

BYEONGMO SEO

College of Design, North Carolina State University, Raleigh, NC, 27607, USA.
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SUMMARY

- 8 years of research experience in building science/engineering, including HVAC systems, building energy modeling, deep learning, thermal comfort, and optimal control
- 50+ total publications: 19 published/accepted journal papers; 24 conference papers; 9 peer-reviewed reports
- Special expertise: building energy simulation and data analysis; energy performance evaluation, and deep learning-based control & optimization
- Research experience with National Research Institutes and Universities in Republic of Korea

EDUCATION

Ph. D. in Design (Design for Energy and Sustainability), College of Design, North Carolina State University,

Raleigh, NC, United States **Aug. 2018 – May. 2023**

- Area of Concentration: Building Energy Savings, Building Simulation, HVAC System, Optimal Control, Deep Learning Technology
- Ph.D. Dissertation: Development of HVAC Optimal Control Algorithm for Cooling Energy Efficiency Improvement in Commercial Building Using Machine Learning and Digital Twin Technology
- Advisor: Soolyeon Cho, Ph.D.
- GPA: 3.87/4.0

Master of Science, Department of Architectural Engineering, Hanbat National University, Daejeon, Republic of Korea

Aug. 2017

- Areas of Concentration: Building Energy and HVAC systems
- Master's Thesis: Comparison of Cooling Energy Performance Between Conventional AHU System and DX AHU-Water Source VRF Heat Pump System in an Office Building
- Advisor: Kwang Ho Lee, Ph.D.
- GPA: 4.0/4.0

Bachelor of Science, Department of Architectural Engineering, Hanbat National University, Daejeon, Republic of Korea

Feb. 2015

- GPA: 3.23/4.0

TEACHING AND RESEARCH EXPERIENCE

Graduate Teaching Assistant, Hanbat National University, Daejeon, Korea

Sep. 2016 – Jun. 2017

Graduate Research Assistant, Hanbat National University, Daejeon, Korea

Mar. 2015 – Aug. 2017

North Carolina State University, Raleigh, NC, United States **Aug. 2018 – Present**
01/13/2023

Ph.D. Graduate Research Assistant, North Carolina State University, NC, United States Aug. 2018 – Present

- Development of EMS with Optimal Control Algorithm for Energy Efficiency Improvement in Commercial Building Using AI and Digital Twin Technology, Korea Evaluation Institute of Industrial Technology, Republic of Korea, Apr. 2021 – Present
- Development of AI-Based Optimal Control Algorithms for Efficient Supply of Energy Resources, Korea Energy Technology Evaluation and Planning, Republic of Korea, May. 2019 – Apr.2022
- Development of AI ANN-Based Load Prediction Model for Optimal Control of MMHP Systems, Institute of Information & Communications Technology Planning & Evaluation (IITP), Republic of Korea, Jul. 2019 – Dec.2020
- Artificial Intelligence Model Development for the Energy Optimization of Smart City Living Lab, Republic of Korea Institute of Construction Technology, Republic of Korea, Oct. 2018 –Sep.2020
- Development of an IoT-based Smart Modular Envelope Package for Green Remodeling and IEQ Improvement, Korea Energy Technology Evaluation and Planning, Republic of Korea, Jan. 2018 – Jan. 2020

Master's Graduate Research Assistant, Hanbat National University, Republic of Korea Mar. 2015 – Aug. 2017

- Development of an Artificial Neural Network & Deep-Learning Based Occupant Behavior Recognition and MET Estimation Model for improving Accuracy of PMV Prediction (10%) and Building Energy Efficiency (5%), Ministry of Land, Infrastructure, and Transport, South Korea. Apr. 2017 – Aug. 2017
- Development of Vertical Closed Loop Geothermal Heat Exchanger and GSHP System for Performance Enhancement, Korea Institute of Energy Technology Evaluation and Planning, Republic of Korea, Dec. 2016 – Aug. 2017
- Artificial Intelligence and MPC Based Optimized Operation Tool Development for DX AHU-Water Source VRF System, Samsung Electronics, Republic of Korea, Apr. 2016 – May. 2017
- Development and Experimental Validation of Heat Pump VRF System Simulation Model and Library, Samsung Electronics, Republic of Korea, May. 2015 – Oct. 2015

