Korea Conference (UKC) 2023 Travel Support, Korean-American Scientists and Engineers Association (KSEA) <ul style="list-style-type: none"> 36th US-Korea Conference on Science, Technology, and Entrepreneurship (Aug. 2-5) Venue: Dallas, TX, USA
2023	AEE Scholarship (\$1,000), AEE Foundation
2023	IIBEC Travel Fellowship (\$2,500) <ul style="list-style-type: none"> 40th IIBEC International Convention and Trade show (Mar. 3-6) Venue: Houston, TX, USA
2023	Ph.D. Travel Scholarship (\$1,000), North Carolina State University <ul style="list-style-type: none"> 2023 ASHRAE WINTER CONFERENCE (Feb. 5-8) Venue: Atlanta, GA, USA
2022-2023	University Graduate Fellowships (\$4,000), North Carolina State University <ul style="list-style-type: none"> This fellowship is awarded to outstanding new doctoral students
Spring 2017	Pioneer C Scholarships (\$1,220), Gyeongsang National University <ul style="list-style-type: none"> This scholarship is awarded to students with outstanding academic achievement
Fall 2016	Pioneer A Scholarship (\$1,760), Gyeongsang National University <ul style="list-style-type: none"> This scholarship is awarded to a student with the highest academic achievement in the semester
Fall 2016	Global Pioneer Program Scholarships (\$1,800), Gyeongsang National University <ul style="list-style-type: none"> This scholarship supports students for overseas field tours relevant to green building, building retrofit trip to visit Sheffield Univ. (UK), KU Leuven Univ. (Prof. Staf Roels, Belgium), Physibel (Prof. Piet Standaert, Belgium), Scheldebouw of Permasteelisa Group (Group R&D Manager. Henk De Bleecker, Belgium), Green Buildings (UK, Netherlands, Germany), etc.
Spring 2016	Internationalization B Scholarship (\$700), Gyeongsang National University
Spring 2016	Gyeongsang Scholarships (\$2,160), Gyeongsang National University <ul style="list-style-type: none"> This scholarship is awarded to a student in first place in the Department of Architectural Engineering
2016	Seonghwa Industrial Corporate Scholarships (\$2,000)
Fall 2015	Pioneer C Scholarships (\$1,000), Gyeongsang National University <ul style="list-style-type: none"> This scholarship is awarded to students with outstanding academic achievement

Assistantships

2022-Present	Research Assistant, North Carolina State Univ. (\$21,000 For 1 Year)
2021	Research Assistant, Gyeongsang National Univ. (\$20,500 For 1 Year)
2020	Research Assistant, Gyeongsang National Univ. (\$21,500 For 1 Year)
Spring, 2019	Teaching Assistant, Gyeongsang National Univ. (\$1,200 For 1 Semester)
2019	Research Assistant, Gyeongsang National Univ. (\$19,400 For 1 Year)
2018	Research Assistant, Gyeongsang National Univ. (\$21,600 For 1 Year)

Patents and Certificates

Patents

- P3** "Operation Control System and Method for High Difference and Low Condensing Temperature Water on Cooling Towers", Patent application:10-2021-0048529. Patent registration: 10-2325379. Republic of Korea.
- P2** "The Notification System for Layer chicken", Patent application: 10-2019-0173894. Patent registration: 10-2363864. Republic of Korea
- P1** "Method for Predicting a Temperature-Humidity Index in a Windowless Laying Hen Houses Which Employing a Cross-Type or Tunnel Type Ventilation System", Patent application: 10-2019-0064580. Patent registration: 10-2308895. Republic of Korea.

Certificates

- CERT5** "Certificate of Attendance", Climate Change AI Summer School 2024, June 20 - August 05, 2024.
- CERT4** "Certificate of Attendance", Climate Change AI Summer School 2023, June 23- July 26, 2023.
- Climate Change AI is a global non-profit that catalyzes impactful work at the intersection of climate change and machine learning. -
- CERT3** "Certificate of Engineer Building Facilities", The Human Resources Development Service of Korea, Republic of Korea, 2018.
- CERT2** "Building Energy Analysis Skill UP Training (Based on ISO 13790, DIN V18599)", Institute for Passive Zero Energy Building (IPAZEB), 2017.
- CERT1** "Certificate of Engineer Architecture", The Human Resources Development Service of Korea, Republic of Korea, 2017.

Professional Experience

Journal Reviewer *2023 – Present*
· Energy and AI

ASHRAE Technical Committees (TC) *2023 – Present*
· TC 6.2: District Energy
· TC 7.5: Smart Building Systems
· TC 9.9: Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment

ASHRAE Technical Paper Reviewer *Jun. 2024 - Present*
· 2025 ASHRAE Winter Conference (Orlando, FL)
· 2024 ASHRAE Annual Conference (Indianapolis, IN)

Research Affiliate Lawrence Berkely National Laboratory (LBNL), Berkeley, CA, USA.
Jun. 2024 – Aug. 2024

President ASHRAE at NC STATE Univ., Raleigh, NC, USA.

Vice-President	Aug. 2024 – Present Aug. 2023 – Jul. 2024
Member	Student Energy Club at NC STATE Sep. 2023 - Present
Secretary	PhD Student Association (PhDSA), Ph.D. in Design, NC STATE Aug. 2023- Aug. 2024
Graduate research assistant	BET Lab., NC STATE Univ., Raleigh, NC, USA. Aug. 2022 – Present
Graduate research assistant	BEL Lab., Gyeongsang National Univ., Jinju, South Korea. Sep. 2017 – Aug. 2022
Administrative assistant	Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS) – Yeong Nam (YN) chapter Jul. 2020 – Mar. 2021
Teaching assistant	Gyeongsang National Univ., Jinju, South Korea Spring, 2019
Administrative assistant	Architectural Institute of Korea (AIK) Busan-Gyeongnam chapter Apr. 2018 – Mar. 2019
Construction field engineer intern Singapore Marina One Site: LEED Platinum, BCA Green Mark Platinum	HYUNDAI E&C Co., Singapore Jan. 2017 – Feb. 2017
Tactical aircraft maintenance crew	Republic of Korea Air Force., Sacheon, South Korea Sep. 2012 – Sep. 2014

Other Activities

Seminar

2024 Summer	Climate Change AI Summer School (Virtual Session)
2023-Present	ACM SIGEnergy Graduate Student Seminar.
2023 Summer	Climate Change AI Summer School (Virtual Session)

Workshops

2017	The 2 nd Joint Workshop of Architectural Engineering: Gyeongsang National Univ. (South Korea) & Kyushu Univ. (Japan)
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Professional Affiliations

2023-Present	Student Member, Association of Energy Engineers (AEE)
2023-Present	Student Member, International Institute of Building Enclosure Consultants (IIBEC)
2023-Present	Student Member, Association for Computing Machinery (ACM) SIGEnergy
2022-Present	Member, Korean Building Scientists and Engineers Association (KOBSIE) in USA
2022-Present	Student Member, American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
2023-Present	Student Member, Korean American Scientists & Engineers Association (KSEA)
2018-Present	Member, International Building Performance Simulation Association (IBPSA)
2018-Present	Member, Architectural Institute of Korea (AIK)
2017-Present	Member, Korean Institute of Architectural Sustainable Environment and Building Systems (KIAEBS)