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Contents

President's message

Dear IBPSA Colleagues and Friends

What a wild weather year… we didn't see warm temperatures (above 38ºC / 100ºF) in Washington, DC until September (normally in July/August). This while the rest of the world was seeing exceptionally high temperatures – including Antarctica and global records above 50ºC / 122ºF in many places.

Back to IBPSA – as you probably saw, we held our annual election over August/September, selecting 5 directors-at-large as well as 11 affiliate directors. Five directors-at-large were re-elected. Let's welcome new affiliate directors Neveen Hamza (IBPSA-England, Newcastle University), Vishal Garg (IBPSA-India, Plaksha University), Paul O'Sullivan (IBPSA-Ireland, Munster Technological University), and Yohei Yamaguchi (IBPSA-Japan, Osaka University). The full list of members of your board is at **www.ibpsa.org/board-of-directors**.

Also, of note – IBPSA-Germany(+Austria) and IBPSA-Switzerland recently merged to form the new IBPSA-DACH (German-speaking affiliate).

If you haven't looked at the IBPSA Publications web page, you should. It's now completely indexed with DOIs, PDFs, and organized by conference: **https://publications.ibpsa.org**. Congratulations and thanks to the Publications committee for their hard work in pulling together the hundreds of papers and thousands of pages of Building Simulation and Regional Conference proceedings.

Speaking of conferences, I was happy to be able to participate in Building Simulation 2023 in Shanghai in early September. It was fantastic to see friends and colleagues post-Covid. Great attendance – both in person and in online-only sessions scheduled for Europe/Africa as well as North American time zones. See the Building Simulation 2023 organizers' report on **page 5**. I want to extend personal thanks to Prof. Yiqun Pan, Conference Chair; Prof. Da Yan, Conference Co-chair; Prof. Borong Lin, Scientific Chair; and Prof. Jun Gao, Scientific Co-chair; on behalf of IBPSA for all their hard work. And particularly thanks to IBPSA-China and to Tongji University and Tsinghua University for allowing these and many others to support the conference. The result was a very successful conference!

At Building Simulation 2023, we announced three awards – Lori McElroy, Distinguished Achievement; Sen Huang, Outstanding Young Contributor; and Rebecca Ward, Godfried Augenbroe Award. 12 new IBPSA Fellows were also recognized in Shanghai - Adrian Chong, Bing Dong, Jing Liu, Michaël Kummert, Zoltan Nagy, Sukumar Natarajan, Masaya Okumiya, Yoshiyuki Shimoda, Liangzhu Wang, Monika Woloszyn, Fu Xiao and Yanping Yuan.

Next year, look for regional conferences. I'm already aware of announcements from IBPSA-USA (SimBuild, May 2024), IBPSA-Ireland (Student Research Symposium, May 2024), IBPSA-Nordic (BuildSim-Nordic, June 2024), IBPSA-Italy (Building Simulation Applications, June 2024), IBPSA- Canada (eSim, June 2024), and IBPSA-DACH (BauSim, September 2024). I'm sure we'll soon be hearing about upcoming ASim (Australasia) as well as U-Sim (Scotland) conferences.

And time to start planning for our next international conference, Building Simulation 2025, in Brisbane, Australia in August 2025: **https://bs2025.org**

Reminder – all IBPSA board and committee meetings are open. We have our Annual General Meeting of the IBPSA membership on 27th October in Dublin. This will be followed by a board meeting on the 27th and 28th. For more info, watch the IBPSA web page. If you are interested and can participate in regular committee meetings, please contact the committee chair (see the website **www.ibpsa.org/contacts** for specific contacts).

Check out the forthcoming calendar of events on **page 35**. Also, of note in this issue of the newsletter is the article on Transforming Education: Innovations in Remote Learning and Experiential Teaching of Building Performance Simulation on **page 19**. Other useful items include software updates, book announcements, and the open calls for submissions to two special issues of the Journal of Building Performance Simulation.

I look forward to seeing more of the IBPSA community over this next year.

Dru Crawley
President IBPSA

Notes from BS 2023

Simulation shapes the better future: A conference of simulation for low carbon design, operation and city

Yiqun Pan and Da Yan, Conference Chairs

IBPSA's 18th International Conference and Exhibition (Building Simulation 2023, BS2023) was held in Shanghai from 4 to 6 September 2023, hosted by Tongji University and Tsinghua University with endorsement from the regional affiliate, IBPSA-China. Professor Yiqun Pan and Professor Da Yan, conference chairs, together with the BS2023 organizing committee, created an efficient, interactive, warm, and safe event.

BS2023 was a hybrid event with a total of 650 attendees from more than 40 countries and regions (441 onsite and 209 online participants). It was one of the largest IBPSA conferences in IBPSA history and the largest international academic conference in the building energy domain in China since the pandemic. Focusing on the theme of **Simulation for the low-carbon design/operation/city**, this conference included 5 keynote speeches, 19 invited speeches, 68 parallel sessions (43 physical and 25 virtual) and 8 workshops (6 physical and 2 virtual), covering 474 oral presentations (266 onsite and 208 online) and 48 poster presentations related to diverse hot topics in the building simulation field including performance-driven design, smart building systems, modeling for the digital world, simulating future metropolis, human-centered simulation/design and so on. The 3-day conference provided a platform for participants to share their latest academic and research progress, including cutting-edge technologies and innovation in building simulation for low-carbon design, operation, and city development.

Conference Review

The conference began with a warm welcoming reception and cocktail in the coffee bar at the conference hotel on Sunday evening.

DAY 1 - 04 September

The first full day opened with a welcome from the organizers Yiqun Pan (conference chair) and Da Yan (conference co-chair), who provided information on the conference and the venue. The opening address was given by Professor Zhiqiang Wu, representing the host - Tongji University, who first welcomed scholars from all over the world to visit China, and by IBPSA's president, Drury Crawley, who introduced the organization and its mission.

The first keynote speech was given by Zhiqiang Wu, an academician of the Chinese Academy of Engineering and a Tongji University professor. Zhiqiang Wu gave an engaging and timely presentation **From Cities to Buildings: Digital Tracking for Carbon Neutrality**, emphasizing the city's decarbonization pathway and the inseparable role of individual buildings in it.

The second keynote speaker was Qingyan Chen, chair professor of building thermal science from the Hong Kong Polytechnic University and the Editor-in-Chief of Building and Environment, whose talk on **Simulations of Airborne Disease Transmissions in Enclosed Environments** analyzed ways to effectively protect people from airborne diseases in enclosed environments such as an airplane cabin.

The first virtual keynote speech was given in the evening by Tianzhen Hong. Tianzhen Hong, a senior scientist in the Building Technology and Urban Systems Division of LBNL, focused his presentation on the nexus of building decarbonization regarding sufficiency, energy efficiency, demand flexibility and climate resiliency.

The day concluded with the conference banquet in the ballroom, with elaborate performances, gifts and toasts to celebrate this wonderful building simulation event and the hard-won biennial gathering.

DAY 2 - 05 September

The second day commenced with the IBPSA award ceremony, where IBPSA announced its new fellows and awardees. Lori McElroy received the IBPSA Distinguished Achievement Award, Sen Huang received the IBPSA Outstanding Young Contributor Award, and Rebecca Ward received the IBPSA Godfried Augenbroe Award, a new award in honor of the late Professor Godfried Augenbroe, recognizing a recent outstanding PhD thesis on the topic of building performance simulation. Finally, 12 people were recognized for their contributions to the field over many years by being made IBPSA Fellows and 5 people received Student Travel Awards for their excellent work in building simulation. In addition, the 2022-2023 Best Paper Award of the Journal of Building Performance Simulation was given to Clotilde Pierson, Marielle P.J. Aarts, and Marilyne Andersen for their co-authored paper **Validation of spectral simulation tools in the context of ipRGC-influenced light responses of building occupants**. The awardees are listed on the following pages. Congratulations to all!

On the evening of 05 September, Lori McElroy, professor of Smart, Resilient Cities in the Department of Architecture at the University of Strathclyde, gave the second virtual keynote speech, **Building Performance Simulation: Challenges and Opportunities in a Changing World**, highlighting the future development of building simulation technology.

After a full day of academic communication, the conference provided the participants with a great opportunity to relax and enjoy the great view of Shanghai – the Huangpu Night River Cruise. The 2-hour cruise tour along the Huangpu River offered a unique view of the distinctive contrasts between classical European architecture and soaring modern skyscrapers from the two sides of the Huangpu River. It was a captivating journey and an unforgettable night for all the participants along the shimmering waters of the Huangpu River, as the iconic lights on the Bund in Shanghai illuminated the night sky.

DAY 3 - 06 September

The third and final day started with keynote speaker Mattheos Santamouris, professor from the University of New South Wales and the Editor-in-Chief of Energy and Buildings. Professor Santamouris delivered a speech on **Regional and Global Overheating and its Impact on Human Beings**, focusing on the relationship between increasingly severe global warming and changes in human physiological and psychological activities.

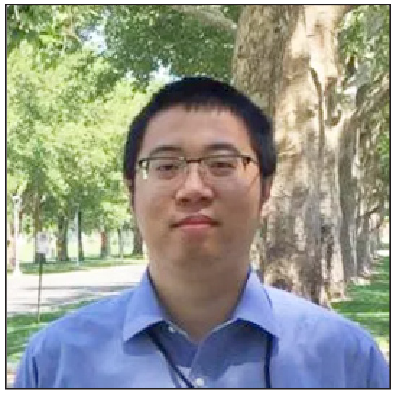
Finally, the conference ended with the closing ceremony, where the BS2023 Awards for the Student Modeling Competition, Best Poster and Best Student Paper were announced as summarized on the following pages. At the closing ceremony, conference chairs Yiqun Pan and Da Yan gave a full review of the conference from its preparation through to its culmination on the final day. The hard work, collaboration, determination, resilience, and unwavering commitment of the whole organizing committee enabled the conference to achieve an excellent outcome. The chairs expressed their sincere thanks to all the participants, sponsors, co-organizers and volunteers who contributed to this. Finally, Quentin Jackson, the current IBPSA Australasia President and the Building Simulation 2025 Conference Chair, sent a cordial greeting to all the participants and warmly welcomed everyone to Brisbane for the next IBPSA event in 2025.

In parallel with the presentations, the conference also organized visits for participants to the Shanghai Tower, Disney Resort Energy Center, and the Student Center of Tongji University, focusing on the energy-saving and low-carbon design of building energy systems. Such demonstration projects provide the most convincing scientific basis for the implementation of energy conservation and emission reduction in the building sector to mitigate climate change.

The 3-day conference ended far too soon, but we believe that by creating an environment that encourages the expression of new ideas and sowing the seeds of continued creative impact, it will bring some lasting benefits. As we bid farewell to this event, let us not forget the bonds we have forged and the friendships we have made. As we look to the future, let us carry forward the spirit of this event. Let us continue to push the boundaries of our potential, explore new frontiers, and strive for excellence in everything we do. The lessons we have learned, the connections we have made, and the inspiration we have gained will guide us towards a brighter tomorrow, so let us use them to shape a better, more inclusive, and prosperous future!