JOURNAL PUBLICATIONS

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- [1] **Byeongmo Seo, Yeobeom Yoon, Kwang Ho Lee, and Soolyeon Cho**, “Comparative Analysis of Cooling Energy Performance Between ANN and LSTM based AHU system control methods in a Commercial Building”, *Buildings (I.F. 3.601)*, 2023. (Under the review)
- [2] **Jiwon Park, Sung Hyup Hong, Sang Hun Yeon, Byeongmo Seo, and Kwang Ho Lee**, “Predictive Model for Solar Insolation Using the Deep Learning Technique,” *International Journal of Energy Research (IF: 5.164)*, Jan. 2023.
- [3] **Yeobeom Yoon, Byeongmo Seo, Jinmog Han, Kwang Ho Lee, and Soolyeon Cho**, “Trends of Research on Building Energy Efficiency utilizing Artificial Intelligence Technologies – Focused on International Journal Papers-“, *Journal of Korea Institute of Ecological Architecture and Environment (KIEAE) Journal*, Dec. 2020.

- [4] Yeo Beom Yoon, **Byeongmo Seo**(co-first author), Brian Baewon Koh, and Soolyeon Cho, “An analysis of energy consumption influenced by floor levels after installation of multi-functional double-skin façade,” *Frontier in Energy (I.F. 1.701)*, May. 2020.
- [5] **Byeongmo Seo**, Yeo Beom Yoon, Byeong Ho Yu, Soolyeon Cho and Kwang Ho Lee, “Comparative Analysis of Cooling Energy Performance Between Water-Cooled VRF and Conventional AHU Systems in a Commercial Building,” *Applied Thermal Engineering (I.F. 4.026)*, Vol. 170, 114992, Apr. 2020.
- [6] **Byeongmo Seo**, Yeo Beom Yoon, Jung Hyun Moon, and Soolyeon Cho, “Application of Artificial Neural Network for Optimum Controls of HVAC Systems in Double-Skinned Office Buildings,” *Energies (I.F. 2.707)*, Dec. 2019.
- [7] Yeo Beom Yoon, **Byeongmo Seo**(co-first author), Brian Baewon Koh, and Soolyeon Cho, “Performance Analysis of a Double-Skin Façade System Installed in Different Floor Levels of Highrise Apartment Building,” *Journal of Building Engineering (I.F. 2.378)*, Vol 26, Nov. 2019.
- [8] Jong Man Lee, **Byeongmo Seo**, Sung Hyup Hong, and Kwang Ho Lee, “Application of Artificial Neural Networks for Optimized AHU Discharge Air Temperature Set-point and Minimized Cooling Energy in VAV System,”# *Applied Thermal Engineering (I.F. 3.771)*, Vol. 153, pp. 726 - 738, May. 2019.
- [9] Da Young Lee, **Byeongmo Seo**(co-first author), Sung Hyup Hong, Jong Min Choi, and Kwang Ho Lee. “Part Load Ratio Characteristics and Energy Saving Performance of Standing Column Well Geothermal Heat Pump System Assisted with Storage Tank in an Apartment,” *Energy (I.F. 4.968)*, Vol. 174, pp. 1060-1078, May. 2019
- [10] Sanghun Yeon, Byeongho Yu, **Byeongmo Seo**, Yeobeom Yoon, and Kwang Ho Lee, “ANN Based Automatic Slat Angle Control of Venetian Blind for Minimized Total Load in an Office Building,” *Solar Energy (I.F. 4.374)*, Vol. 180, pp. 133-145, Mar. 2019.
- [11] Da Young Lee, **Byeongmo Seo**(co-first author), Yeo Beom Yun, Sung Hyup Hong, Jong Min Choi, and Kwang Ho Lee, “Heating Energy Performance and Part Load Ratio Characteristics of Boiler Staging in an Office Building,” *Frontiers in Energy (I.F. 0.753)*, Vol. 12, pp. 1-15, Dec. 2018.
- [12] Min Ji Kim, **Byeongmo Seo**(co-first author), Jong Man Lee, Jong Min Choi, and Kwang Ho Lee, “Part Load Ratio Characteristics and Energy Saving Potential of Vertical Closed Loop Ground Source Heat Pump System Combined with Storage Tank in an Office Building,” *Energy and Buildings (I.F. 4.457)*, Vol. 179, pp. 239-252, Nov. 2018.
- [13] Byeong Ho Yu, **Byeongmo Seo**, Sung Hyup Hong, Sang Hun Yeon, and Kwang Ho Lee, “Influences of Different Operational Configurations on Combined Effects of Room Air Stratification and Thermal Decay in UFAD System,” *Energy and Buildings (I.F.4.457)*, Vol. 176, pp. 262-274, Oct. 2018.
- [14] Seong Hyeop Hong, Sang Hun Yeon, **Byeongmo Seo**, Byeong Ho Yu, and Kwang Ho Lee, “PMV based thermal comfort variations depending on MET change,” *Korea Institute of Ecological Architecture and Environment*, Vol. 1, Jan. 2018.
- [15] Sang Hoon Yeon, **Byeongmo Seo**, Je Hyeon Lee, Jin Woo Moon, and Kwang Ho Lee, “Modeling Technique of Artificial Neural Network based Optimized Operation Model through Co-simulation between EnergyPlus and Matlab,” *Korea Green Building Council*, Vol. 18, No 2, pp. 7-15, Jun. 2017.
- [16] **Byeongmo Seo** and Kwang Ho Lee, “Artificial Intelligence and MPC Based Optimized Operation of DX AHU-Water Source VRF System,” *Korean Association of Air Conditioning Refrigerating and Sanitary Engineers*, Vol. 34, No 1, pp. 84-91, Jan. 2017.