Albums, posters, and recordings are available on the BS2023 website at **https://bs2023.org/gallery, and** proceedings will be soon available on the IBPSA website at **https://publications.ibpsa.org** .

IBPSA Awards 2023


IBPSA Distinguished Achievement Award

Presented to Lori McElroy (above left), this award recognizes her 'distinguished record of contributions to the field of building performance simulation over a long period'.

IBPSA Outstanding Young Contributor Award

This award recognizes an individual at the beginning of their career 'who has demonstrated potential for significant contributions to the field of building performance simulation': Sen Huang (centre)

IBPSA Godfried Augenbroe Award

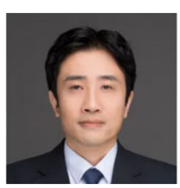
This new award, in honor of the late Professor Godfried Augenbroe, was presented to Rebecca Ward (above right) to recognize her 'outstanding PhD thesis on the topic of building performance simulation'.

New IBPSA Fellows 2023

IBPSA Fellowships are awarded to members who have attained distinction in the field of building performance simulation (or in the allied arts or sciences), by either the teaching of major courses in said arts and sciences, or by way of research, simulation code development, original work, or the application of building simulation on projects of a significant scope. The recipients in 2023 are:

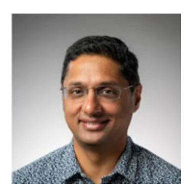

Adrian Chong


Bing Dong


Jing Liu

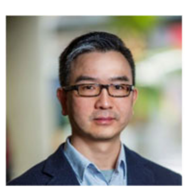

Michaël Kummert


Zoltan Nagy


Sukumar Natarajan

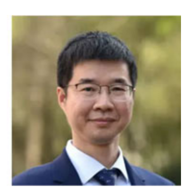

Masaya Okumiya


Yoshiyuki Shimoda


Liangzhu Wang


Monika Woloszyn

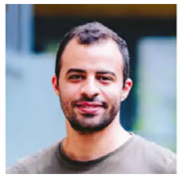

Fu Xiao


Yanping Yuan

Student Travel Award

In BS2023, IBPSA continues to award students with excellent work in building simulation and sponsor their trips to the conference:


Blair Birdsell


Amr Auf Hamada

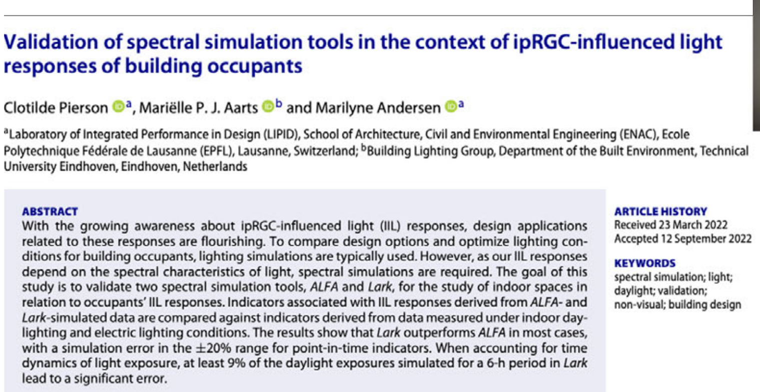

Yu Li


Maria Coral Ness


Chengnan Shi

JBPS Best Paper Award (2022-2023)

The Journal of Building Performance Simulation (JBPS) is the official journal of IBPSA and has been published since 2008. Every second year the Journal of Building Performance Simulation bestows the "best paper" award to the authors of an article that has been published over the preceding two years. The 2022-2023 Best Paper Award of Journal of Building Performance Simulation was given to Clotilde Pierson, Marielle P.J. Aarts, and Marilyne Andersen for their co-authored paper **Validation of spectral simulation tools in the context of ipRGC-influenced light responses of building occupants**.



Validation of spectral simulation tools in the context of ipRGC-influenced light responses of building occupants

Clotilde Pierson [a], Mariëlle P. J. Aarts [b] and Marilyne Andersen [a]

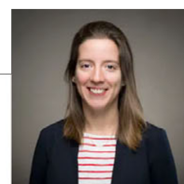
[a]Laboratory of Integrated Performance in Design (LIPID), School of Architecture, Civil and Environmental Engineering (ENAC), Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland; [b]Building Lighting Group, Department of the Built Environment, Technical University Eindhoven, Eindhoven, Netherlands

ABSTRACT

With the growing awareness about ipRGC-influenced light (IIL) responses, design applications related to these responses are flourishing. To compare design options and optimize lighting conditions for building occupants, lighting simulations are typically used. However, as our IIL responses depend on the spectral characteristics of light, spectral simulations are required. The goal of this study is to validate two spectral simulation tools, *ALFA* and *Lark*, for the study of indoor spaces in relation to occupants' IIL responses. Indicators associated with IIL responses derived from *ALFA*- and *Lark*-simulated data are compared against indicators derived from data measured under indoor daylighting and electric lighting conditions. The results show that *Lark* outperforms *ALFA* in most cases, with a simulation error in the ±20% range for point-in-time indicators. When accounting for time dynamics of light exposure, at least 9% of the daylight exposures simulated for a 6-h period in *Lark* lead to a significant error.

ARTICLE HISTORY
Received 23 March 2022
Accepted 12 September 2022

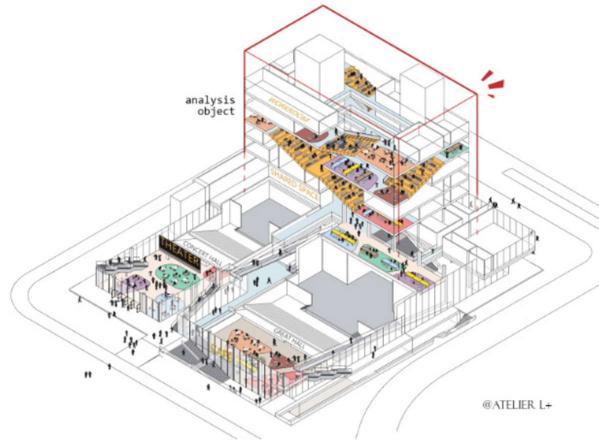
KEYWORDS
spectral simulation; light; daylight; validation; non-visual; building design



Student Modelling Competition

To provide direct engagement and participation opportunities for student members, BS2023 organized a Student Modelling Competition as a crucial part of the conference. This year's competition program aimed to design and optimize a nearly net zero carbon emission building using Building Performance Simulation.

The building for analysis was the Student Activity Center of Tongji University, located in Jiading Campus, Shanghai. It synthesizes multiple functional spaces within a promenade circulation. Experimenting with the idea of thermal-dynamic architecture, it also provides an opportunity for natural ventilation by linking different prototype units. Participating teams were encouraged to use active measures (such as photovoltaic, battery storage, charging pile or ice storage) and passive measures (such as fluctuating room temperature, thermal storage in walls, controllable lighting, and other demand side management) for carbon reduction in the operation phase.



In total, 20 young and energetic teams from 14 institutes spanning 7 countries in Asia, Africa, America, and Europe participated in this competition and 2 teams were selected as finalists.

Eventually, the CEPT team from India emerged as the winner of this year's competition. Two Highly Commended prizes are awarded to the DTU+PolyU joint team (group) and Juan Manuel Gavieiro (individual) from Argentina. The organizers would like to thank all participants for their efforts and creations in this modeling project, and would also like to express their appreciation to Prof. Christina Hopfe and Dr. Xin Zhou for organizing the competition, and to our panel members: Mary Myla Andamon, Eleonora Brembilla, Francesca Cappelletti, Jianlin Liu, Wei Tian, Zhun Yu, and Wangda Zuo for their valuable insights. Special thanks to Prof. Linxue Li for sharing this project and its underlying design philosophy.

Winner: Team CEPT

Centre for Environmental Planning and Technology (CEPT) University, India

Arjita Gupta
Debanjana Das
Mohammed Umar
Mohi Saxena with
IBPSA President
Dru Crawley

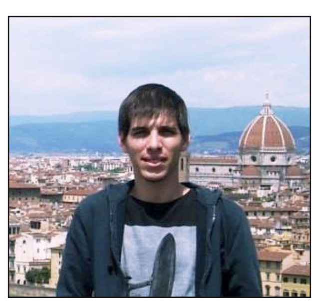
Highly Commended (group): Team DTU + PolyU

Technical University of Denmark
The Hong Kong Polytechnic

Reza Mokhtari (DTU)
Hanbei Zhang (PolyU)
Wei Liao (PolyU)
Rongling Li (DTU)

Highly Commended (individual): Juan Manuel Gavieiro

Faculty of Architecture, Design and Urbanism,
University of Buenos Aires, Argentina



Juan Manuel Gavieiro

Winner: Team CEPT

BS2023 – Student Modelling Competition

Arjita Gupta[1], Debanjana Das[1], Mohammed Umar[1], Mohi Saxena[1]

1 CEPT University, Faculty of Technology, Masters in Building Energy Performance, Ahmedabad, Gujarat, India

BS 2023 4-6 SEPT SHANGHAI

STUDENT MODELING COMPETITION

1. Introduction

In September 2020, President Xi Jinping announced that China would "aim to achieve carbon neutrality before 2060". Since the energy sector accounts for about 90% of China's greenhouse gas emissions, energy policy must drive the country's transition to carbon neutrality. Regulations have been implemented to promote national goals by encouraging low-carbon business strategies in state-owned enterprises, including carbon accounting and targeting.

The Students' Activity Center of Tongji University in Shanghai aims to achieve nearly net zero carbon emissions through a project focusing on carbon emission reduction. The tower includes offices, lobbies, restrooms, and service areas. The central atrium is divided into two parts, with skylights for lighting and full-height glazing for lobby spaces. The façade features vertical fins for shading and indoor wind channeling. Energy model optimization covers emissions from cooling, heating, lighting, and plug loads. Design iterations were experimented to achieve the target EUI of 70 kW.h/(m².a), the current leading value of buildings in Shanghai.

CLIMATE ANALYSIS

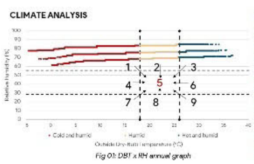


Fig 01: DBT x RH annual graph

1 Heating & Dehumidification
2 Dehumidification
3 Cooling & Dehumidification
4 Heating
5 Thermally Comfortable
6 Cooling
7 Heating & Humidification
8 Humidification
9 Cooling & Humidification

BUILDING ENERGY MODELING

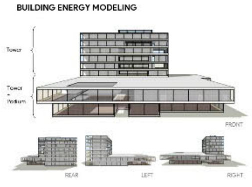


Fig 02: SAC Energy Model - Views

THERMAL ZONING

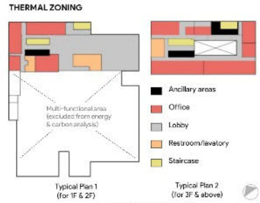


Fig 03: Thermal Zoning Plan

2. Methodology

The general workflow was an iterative process to achieve best optimization of each aspect of the SAC building – envelope parameters, glass thermal properties (passive parameters) and HVAC, lighting, and PV (active systems); until the target EUI was achieved.