- [17] **Byeongmo Seo** and **Kwang Ho Lee**, “Detailed Analysis on Part Load Ratio Characteristics and Cooling Energy Saving of Chiller Staging in an Office Building,” *Energy and Buildings (I.F. 4.457)*, Vol. 119, pp. 309-322, May. 2016.
- [18] **Byeong Mo Seo**, **Jeong Eun Son**, and **Kwang Ho Lee**, “Detailed Analysis on Operation characteristics and Cooling Energy Saving Effect of Chiller Staging in an Office Building,” *The Society of Air-Conditioning and Refrigerating Engineers of Korea*, Vol.28, No 4, pp. 137-144, Apr. 2016.
- [19] **Byeong Mo Seo**, **Byeong Ho Yu**, and **Kwang Ho Lee**, “A Detailed Analysis of the Part Load Ratio and Cooling Energy Characteristics of Chiller Operation in an Office Building,” *The Society of Air-Conditioning and Refrigerating Engineers of Korea*, Vol.27, No 11, pp. 567-573, Nov. 2015.
- [20] **Byeong Ho Yu**, **Byeong Mo Seo**, **Jin Woo Moon**, and **Kwang Ho Lee**, “Analysis of the Part Load Ratio Characteristics and Gas Energy Consumption of a Hot Water Boiler in a Residential Building under Korean Climatic Conditions,” *The Society of Air-Conditioning and Refrigerating Engineers of Korea*, Vol.27, No 9, pp. 455-462, Sep. 2015.

CONFERENCE PAPERS AND PRESENTATIONS

- [1] **Sung Hyup Hong**, **Byeongmo Seo**, **Youngjun Lee**, and **Kwang Ho Lee**, "Comparative Assessment of Predictive Model Accuracy for Solar Insolation Using Artificial Intelligence Technique," *ISHVAC 2021, 12th International Symposium on Heating, Ventilation and Air-conditioning*, Seoul, South Korea, Nov. 2021.
- [2] **Yeobeom Yoon**, **Byeongmo Seo**, **Suwon Song** and **Soolyeon Cho**, “Energy Efficiency Analysis of Various HVAC Operational Strategies in a Public Service Building”, *Proceeding of Conference for US-Korea Conference (UKC) 2020 International Conference, Virtual, Dec. 2020*.
- [3] **Byeongmo Seo**, **Yeobeom Yoon**, **Sangmu Bae**, **Yujin Nam**, and **Soolyeon Cho**, “ANN-based Loads Prediction Model of Multi-source, Multi-use Heat Pump (MMHP) for Net Zero Energy Buildings (ZEBs)”, *Proceeding of Conference for US-Korea Conference (UKC) 2020 International Conference, Virtual, Dec. 2020*.
- [4] **Yeobeom Yoon**, **Byeongmo Seo**, **Suwon Song**, and **Soolyeon Cho**, “Optimal Operation Strategies of Three Different HVAC Systems Installed in a Building”, *Proceeding of Conference for EAAE-ARCC International Conference & 2nd VIBRArch., Valencia, Spain, Nov. 2020*
- [5] **Hany Gaballa**, **Yeobeom Yoon**, **Byeongmo Seo**, and **Soolyeon Cho**, “Application of artificial neural network in solar radiation prediction for real-time simulation”, *Proceeding of Conference for EAAE-ARCC International Conference & 2nd VIBRArch., Valencia, Spain, Nov. 2020*
- [6] **Yeo Beom Yoon**, **Byeongmo Seo**, and **Soolyeon Cho**, “Optimal Control Variables of the Heating, Ventilating, and Air Conditioning System in Commercial Buildings”, *Proceeding of Conference for UKC 2019 International Conference, Chicago, IL, United States, Aug. 2019*.
- [7] **Byeongmo Seo**, **Yeo Beom Yoon**, and **Soolyeon Cho**, “Development Method of ANN-Based Load Prediction Model for the HVAC Optimal Controls”, *Proceeding of Conference for UKC 2019 International Conference, Chicago, IL,*

United States, Aug. 2019.

- [8] **Byeongmo Seo, Yeo Beom Yoon, Suwon Song, and Soolyeon Cho**, "ANN-based thermal load prediction approach for advanced controls in building energy systems," *Proceeding of Conference for ARCC 2019 International Conference, Toronto, Canada, May. 2019.*
- [9] **Yeo Beom Yoon, Byeongmo Seo, Traci Rose Rider, and Soolyeon Cho**, "Application of Artificial Intelligence Algorithms in Smart Building Systems: A literature review", *Proceeding of Conference for ARCC 2019 International Conference, Toronto, Canada, May. 2019.*
- [10] **Byeongmo Seo, Kwang Ho Lee, Soolyeon Cho**, "Comparison of Cooling Energy Consumption between Conventional AHU System and DX AHU-Water Source VRF Heat Pump System in an Office Building," *UKC 2018, US-KOREA Conference on Science, Technology and Entrepreneurship, New York City, USA, Aug. 2018.*
- [11] **Da Young Lee, Byeongmo Seo, Jong Min Choi, and Kwang Ho Lee**, "Comparative Analysis of the Heating Energy Performance of SCW Geothermal Heat Pump System with and without Heat Storage Tank," *Summer Conference for The Society of Air-conditioning and Refrigerating Engineers of Korea, Youngpyung, Republic of Korea, Jun. 2018.*
- [12] **Sang Hoon Yeon, Byeongmo Seo, Je Hyeon Lee, Jin Woo Moon, Jong Min Choi, and Kwang Ho Lee**, "Artificial Neural Network based Model Predictive Control for Optimization of Direct Expansion AHU-Water Source VRF System," *UKC 2017, US-KOREA Conference on Science, Technology and Entrepreneurship, Washington DC, USA, Aug. 2017.*
- [13] **Byeongmo Seo, Je Hyeon Lee, and Kwang Ho Lee**, "Comparison of Cooling Energy Performance Between DX AHU-Water Source VRF System and Conventional AHU System in an Office Building," *Summer Conference for The Society of Air-conditioning and Refrigerating Engineers of Korea, Youngpyung, Republic of Korea, Jun. 2017.*
- [14] **Da Young Lee, Byeongmo Seo, Hyuk Ju Kwon, and Kwang Ho Lee**, "Heating performance and partial load ratio characteristics of boiler staging in office building," *Summer Conference for The Society of Air-conditioning and Refrigerating Engineers of Korea, Youngpyung, Republic of Korea, Jun. 2017.*
- [15] **Sanghun Yeon, Jeongeun Son, Byeongmo Seo, and Kwang Ho Lee**, "Impact of the Perimeter Zone Diffuser Slot Angle on Room Air Stratification and Energy Performance in Underfloor Air Distribution System," *Asim 2016, 3rd Asia Conference of International Building Performance Simulation Association, Jeju Island, Republic of Korea, Nov. 2016.*
- [16] **Sanghun Yeon, Byeongmo Seo, Hyuk-Ju Kwon, and Kwang Ho Lee**, "Room Air Stratification and Energy Performance of UFAD System according to Perimeter Zone Diffuser Slot Angle using EnergyPlus," *ICPRE 2016, 2016 International Conference on Power and Renewable Energy, Shanghai, China, Oct. 2016.*
- [17] **Jeong Eun Son, Jae Ho Lee, Byeongmo Seo, and Kwang Ho Lee**, "Impact of the Number of Diffusers on Room Stratification and Energy Performance in UFAD System," *IAQVEC 2016, 9th Intl. Conference on Indoor Air Quality Ventilation & Energy Conservation In Buildings, Incheon, Republic of Korea, Oct. 2016.*
- [18] **Byeong Ho Yu, Keum Ho Lee, Jae Ho Lee, Byeongmo Seo, In Tak Hyun, and Kwang Ho Lee**, "Impact of Raised Access Floor Insulation on Thermal Decay in Underfloor Air Distribution System," *IAQVEC 2016, 9th Intl. Conference on Indoor Air Quality Ventilation & Energy Conservation In Buildings, Incheon, Republic of Korea,*