2.1 HVAC System Optimization

The building envelope underwent minimal iterations to maintain its architectural characteristics, with an optimized HVAC system playing a crucial role in achieving the target EUI for the SAC. The HVAC system was analyzed for parameters like indoor air temperature, indoor RH, total cooling, latent loads, heating and cooling electricity, electricity consumption, and CO2 emissions. A retrofitting approach was used, considering practicality and thermal comfort requirements. The system was optimized using variable refrigerant flow (VRF)..

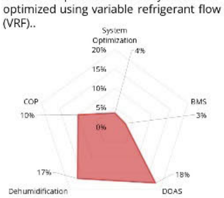


Fig xx: Individual impact on EUI

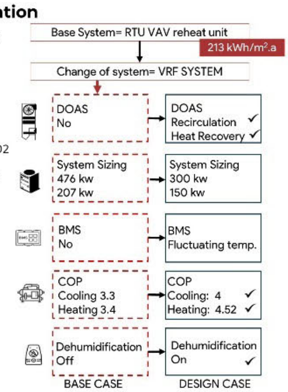
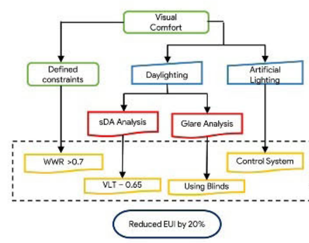


Fig xx: Design iteration for HVAC Optimization

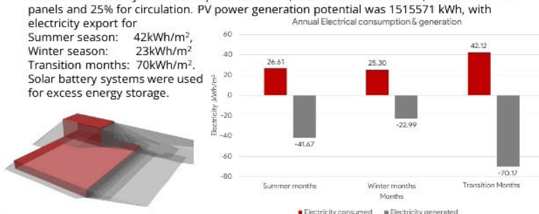
2.2 Visual Comfort

ASHRAE/IES/IESNA Standard 90.1 includes requirements for controlling daylighted areas that meet certain criteria. It specifies the amount of daylight that indoor workplaces must have to satisfy the visual comfort of the occupants. The idea is to apply control strategies along with available daylight to reduce the lighting gains and the electricity consumption and hence reducing the overall EUI.



3. Photovoltaics

Solar radiation analysis revealed potential for PV, with 1842 m² area used, with 1365m² for panels and 25% for circulation. PV power generation potential was 1515571 kWh, with electricity export for
Summer season: 42kWh/m²,
Winter season: 23kWh/m²
Transition months: 70kWh/m².
Solar battery systems were used for excess energy storage.



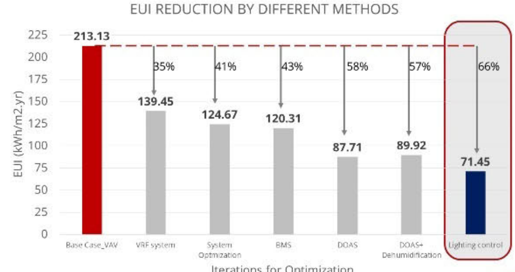
4. Conclusion

The project aimed to create a net zero carbon emission building using active and passive strategies. The Optimized Case achieved a 66% reduction in energy use index, with efficient lighting control and optimized HVAC system. Solar panels offset CO2 emissions, resulting in a nearly 100% reduction.

	Base Case VAV	Case 1 HVAC Optimize	Case 2 Fresh Air Ingress	Case 3 Lighting Control	Case 4 PV Potential	Final Design Case
Glazing	•	•	•	✔	•	✔
Lighting control	•	•	•	✔	•	✔
HVAC	•	✔	•	•	•	✔
Renewable Energy	•	•	•	•	✔	✔
Comfort + Air Quality	•	✔	✔	✔	•	✔

Target EPI - 70 kW.h./m².a

EUI REDUCTION BY DIFFERENT METHODS

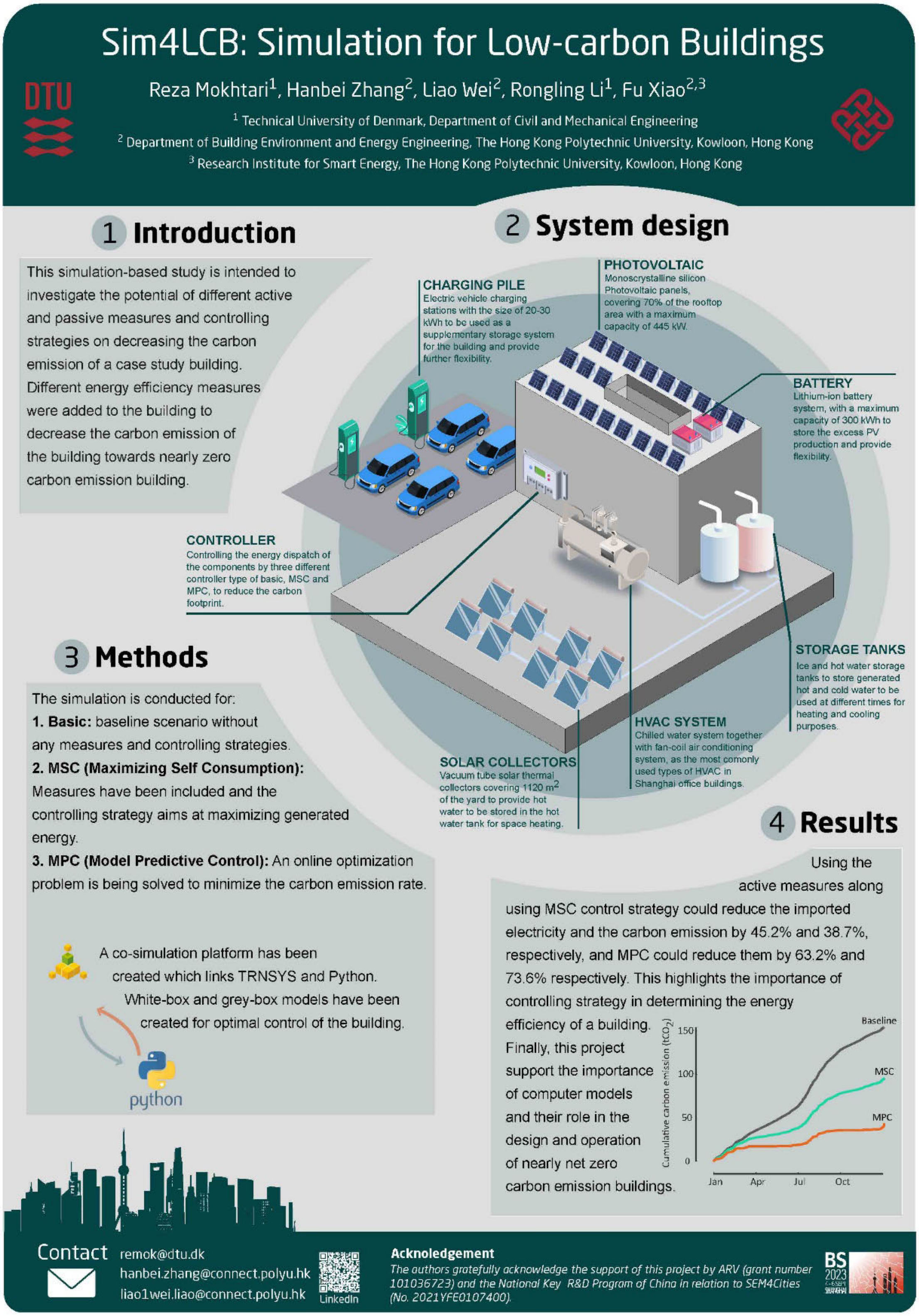


CEPT University , Ahmedabad , Gujarat, INDIA

For more details
Please contact mohi.pbe22200@cept.ac.in

Online Resource

Highly Commended (group): Team DTU + PolyU



Highly Commended (individual): Juan Manuel Gavieiro

Simulation, design and optimization of a nearly net zero carbon emission building

Juan Manuel Gavieiro

Faculty of Architecture, Design and Urbanism. University of Buenos Aires. Argentina

BS 2023 4-6 SEPT SHANGHAI

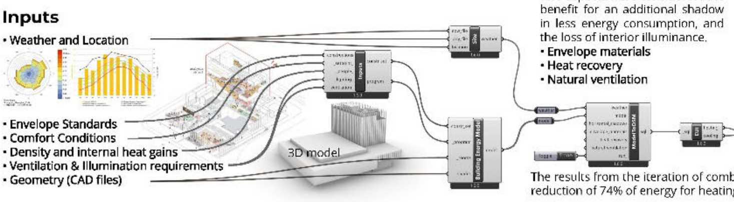
STUDENT MODELING COMPETITION

1 Introduction

The building on analysis is the Student Activity Center on Jiading campus, Tongji University, in Shanghai. The building includes strategies for a high efficiency of energy. The goal is to analyze it, model and simulate the operation, to design strategies for reducing the energy use and carbon emissions. Passive and active measures are used and the iterative energy simulations reveal the possibilities and benefits for each one.

Inputs

- Weather and Location
- Envelope Standards
- Comfort Conditions
- Density and internal heat gains
- Ventilation & Illumination requirements
- Geometry (CAD files)

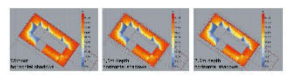


2 Simulation

Two energy models were built, one simplified with the rooms and internal walls following the modulation, and another detailed with the room sizes according to reality. With a simplified model it is easier to do more simulations in less time, and with those results, decide what parameters and variables to simulate on the detailed model. The software used for modeling the rooms was Autocad, then imported in Rhinoceros. The variable parameters were defined in Rhinoceros with the visual programming plugin Grasshopper. The simulations were made with Ladybug Tools. For iterations Colibri plugin was used.

Studied parameters

- Horizontal shadows
  Two aspects were considered: the benefit for an additional shadow in less energy consumption, and the loss of interior illuminance.
- Envelope materials
- Heat recovery
- Natural ventilation



Daylight autonomy comparison for a typical level.

EUI for Heating + Cooling on Ideal Air Simulation

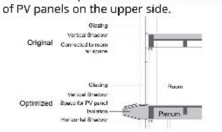
Parameters Combination	Natural ventilation 0 / Heat Recovery 0	Natural ventilation 1 / Heat Recovery 0	Natural ventilation 0 / Heat Recovery 1	Natural ventilation 1 / Heat Recovery 1
Shadows 0 + Envelope 0	59	48.7	29.3	22.3
Shadows 0 + Envelope 1	45.9	37.2	25	18.5
Shadows 1 + Envelope 0	41.2	33.6	22.2	17.1
Shadows 1 + Envelope 1	34.2	27.6	20	15.4

The results from the iteration of combined parameters with an IdealAir show a maximum reduction of 74% of energy for heating and cooling, from the worst scenario to the best.