Oct. 2016.

- [19] Byeong Ho Yu, Byeongmo Seo, Jung-Eun Son, and Kwang Ho Lee, "Impacts of Thermal Decay on the Energy Performance Degradation in UFAD (Underfloor Air Distribution) System," *CLIMA 2016, 12th REHVA World Congress, Aalborg, Denmark, May. 2016*.
- [20] Byeongmo Seo, Byeong-Ho Yu, Jung-Eun Son, Won Keun Lee, and Kwang Ho Lee, "Cooling Performance and Energy Saving Effect of Chiller Staging in an Office Building," *Autumn Conference for Korean Institute of Architectural Sustainable Environment and Building Systems, Busan, Republic of Korea, Nov. 2015*.
- [21] Byeong Ho Yu, Byeongmo Seo, Jung-Eun Son, and Kwang Ho Lee, "The Influence of Thermal Decay on Cooling Energy Consumption in UFAD Compared to CBAD System," *Autumn Conference for Korean Institute of Architectural Sustainable Environment and Building Systems, Busan, Republic of Korea, Nov. 2015*.
- [22] Byeong Ho Yu, Byeongmo Seo, Jin Woo Moon, and Kwang Ho Lee, "Analysis of the Part Load Ratio Characteristics and Gas Energy Consumption of Hot Water Boiler in Korean Residential Building," *Summer Conference for The Society of Air-conditioning and Refrigerating Engineers of Korea, Youngpyung, Republic of Korea, Jun. 2015*.
- [23] Byeongmo Seo, In Tak Hyun, and Kwang Ho Lee, "Development of Excel-based Interface for the Streamlined HVAC System Simulation using EnergyPlus," *Spring Conference for Architectural Institute of Korea, Youngin, Republic of Korea, Apr. 2015*.
- [24] Byeongmo Seo, In Tak Hyun, and Kwang Ho Lee, "Development of Excel-based Interface for the Streamlined VRF System Simulation using EnergyPlus (Focusing on Input Process)," *Spring Conference for The Korean Solar Energy Society, Gwangju, Republic of Korea, Mar. 2015*.