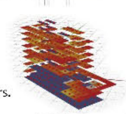
3 Design

From the studied parameters the following inputs were defined:

- **Materials**
  From the selected materials, the calculated U factors were:
  - Indoor walls: 0,68 W/(m²·K).
  - Outdoor walls: 0,54 W/(m²·K).
  - Internal floor: 1,15 W/(m²·K).
  - Outdoor roof: 0,27 W/(m²·K).
  - Windows: 1,22 W/(m²·K).
- **HVAC selected**
  After testing on different systems, the HVAC was configured with:
  - Corridors and lobbies: DOAS with fan coil chiller. 75% efficiency heat recovery.
  - Offices: DOAS with VRF system. DCV and 75% efficiency heat recovery.
  - Conference Room: All-Air PVAV with central air source reheat system.
  - Restrooms: Ventilation and Electric Tankless Heater for hot water.
- **Horizontal louvers** which will reduce the summer solar gain, adds more isolation to the envelope and allows the addition of PV panels on the upper side.



- **Light control** on a BMS with minimal room illuminance configured, with sensors and automatic dimmers.

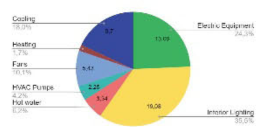


- **Natural ventilation** on a BMS that control the openings, according to the outdoor temperature and wind flow.

4 Detailed simulation

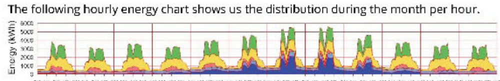
Energy use simulation

A detailed simulation was done with all the design inputs. The output frequency was hourly, to analyze the data with the renewable energy and the carbon emission factors. Louves shows 19% reduction for cooling and heating energy, while natural ventilation reduces an average of 23%. Light control gives a benefit of 18% less energy on lighting.

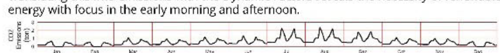


The EUI for the building is 53,7 kWh/m2.

The following hourly energy chart shows us the distribution during the month per hour.



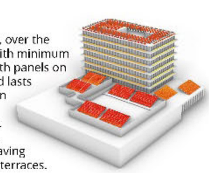
Translating this into emissions with the Dynamic Factors reveals the necessity of renewable energy with focus in the early morning and afternoon.



5 Optimization

Photovoltaic panels

Over the tower of the building and around the facade, over the horizontal louvers, a sector of panels was analyzed, with minimum elevation angle. The podium roof could be covered with panels on a bigger angle, to receive more energy in the firsts and lasts hours of sun. Calculating the dynamic carbon emission factors and the building use, it has more effect on emissions to capture solar energy during these hours. Eight installations with 20° elevation were configured, according to the available spaces over the podium, leaving free areas for the HVAC equipment, roof glazings and terraces.



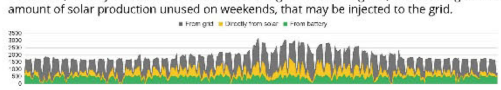
Energy storage

Calculations for PV production were made, considering a strategy for battery filling priority on hours in which, according emission factors, it is more useful to use energy from the grid and store the solar energy. The battery capacity was defined at 500 kWh, after a cost-benefit analysis.

For the ice storage, when calculating with the same system size, the reduction is not very significant, because the lower carbon factors are aligned with the moments of full HVAC usage in summer. There could be a bigger reduction if a bigger HVAC system or the podium would be considered.

6 Results

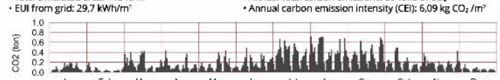
The optimization results show that 55% from the energy use is from the grid, and the 45% from solar, directly or with the batteries. According to the building use, there is a significant amount of solar production unused on weekends, that may be injected to the grid.



The use of panels without batteries could reduce the electricity grid consumption, but for the carbon emission goal the battery is essential, as the maximum solar production is aligned with the hours with lower or zero carbon emission factors.

The final calculations gives the following results:

- Total simulated area: 11348 m²
- EUI from grid: 29,7 kWh/m²
- Annual total carbon emissions: 69 tons of CO_2
- Annual carbon emission intensity (CEI): 6,09 kg CO_2 /m²



The final results show the possibility of reaching near net zero building emissions, and the previously calculated strategies that can be applied to accomplish the goal.

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Online Resource

BS2023 Award for the Best Poster

- *Predicting air infiltration and window state in residential dorms using deep neural networks coupled with EnergyPlus*
  Pratik Raj Pandey, Nina Sharifi, Bing Dong
  Syracuse University

BS2023 Awards for the Best Student Papers

- *Pricing scheme design for vehicle-to-grid considering customers risk-aversive behaviors*
  Yi Ju
  University of California, Berkeley

- *Occupancy based optimization of energy-saving control method for indoor heating equipment in exhibition hall buildings*
  RuoXi Liu
  Southeast University

Best of 'Ask a Modeler':

BEM practitioners share tips and updates

'Ask a Modeler' is an advice column for the building simulation community. Each month, a question posed by the IBPSA community is answered by recognized building professionals to get their expert perspectives. The Ask a Modeler Subcommittee's mission is to disseminate building energy modeling (BEM) ideas and knowledge by bringing world-class BEM experts, practitioners, and enthusiasts to an accessible, curated advice column. Below, we are reprinting a recent question and answer from this column. For everything from updating energy-modeling software to strategic advice for leveling-up your BEM career, you can find it here!

How do you model novel or atypical envelope materials or assemblies?

— Loves the Leading Edge

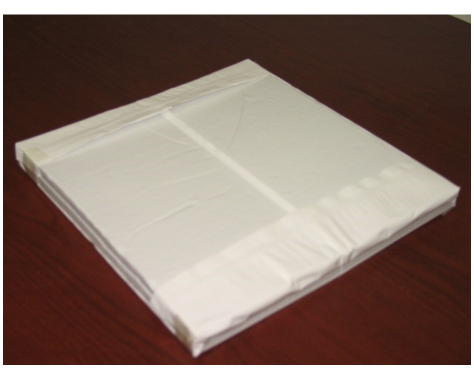
Dear Leading Edge,

Energy modeling is a critical tool in evaluating the performance of new envelope technologies under diverse sets of conditions – building type, operation, climate conditions, and others. Laboratory testing of envelope technologies is typically limited in scale and often performed under a prescribed set of standard conditions. Field testing is usually expensive, may still be limited in scale and can really be performed only under a handful of operational and climate conditions.

Kaushik Biswas, PhD
Senior Engineer, GTI Energy
kbiswas@gti.energy

The properties of traditional envelope technologies like cavity insulation and exterior rigid insulation are well understood and captured within various building energy modeling tools. However, there are emerging technologies for envelope applications, like vacuum insulation panels (VIPs), passive energy storage via phase change materials (PCMs), anisotropic materials, etc., that need additional consideration.

For this column, I'll focus on my experience with characterizing VIPs in envelope applications for modeling and simulations. VIPs are made of a micro- or nano-porous core material – typically fumed silica and fiberglass – that is evacuated and encapsulated within a sealed barrier film.[1] The combination of the micro-/nano-porosity and vacuum provide VIPs an ultra-low thermal conductivity, at least 10x less than traditional fibrous or foam insulation. The rated conductivity of VIPs is what is known as the center-of-panel (COP) conductivity, i.e., the central portion of the VIP that coincides with the evacuated core and is sufficiently away from the edges. However, the performance of an envelope assembly containing VIPs needs to consider the "effective" conductivity of VIPs, which includes the heat transfer along the high-conductivity barrier film along the edges of the VIPs.

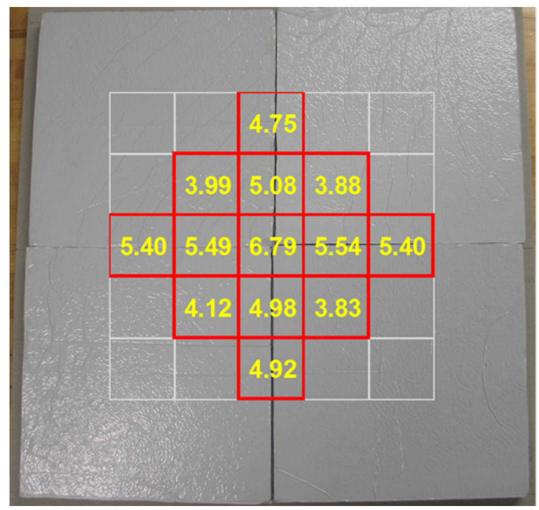


VIP with a polymer based barrier film (produced by NanoPore Inc)

When modeling an envelope assembly containing VIPs, it is not realistic to explicitly model the heat transfer through the VIPs' barrier films due to orders-of-magnitude difference in their length scales. The dimensions of the modeled envelope assembly can span a meter or several meters, while the thickness of the barrier film is of the order of 10-100 μm, so a ratio of >=10^4 in largest to smallest dimension that would need to be modeled.

Instead, there are several methods of approximating the impact of the barrier films on the effective thermal conductivity of VIPs. The simplest is to refer to available literature on measurements and numerical studies focused on VIPs. For example, Sprengard and Holm (2014)[2] performed detailed numerical analysis of the heat flows along the VIP edges for two different VIP sizes and several barrier film configurations. They noted that the effective conductivity of the VIPs can increase by 2% to 65% due to the "edge effects" depending on the VIP size and barrier film type. In general, the impact of edge effects is larger in smaller VIPs.

A more assembly-specific method is to combine small-scale measurements of VIPs and VIP assemblies with analytical methods to estimate the effective conductivity or thermal resistance of VIPs and apply them for modeling larger envelope assemblies. This is what our team did in 2017[3], where we measured the heat flows across multiple small-scale (0.61 m × 0.61 m) VIP assemblies in a multi-transducer heat flow meter apparatus (HFMA). This HFMA was equipped with thirteen 5.1 cm × 5.1 cm heat flux transducers which measured the heat flow through different sections of the VIP assemblies – COP areas, interfaces with two VIP edges, an interface with one VIP edge and two VIP corners, and an interface with four VIP corners. These measurements were combined with analytical calculations to estimate the effective conductivity of the VIPs. These calculations were then extrapolated to larger (2.44 m × 2.44 m) test wall assemblies containing VIPs to numerically estimate the overall thermal resistance of the test wall. The numerical estimations matched the test wall resistance measurements within 8-18%.



Sample heat flow measurements through different sections of a VIP assembly

In 2019[4], I also developed a finite element model using a "thin layer" feature in COMSOL to model the heat flows through the barrier films of VIPs within the 0.61 m × 0.61 m VIP assemblies noted above. By running parametric simulations and error minimization compared to the HFMA measurements, a set of barrier film properties (thickness and conductivity) were determined. The barrier film properties combined with the COP measurements of the VIP were used to model a 2.44 m × 2.44 m test wall assembly containing VIPs. In this case, the modeled test wall resistance was within 4.7% of the measured thermal resistance. These estimations of the effective thermal resistance of VIPs can then be used in whole-building energy modeling tools like EnergyPlus.

As a general cautionary note, care is needed when extrapolating the results of the effective VIP conductivities to different scenarios. Some obvious things to note are the core materials and VIP dimensions. The core material has a significant impact on the initial and long-term performance of VIPs. Fiberglass VIPs tend to have a lower initial thermal conductivity than silica VIPs. However, the conductivity of fiberglass VIPs rises sharply with any

[1] https://vipa-international.org/features-of-vips
[2] https://doi.org/10.1016/j.enbuild.2014.03.027
[3] https://vipa-international.org/wp-content/uploads/2021/09/Abstrack-book-complet-BDcoul-1.pdf
[4] Energies 2018, 11, 2228; doi:10.3390/en11092228

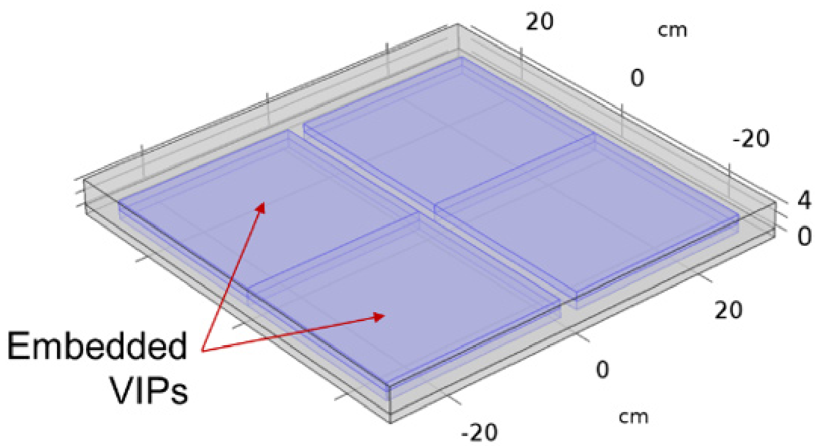
increase in the core pressure (from gases leaking in through compromised seals). Conversely, the rate of change of conductivity with pressure in a silica VIP is lower.

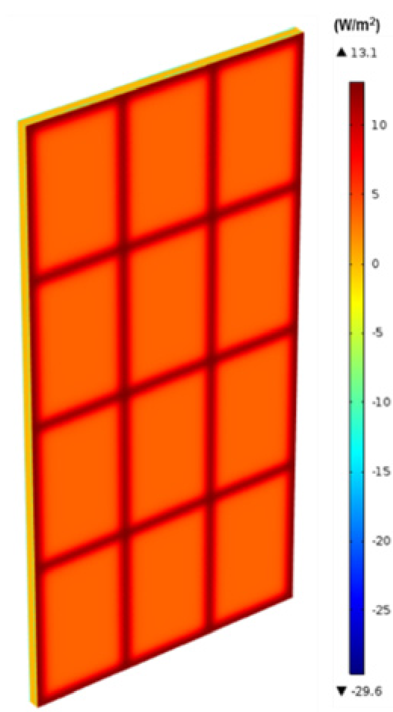
Care must also be taken not to apply the measured/modeled effective conductivity of VIPs of a given dimension to other VIPs that are of significantly different sizes or thickness. When estimating the effective conductivity of VIPs, it is recommended that VIPs of a range of dimensions and thicknesses be evaluated, and the results be applied to envelope assemblies containing VIPs of similar dimensions.

Furthermore, the conductivity of VIPs is temperature dependent. The conductivity is typically lower at lower temperatures. So instead of adopting a single, constant conductivity, a temperature-dependent conductivity function should be implemented in numerical models.

It is great to consider advanced assemblies in our building designs, and it's important to consider the steps one must take in order to accurately represent the emerging envelope technology. Luckily, there is a significant body of past and ongoing research on developing tools and models to estimate the performance of these emerging technologies to help inform the industry and begin designing buildings that utilize these technologies.

COMSOL modeling of VIPs embedded within foam boards





We want to hear your interesting, entertaining, or just-plain-odd questions about life and building performance simulation. Submit your questions to **askamodeler@ibpsa.us** *to be answered by prominent building performance simulation experts. Note that questions requiring an immediate response should be submitted to the community of experts at* **https://unmethours.com**. *Read our other past columns at* **www.ibpsa.us/ask-a-modeler**. *If you are interested in replying to a question as a featured expert or have any other feedback about Ask a Modeler, please email* **askamodeler@ibpsa.us**. ■

Transforming Education

Innovations in remote learning and experiential teaching of Building Performance Simulation

Eleonora Brembilla, TU Delft, The Netherlands

Three years later, the COVID-19 pandemic and resulting lockdowns feel like distant and surreal memories. Beside the many sacrifices, that period sparked a handful of positive changes, born from necessity and from a collective reimagination of how it is possible to feel connected without actually leaving our houses. Education systems at all levels have been revolutionised from one day to the next, leaving us with innovative communication tools and teaching approaches. Not all of them can still be deemed suitable once back to 'normality' – and there is probably nothing that replaces the interaction and adrenaline you get from teaching in-person classes – but there are a few gems that are worth saving. The possibility to reach audiences that were previously left out from access to top universities, courses, teachers, is especially valuable.

Building performance simulation is a discipline that can easily leverage online tools, being largely based on computer software and virtual models. Still, the most successful education strategies are those that provide learners with means to experiment on their immediate surroundings and put new knowledge into practice. Here we present three excellent examples of innovative educational programmes to teach building performance simulation that managed to combine remote strategies with effective experiential learning. The first one – MIT's *Sustainable Building Design for Online Audiences* – is based on the now established format of Massive Open Online Course (MOOC) but places a special emphasis on concept and design exercises aimed at engaging learners with practical tasks. The second one – the *Erasmus+ NLITED* project – offers a flexible platform to learn all aspects of daylighting through lectures given by Europe's top experts in the field, coupled with practice-based summer schools where one can meet teachers and other learners. And the third one – the *Erasmus+ DESRes* project – set up a network of European university courses which can be attended remotely, and which facilitate online collaboration among groups of students, hence training them also for professional remote collaboration – a skill that is ever so important in our present work environments.

Sustainable Building Design for online audiences

Christoph Reinhart and Rowan Elowe, MIT
Alpha Arsano, Northeastern University, Boston

The climate crisis is upon us with many parts of the world experiencing heat waves never seen before, flooding, cold spells, and drought. Since climate patterns now change on generational scales, society needs the architecture, engineering, and construction (AEC) sector to quickly deliver climate-driven buildings that consistently offer comfortable and healthy interiors, operate resources efficiently, and symbiotically interact with the electric grid and transportation sector. The digitalization of architectural design and seamless integration of environmental performance simulations into popular design environments have put sustainable design analysis workflows – from daylighting and glare to thermal comfort and operational building energy use – within reach of designers and even homeowners interested in sustainable, net zero building design. To facilitate the productive use of these simulation-based workflows, learners need to understand the underlying physical phenomena, know how to interpret simulation results, and - critically - be open to change their designs based on the feedback received. The ensuing evidence-based design approach aims to liberate design teams from oversimplified rules of thumb, trigger new design ideas through productive constraints, and elevate fact over dogma.

For over a decade, MIT's *4.464 Environmental Technologies in Buildings* class has taught the basics of climate analysis, daylighting, electric lighting, and operational building energy use in conjunction with weekly BPS exercises. Our class is co-taught to first year students in MIT's professional Master of Architecture (MArch) degree program as well as undergraduate students in Architecture, Energy or Environmental Studies. The underlying course exercises are documented on the MIT Sustainable Building Design Lab's Net Zero Buildings site.

To make the whole course content, including lecture recordings, available to a global audience, the MIT Energy Initiative supported the development of a Massive Open Online Course (MOOC) version of the class. Between February 2020 and August 2023, 50,000 learners from 190 countries – led by the US, India, Brazil, the UK, and Canada – have enrolled in the class. It currently runs once a year for 13 weeks with an estimated required time effort for learners of 8-10 hours per week. Anybody can take the class for free or register for a certificate. The MOOC is part of MITx's Future Energy Systems XSeries Program. Members of the American Institute of Architecture (AIA) qualify for learning units if they purchase and earn the edX verified certificate for the course.

Fig 1: edX course on Sustainable Building Design

Online teaching approach

Similarly, as for the in-residence version of the class, online learners must complete weekly assignments that culminate in a two-week-long design project of a mid-sized commercial building. The MOOC version has two tracks: Track 1 learners conduct the simulation exercises using the ClimateStudio daylighting and energy plugin for Rhinoceros 3D. While access to all required software is free, those learners need access to a newish computer. Track 2 was developed to ensure that learners from all socio-economic backgrounds can access, understand, and enact the course content. For this group, the MIT instructor team developed additional versions of all class exercises that can be conducted using the ClimaPlus web app which was custom developed for this purpose by Alpha Arsano during her doctoral studies at MIT. ClimaPlus is a climate-responsive design platform that utilizes weather data files from around the world to build local climate profiles and allows users to model how various design decisions affect a building's finances, energy use, and greenhouse gas emissions. Using either simplified or state-of-the-art design tools, all learners can thus explore the complex interactions between building design decisions, operational energy costs and the impact of a building on climate change.

Challenges

A considerable challenge in translating the residential course online was scaling open-response assignments for a large number of learners. Much of the assignment content, quantitative in nature, is well suited to automated machine grading on the edX platform, with learners answering calculation-based or conceptual questions in multiple choice, numeric input, and text input formats. Design tasks, however, do not produce uniform responses that can be machine graded, and staff grading at this scale is infeasible. The MOOC design team therefore built new assignments leveraging a peer-review function in edX, while maintaining the key learning objectives of the assignments.

Week 2's direct shading assignment illustrates several nuances of the course's approach to the open-response assignments. The goal of the exercise is for learners to verify the accuracy of digital modeling software that replicates natural light behavior in design models and facilitates the incorporation of natural daylighting versus electrical lighting in these models. When conducted at MIT, this exercise is quite straightforward. Students photograph an object in the sun at 2 different times of the day, and then use ClimateStudio to recreate the object digitally and replicate the shading effect photographed. However, the assignment required careful retooling for the online platform. First, what if the weather is too rainy or overcast and online learners cannot photograph an object casting shade? To avoid a spate of extension requests, the course team uploaded stock images of objects along with the dimensions and date/time information needed to replicate the lighting conditions. For learners without access to modeling software, the course team identified two free online, browser-based resources. The first, 3D Slash, allows learners to quickly and easily create detailed digital models which can be exported as object (.obj) files (**www.3dslash.net/index.php**). 3D Sun-path then allows users to import their object file and input locational and date information to realistically render direct shading effects (**http://andrewmarsh.com/apps/staging/sunpath3d.html**). Thus, learners may freely model the object they photographed and compare the results.