TECHNICAL REPORTS

- [1] Soolyeon Cho, **Byeongmo Seo**, and Juwan Ha "Development of EMS with Optimal Control Algorithm for Energy Efficiency Improvement in Commercial Building Using AI and Digital Twin Technology", *Korea Evaluation Institute of Industrial Technology, Republic of Korea 2022*.
- [2] Soolyeon Cho and **Byeongmo Seo** "Development of AI-Based Optimal Control Algorithms for Efficient Supply of Energy Resources", *Korea Energy Technology Evaluation and Planning, Republic of Korea 2022*.
- [3] Soolyeon Cho and **Byeongmo Seo** "Development of EMS with Optimal Control Algorithm for Energy Efficiency Improvement in Commercial Building Using AI and Digital Twin Technology", *Korea Evaluation Institute of Industrial Technology, Republic of Korea 2021*.
- [4] Yujin Nam, Soolyeon Cho, Yeobeom Yoon, **Byeongmo Seo**, and Sangmu Bae, "Development of AI ANN-Based Load Prediction Model for Optimal Control of MMHP Systems", *Institute of Information & Communications Technology Planning & Evaluation (IITP), Republic of Korea. 2020*.
- [5] Soolyeon Cho, Yeobeom Yoon, and **Byeongmo Seo**, "Artificial Intelligence Model Development for the Energy Optimization of Smart City Living Lab" *Korea Institute of Construction Technology, Republic of Korea. 2020*.
- [6] Soolyeon Cho, Yeobeom Yoon, and **Byeongmo Seo**, "Development of an IoT-based Smart Modular Envelope Package for Green Remodeling and IEQ Improvement", *Korea Energy Technology Evaluation and Planning*,

Republic of Korea, 2019.

- [7] Kwang Ho Lee and **Byeongmo Seo**, “Artificial Intelligence and MPC Based Optimized Operation Tool Development for DX AHU-Water Source VRF System”, *Samsung Electronics, Republic of Korea. 2017.*
- [8] Kwang Ho Lee and **Byeongmo Seo** “Air Conditioner Control Strategy Integrated with Condensation Detection Algorithm, Ministry of Science”, *ICT and Future Planning, Republic of Korea 2016.*
- [9] Kwang Ho Lee and **Byeongmo Seo** “Development and Experimental Validation of Heat Pump VRF System Simulation Model and Library”, *Samsung Electronics, Republic of Korea. 2015*

AWARDS

- [1] **Graduate School Summer Fellowship**, *North Carolina State University, Aug. 2022.*
- [2] **Architectural Design Exhibition Contest**, Excellence Prize, Department of Architectural Engineering, Hanbat National University, Republic of Korea, Dec. 2014.

LEADERSHIP

- [1] **President of Ph.D. Students Association in Design (PHDSA) at North Carolina State University.** Aug. 2020-Jul. 2021.
- [2] **Vice-President of Architectural Engineering**, Hanbat National University, Daejeon, Republic of Korea, Dec. 2012 – Feb. 2014.

SPONSORSHIP

- [1] **Korean-American Scientists and Engineers Association**, *UKC 2019, Aug. 2019 (Travel Support)*
- [2] **RCIF Student Sponsorship**, 34th RCI International Convention and Trade show, Mar. 2019
- [3] **Korean-American Scientists and Engineers Association**, *UKC 2018, Aug. 2018 (Travel Support)*

AFFILIATIONS

- [1] **Architectural Research Centers Consortium**, Student Member, 2019-present
- [2] **RCI International Convention**, Student Member, 2019-present
- [3] **American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)**, Student Member, 2018-present
- [4] **Korean-American Scientists and Engineers Association**, Student Member, 2018-present
- [5] **The Society of Air-conditioning and Refrigerating Engineers of Korea (SAREK)**, Student Member, 2015–

present.

[6] **Architectural Institute of Korea (AIK)**, Student Member, 2015–present.

[7] **The Korean Solar Energy Society (KSES)**, Student Member, 2015–present.

[8] **Korea Institute of Architectural Sustainable Environment and Building Systems (KIAEBS)**, Student Member, 2014–2015.