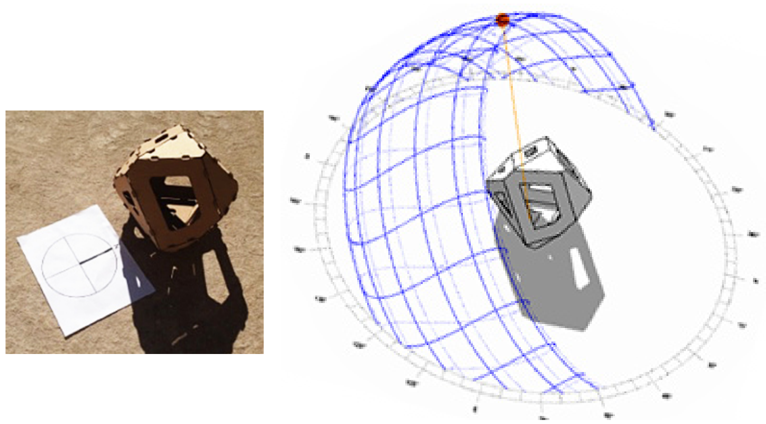


Fig 2:
Comparison of a photographed and modeled shaded object
(Image Jeff Geisinger)

Image pairs such as the one in Figure 2 are the online deliverables for the Week 2 Direct Shading assignment. As a teaching assistant could not possibly review thousands of submissions of photographs and digital models, the MOOC team uses the edX platform's open-response assessment (ORA) function to automatically assign a learner's submission to other submitters for evaluation based on a customized assignment rubric. Each learner is assigned 3 evaluations. The rubric was carefully designed to be intuitive and so that peers did not need to be experts in the software or analysis to evaluate submissions. Instead, they graded 3 key components:

- whether the required photographs and models were submitted (4 points)
- the degree to which the digital models resembled the photographed objects (2 points)
- a small discretionary percentage for the complexity of the object modeled. (1 point)

The learner's final grade is the median score across the peer reviews received. Learners are also able to provide feedback on how they believe the ORA process operated, and how fair their scores were, after reading their reviews. The course staff review the feedback and may override grades as appropriate. The benefit of this open response peer review system is not only a scalable grading mechanism, but a chance for learners to critically evaluate others' approaches to the assignment prompt, reflect on their own, and receive feedback from their peers. A similar approach is adopted for the final, two-week design project. More information on the course including a comparison between expert and peer reviewed grading results for select final projects can be found in the 'Lessons Learned from Teaching Thousands of Learners Worldwide' chapter in the forthcoming *Energy Education in a Transitioning World*, edited by Valentini Pappa and Antje Danielson and published by Cambridge University Press.

NLITED Summer School

Mandana S.Khanie, Technical University of Denmark

The NLITED Summer School is an intensive one-week training program on daylighting in buildings. It is part of the New Level of Integrated Techniques for Daylighting Education (NLITED) project, funded by the EU through the Erasmus+ programme. The project is run by four universities: Unviersità Degli Studi Niccolò Cusano, Italy, led by Federica Giuliani; Technical University of Denmark, coordinated by Mandana S.Khanie; Polytechnic Gdansk Poland, coordinated by Natalia Sokol; and Lund University, Sweden, coordinated by Niko Gentile.

The NLITED educational project is held in two parts:

- The first part is an online platform providing theoretical daylighting knowledge. The platform is divided into modules covering specific aspects of daylighting in buildings, such as daylighting basics, simulation, and daylight design.
- The second part is a one-week intensive training seven-day bootcamp at a university in one of the four participating countries. During the summer school, participants learn how to apply the theoretical knowledge they have gained from the online platform to real-world projects. They also have the opportunity to network with other professionals in the field of daylighting.

The summer school is taught by a team of experienced daylighting professionals from different European universities and industry partners. Participants have the opportunity to learn from the experts, gain practical experience in daylighting design, and network with other professionals in the field. The program covers a wide range of topics related to daylighting, including:

- Daylighting basics
- Daylight simulation
- Daylight design
- Daylight and human health
- Daylight and energy efficiency
- Daylight and architectural design

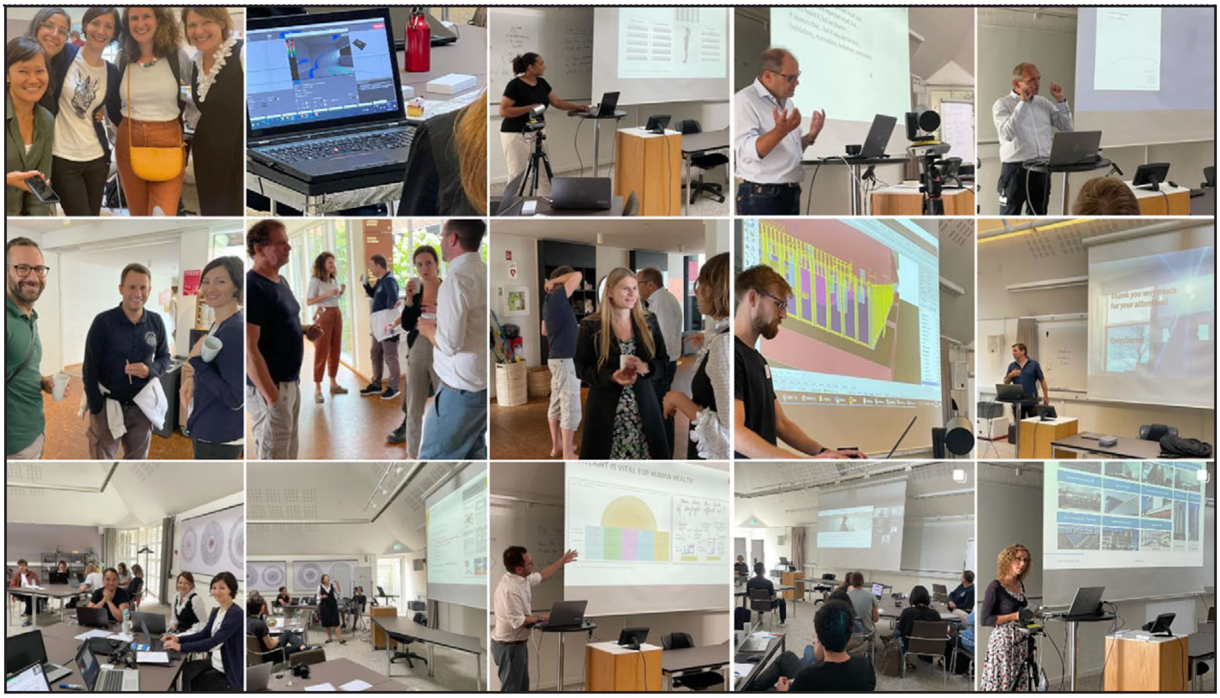
The main objectives of the summer school are to:

1. Foster an Engaging Learning Experience: Develop an interactive and captivating approach to learning.
2. Provide Comprehensive Work Exposure: Allow participants to gain holistic work experience.
3. Facilitate Networking with Industry Experts and Firms: Create opportunities for participants to connect with professionals and companies in the industry.
4. Meet the needs of both Master's and Ph.D. students and Professionals: Tailored to benefit not only Master's and PhD students but also professionals seeking an immersive study program.
4. Culminate in a Presentable Final Product (Event/Competition): Conclude with creating a tangible and presentable final project, which may involve events or competitions.

In 2022, the NLITED Summer School was held in Copenhagen at the Technical University of Denmark (DTU). After an intensive one-week training program on daylighting in buildings, the participants of NLITED presented their work in BuildSim 2022, the 10th BuildSim Nordic conference and 2nd IBPSA-Nordic International conference, hosted by DTU and chaired by Christian Anker Hviid and Mandana Sarey Khanie. The presentations were evaluated by a panel of experts, and the best presentation was given an award by VELUX A/S. In 2023, the summer school was held in Gdansk and organised by DTU and Polytechnique Gdansk. In a similar structure, the participants presented their final work at the Gdynia Design Day event, hosted by PPNT Gdynia.

To learn more about the summer school and see the participants' presentations, please visit the NLITED website: **www.nlited.eu/copenhagen-2022** and **www.nlited.eu/gdansk-2023**.

NLITED Summer School



NLITED 2022

NLITED 2023

DesRES - Digital Erasmus - a roadmap to using building performance simulation to achieve resilient design

Christina Hopfe, TU Graz, Austria

How the idea came about

Delivering good projects requires a good team. In this project, we had three different project partners: TU Graz, TU Delft and Strathclyde University. Three staff members from TU Graz, Prof Robert McLeod, and Dr Matej Gustin and myself (Prof Christina Hopfe) participated in the project. TU Delft was represented by Dr Eleonora Brembilla. At Strathclyde University the project team members were Prof Lori McElory and Dr Daniel Costola.

The original project idea was developed during the beginning of the pandemic by Eleonora, Rob, Lori and myself. All of us had started new positions at this time and (in the case of Eleonora, Rob and myself) had even moved to a different country. Feeling isolated in lockdowns, and with an uncertain future ahead of us, we wondered what we could do to encourage students, in particular internationals, to engage more actively with teaching. Another key part of the project sought to address inclusivity using digital learning and teaching methods. Such approaches can help to overcome some of the traditional barriers to participation through their partial anonymity and enhanced flexibility. In so doing we hoped to encourage under-represented groups to engage with the subject area of building performance and simulation.

Description of the programme

Our project is entitled DesRES, abbreviated from 'Digital Erasmus - a roadmap to using building performance simulation to achieve resilient design'. It seeks to provide safe, remote student teaching by transforming the learning experience of students in built environment disciplines. Our objective was to develop a dynamic, experiential methodology aimed at maximizing student engagement and learning opportunities in a digital and transnational environment.

Building simulation is traditionally taught in a classroom setting with access to computer labs, where students learn how to use the software in direct contact with staff. During the Covid-19 pandemic this was no longer possible. We were therefore targeting students enrolled in MSc programmes that included courses on building performance and resilience, but who were no longer able to participate in live classroom-based activities. Our aim was to design a concept that would make it easier to target students from all over the world, allowing them to participate in learning events digitally but without the high enrolment costs charged by some universities.

For example, subscribing as a student at TU Graz in Austria, students do not have to pay any student fees. It's for free, whether you are a native of Austria, Europe, or an international student. With this collaboration, students subscribed in any of the participating universities were able to digitally participate in the other universities' DesRES courses.

By adopting this approach, we were able to take into account both the uncertainties imposed by the pandemic and the personal obstacles that many students with disabilities might face in normal classroom settings, as well as the often unacknowledged barriers faced by those who cannot attend conventional classes (for a variety of other reasons).

In short, DesRES offers a pandemic-proof working environment that also enhances equality, diversity, and inclusion (ED&I) opportunities.

Relation to Building Performance Simulation

It's all about simulation: in line with our inclusive and digital teaching framework, three new modules (each taught by one of the partnering universities) were developed to challenge students to work in interdisciplinary transnational teams, digitally, across borders, thereby offering some of the benefits of the classical Erasmus 'year abroad' experience. These modules range across measuring, monitoring, and analysing data, modelling, simulation, and calibration, looking at diverse performance aspects such as health and comfort, energy and indoor air quality and moisture and indoor environmental quality. We have developed three new modules, one at each university, offering a different challenge. The whole series of modules together develops a deeper understanding of building performance simulation. More information on the different modules can be found on our website **www.desres.eu**.

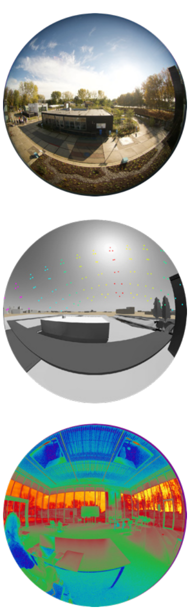
What are its strengths/novelties

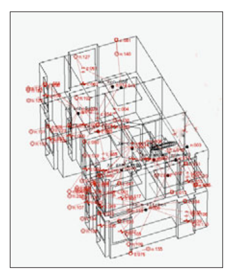
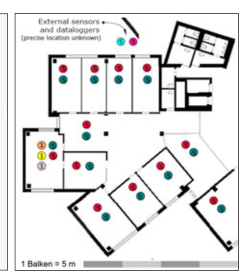
We expect the opportunity to undertake transnational studies using an interactive approach to appeal to those who might not have had the opportunity to consider becoming an engineer and studying simulation in the past, and that the project will provide them with as close to an immersive experience as is possible in a digital realm.

Our learning format combines live data-streams from real buildings with the use of validated simulation models of the same buildings in order to create a highly realistic and interactive learning environment. This concept helps to overcome the barriers imposed by the absence of site-visits and studio tutorials, which have been a common feature of experiential learning in the built environment. This learning format is designed to immerse the students in real-world problem solving and experimentation, commensurate with the attainment outcomes of master's level programs. Through our Digital Erasmus approach, the students gain valuable additional experience in interdisciplinary working and critical thinking.

We hope to widen the concept out to other programmes and modules and are currently in the process of applying as a new IBPSA project. So stay tuned!

More information on the project can be found on **www.desres.eu**. ■




POWER: NASA Prediction of Worldwide Energy Resources

Supporting building information modeling, sustainable design, and decarbonization efforts

Introduction

One of the three main areas of focus for NASA's Prediction of Worldwide Energy Resources (POWER) Project is supporting the building modeling community, including information relevant to renewable energy. POWER, which is part of the newly forming NASA Earth Action program, provides access to data from Earth-observing satellites and atmospheric assimilation models to enable sustainable decision-making across multiple disciplines anywhere in the world. POWER provides freely available global, surface solar irradiance and meteorological datasets from NASA Earth observations and modeling through a suite of web services. POWER data, now spanning over 40+ years, is made accessible in formats conducive to building applications, within a few days of real-time and with documented uncertainties. The data are made available as time series, statistical tables, images, and GIS compatible formats.

Data products & services

Utilizing NASA's Earth Observation and global model datasets, NASA POWER provides solar and meteorological parameters such as:

- Hourly and daily time series: mean/maximum/minimum temperature, wet bulb temperature, relative and specific humidity, precipitation, solar irradiance (within two months of real-time; solar quantities are daily only)
- Daily/monthly/annual time series: heating and cooling degree days
- Climatological Averages: Climate design conditions report and Building Climate Zones (both using ASHRAE Definitions)

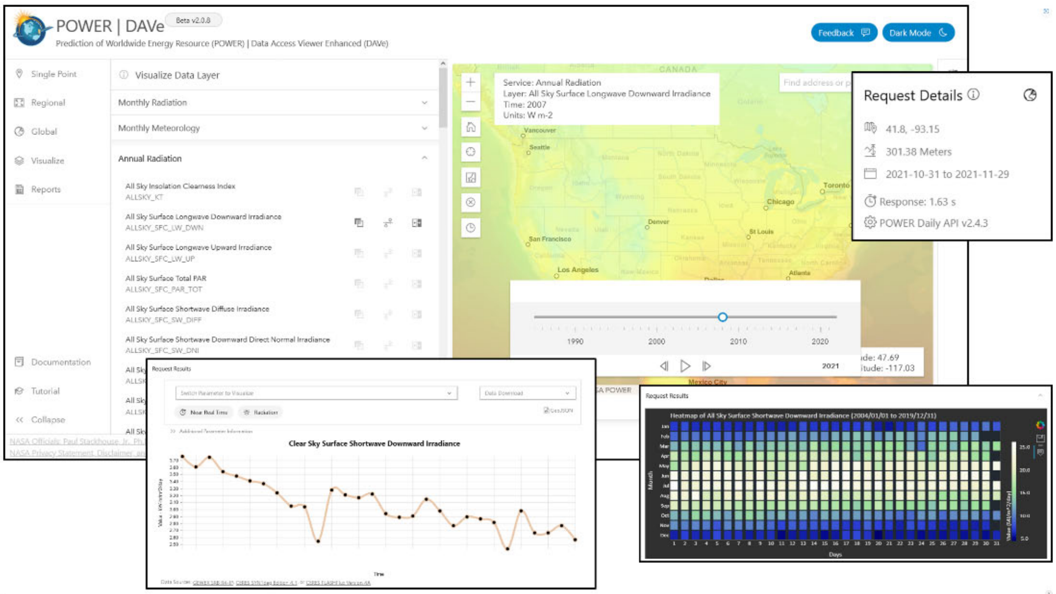
The sustainable infrastructure industry has historically used NASA POWER data for many broad applications, including infrastructure design standards, Building Information Modeling (BIM), green building design and operations, reduction of greenhouse gas (GHG) emissions, and increased system resilience.
POWER is currently providing data via the following basic services:

- Application Programming Interface (API)
- Data Access Viewer (DAV)
- Geospatial feature & image services

NASA managed AWS open data registry

The POWER API delivers data in formats such as EPW, CSV, NetCDF, GeoJSON, ASCII, and more. For instance, building energy model users often request our data in the EnergyPlus Weather (EPW) file format supported by multiple modeling decision tools. The API, invoked through a URL (Uniform Resource Locator) command, provides timely responses, and can be easily integrated into external applications.

The Data Access Viewer – which is currently in its Beta release – is a web mapping application that provides easy-to-use visualization tools, data sub-setting, downloading, and charting. Users can also efficiently complete data requests to generate integrated climate reports and building thermal zones, which is based off the ASHRAE (formerly known as the American Society of Heating, Refrigerating and Air-Conditioning Engineers) standards.



The tools and charting resources available through the enhanced POWER Data Access Viewer (DAVe)
Credit: NASA POWER

POWER's geospatial and feature image services give users the option to visualize their data using Esri ArcGIS. These services are available through NASA's ArcGIS Online platform. POWER provides the following image services:

- Monthly, Annual, and Climatology solar radiation and meteorological parameters (see above)
- Value-added parameters such as Tilted Surfaces Irradiance with associated solar geometric quantities and Battery Sizing parameters, and soon-to-be released wind power classes (as defined by National Renewable Energy Laboratory)
- Examples of Building Thermal Climate Zones & Building Thermal Moisture Climate Zones fusing ASHRAE(R) definitions, including difference maps comparing periods at the beginning and end of the records

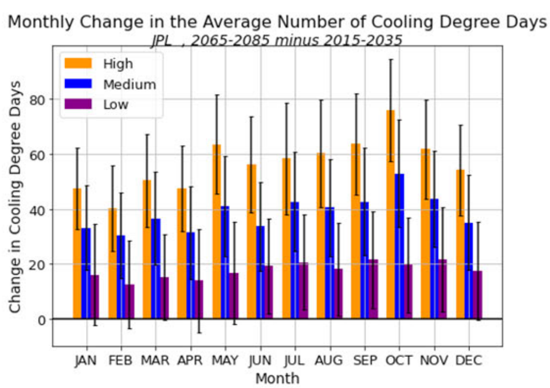
Finally, users can seamlessly access POWER's central data directly from the NASA managed Amazon Web Services Open Data Portal in a specialized large file format. Python libraries are available to efficiently gain direct access and process POWER's data products from these files. These standardized POWER datasets are tailored for quick long-temporal and cross-variable analysis and are readily accessible to support machine learning applications. This service provides the most complete near real-time data access available.

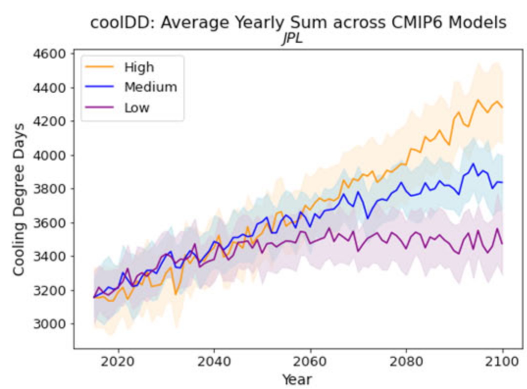
Future climate products and services

There is an active effort to expand the data offerings from POWER to include climate services with data from future climate projections. These services will help POWER users make informed decisions that better account for projected climate change scenarios. For instance, this information will help users design future HVAC

(Heating, Ventilation and Air-Conditioning) systems providing estimates of energy used by these systems under projected future climate conditions. The future climate services aim to help master planners account for projected climate change while making better informed decisions about future HVAC energy needs and the desire to meet net zero building goals.

The future climate services are based on the NASA Earth Exchange Global Daily Downscaled Projections climate dataset derived from 22 different General Circulation Model (GCM) runs conducted under the Coupled Model Intercomparison Project Phase 6 (CMIP6) and across three of the four "Tier 1" greenhouse gas emissions scenarios (NEX-GDDP-CMIP6; Eyring et al. 2016). The downscaled data is provided by NASA Earth Exchange (Thrasher et al. 2022). The basic data provided include daily averages of 9 surface variables (daily mean/maximum/minimum temperature, daily sum of precipitation, daily mean downward longwave and shortwave radiative flux, daily mean surface wind speed, and daily mean specific/relative humidity), covering the years 2015 to 2100 (North of 60 degrees South latitude). Data from three emissions scenarios (low [ssp1_26], medium [ssp2_45], and high [ssp3_70] emissions) are included to provide a contrast of potential future climates (O'Neill et al. 2014;2017). We have performed our own additional analyses to bias correct these to the historical data products noted above. As these initial simulations are daily averaged, an effort is ongoing to create data products based on hourly-based statistics.





Center	Thermal Zone Change?	Moisture Zone Change?	Thermal Zone Change	Moisture Zone Change	When in High Emissions Scenario?	When in Medium Emissions Scenario?	When in Low Emissions Scenario?
Goddard	Yes	Yes	4-->2	4A-->2A	After 2034 (to 3) After 2092 (to 2)	After 2034 (to 3)	After 2034 (to 3)
JPL	**Yes**	**Yes**	**3-->2**	**3A-->2A**	**after 2085**	**No change**	**No change**

The figures show the projected changes in the annual total and the monthly average of cooling degree days (defined with an 18 degrees Celsius threshold) at the NASA Jet Propulsion Laboratory (JPL) in Pasadena, CA. Both annual changes from 2015-2100 (line plot) and 50-year monthly changes (bar plot) are shown. The table highlights the change in ASHRAE thermal and moisture zones at selected NASA centers in the future climate (Goddard Space Flight Center – GSFC, Greenbelt, MD, JPL, Langley Research Center, Hampton, VA) *Credit: NASA POWER*

The ability to calculate statistics for 3 climate scenarios relative to the current base state will be included in the future climate services. Users will be able to calculate annual means and sums, along with long-term statistics such as extreme values and interannual variability for arbitrary periods. The information will be provided for multiple scenarios to provide a measure of the statistical changes in key climatological variables as a function of time and projection.

Conclusion

The NASA POWER Project strives to provide the building modeling community with the data and tools needed to visualize data, make decisions, and develop standards that help enable the modeling and assessment of building energy systems from NASA's Earth observations and modeling research. Alongside our active efforts in data processing and parameter improvement, POWER's plan to continuously provide solar and meteorological data will support the development of sustainable infrastructure and efforts toward achieving decarbonization and net-zero goals. To learn more about the NASA POWER Project or to communicate your data needs users are encouraged to visit our website (**https://power.larc.nasa.gov**), or email our team directly at **larc-power-project@mail.nasa.gov**. Dr Paul Stackhouse, the POWER Project PI can be reached at **paul.w.stackhouse@nasa.gov**

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IBPSA Project 2

Building Optimization Testing Framework (BOPTEST)

David Blum[1] *and Lieve Helsen*[2]

Project Overview

IBPSA Project 2 (**https://ibpsa.github.io/project1-boptest/ibpsa/index.html**) will continue development of the BOPTEST framework to meet the growing needs of control strategy development and benchmarking for building and district energy systems worldwide. This project extends the work that was started under IBPSA Project 1 Work Package 1.2 (**https://ibpsa.github.io/project1/index.html**). Software development will continue under the same open-source license to facilitate community development and to enable access to all, including third-party developers to build applications utilizing BOPTEST.

The project runs from 2023 to summer 2027 and coordinates and further develops the work of participating organizations on BOPTEST. The expected project outcomes are as follows:

1. Outreach and community building activities that encourage community feedback on development and usage.
2. Enhanced framework software infrastructure for improved performance and additional features.
3. New emulators representing additional application scopes of interest to the community.
4. Benchmark performance results from control strategy solutions using BOPTEST.

This article describes the motivation, objectives, organization, and ongoing work within IBPSA Project 2.

Motivation

Needs for advanced and improved control strategies (CS) in building and district energy systems are growing due to requirements for reducing energy use, greenhouse gas emissions, and operating costs, providing flexibility to the electrical grid, as well as ensuring performance of novel hybrid and collective system architectures. Examples of such CS are advanced rule-based control, such as ASHRAE Guideline 36 [ASH21], Model Predictive Control (MPC) [Drg20], and Reinforcement Learning [Wan20]. However, while these and other CS show promise, three challenges slow their widespread adoption:

1. The performance of each CS is typically demonstrated on individualized case studies and quantified using different metrics, making it difficult to benchmark and compare their performance, identify the most promising approaches, and identify needed development.
2. Demonstrations in real buildings and district energy systems pose large operational risks and difficult environments for controlled experiments.
3. Development of realistic simulation models for CS testing and evaluation requires significant building science and modeling expertise not necessarily held by experts from fields which could contribute to new CS development, such as process control, optimization, and data science.

The building simulation (BS) community can address these challenges by providing suites of publicly available, high-fidelity simulation models to be used for benchmarking CS. Furthermore, providing a comprehensive

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framework to deploy, interact with, and generate key performance indicators (KPI) from these emulators would ensure their benchmarking capability and make them readily available to related control and data science fields outside of the BS community. There exists precedent for such an approach within the BS field with the development of the BESTEST [Jud95] and subsequent ASHRAE Standard 140 [ASH11] as well as the optimization fields (e.g., Decision Tree for Optimization Software [Mit22]) and data science (e.g. Gymnasium [Far23]).

The BOPTEST Concept and Approach

BOPTEST is a software framework developed with the goal of testing Advanced CS (ACS) and objectively comparing ACS on a set of standardized test cases, as shown in Figure 1, and described in detail by Blum et al. [Blu21]. BOPTEST has been implemented such that predefined, high-fidelity building models (so-called "test cases") are used for virtual test cases which can be simulated interactively with test controllers using a containerized run-time environment (RTE) and exposed API. The simulation data generated during tests is then used to compute standardized KPIs within the RTE, allowing a comparison of different ACS on the same test setup. The building models are developed with sufficient level of physical detail and temporal resolution for simulating closed-loop control behavior. Furthermore, the framework provides a library of test cases that can readily be used to test the performance of a controller across a set of buildings. To ensure transparency, all development is open-source. The following section will provide more details on the test cases, RTE, test design, and KPIs.

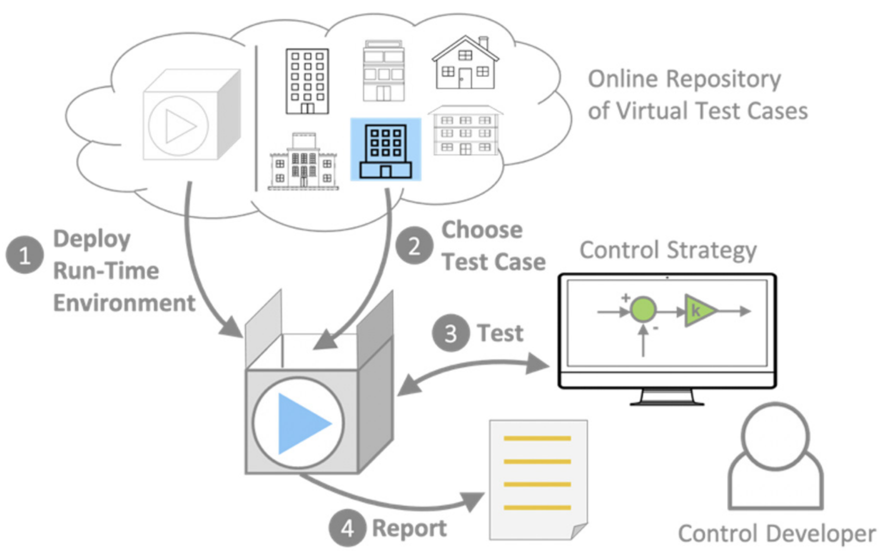

Fig 1: BOPTEST, consisting of accessing a run-time environment, choosing a test case from a repository of test cases, conducting the test of the control strategy, and obtaining a standardized report of the control performance.

The developed test cases cover a range of complexities and system types, including single and multi-zone residences and offices with air and water-based systems. Test cases are written using Modelica [Mat97] and packaged using the Functional Mockup Interface (FMI) [Blo11], as a Functional Mockup Unit (FMU). The test case FMUs contain all needed resources to not only simulate the building, such as weather and internal load schedule data, but also calculate KPIs, like electricity prices, carbon dioxide emission factors, and target zone temperatures. A set of specialized Modelica blocks have been developed to aid in the development of the models for specifying which control points can be written to and which measurements are made available. Only points that are deemed reasonable for a controller to have access to in real applications are exposed. In addition, baseline control is implemented in the building models which include both supervisory and local-loop controllers, as Modelica allows for such explicit control representation. It is left to the test controller to choose which points to overwrite, while those not overwritten will continue using the embedded control. This allows a test controller to, for example, only overwrite supervisory control points like zone temperature set points or static pressure set points and leave local-loop controllers to maintain the set point, or to directly control actuators like motor speeds and valve positions.

The RTE is delivered using containerization with Docker. This allows for the exact specification and deployment of the framework's computing environment on virtually any computing resource, whether it be locally or in the cloud, and on Linux, MacOS or Windows. Note that a publicly available web-service has been made available that allows users to work with BOPTEST without needing to deploy it locally. The Docker container uses Python to manage the simulation, using the PyFMI package [And16], calculate KPIs, generate forecasts, and generally manage data. An HTTP RESTful API is exposed for a user and controller to interact with BOPTEST and a test case. The API includes methods to view the available control inputs and measurement outputs from a test case, initialize the simulation to a specific time, choose from predefined testing scenarios (e.g. specific time period of test or electricity price profile), choose a controller communication step size, advance the simulation time with any control overwrite values, read measurement data, retrieve forecasts of weather, energy prices, and internal loads, and retrieve calculated KPI values. The design and use of the RTE ensures that experimentally consistent and sufficiently detailed results are obtained regardless of the deployment platform. Furthermore, the controller can be implemented in any computer language as long as it can communicate through the HTTP-based API. Additional interfaces have been developed on top of the HTTP API, including for Gymnasium [Far23], BACnet [ASH16], and VOLTTRON [VOL23].

To evaluate the performance of a controller, a set of key performance indicators (KPI) are calculated within the RTE based on data from test simulations. The currently available KPIs include energy use, energy cost, CO_2 emissions, peak demand, thermal comfort, indoor environmental quality, and computational time of the controller. To facilitate benchmarking, predefined testing scenarios are available for a user to choose for each test case. Currently, these include specific time periods consisting of two-week tests around peak and typical heating and cooling periods as well as a choice of three different electricity price profiles consisting of constant, dynamic, and highly dynamic, which can be used to test the capability for load shifting by a test controller. Finally, an online dashboard is being developed that will allow for users to share results of tests and for others to view and sort such results.

Project Plans and Coordination

IBPSA Project 2 will extend the work begun under IBPSA Project 1 to develop the BOPTEST framework within an open, international collaboration. The project is organized into four primary tasks, which are each summarized below.

Task 1: Outreach and Community Building

This task focuses on activities that encourage, facilitate, and disseminate BOPTEST usage, adoption, and feedback to development. This includes several objectives. First, surveying and engaging with the research and practitioner communities to inform software and test case development, such as suggesting useful software functionality and identifying the most interesting control problems or applications. Next, this task includes collecting known case studies making use of BOPTEST and testimonials from various stakeholders in the control design, delivery, ownership, and policy-making process who find value in BOPTEST. This also includes collecting, tracking, and reporting usage statistics, such as papers citing BOPTEST, number of tests run using the web-service, number of results reported to online results dashboard, and software release downloads. This task will also develop and deliver workshops and tutorials on the usage of BOPTEST, either stand-alone or in coordination with conferences sponsored by IBPSA or other relevant organizations. Finally, this task will maintain a project website to provide information for the various components of BOPTEST as well as listing and making available outreach material such as publications, tutorials, and meeting information.

Task 2: Methods and Infrastructure

This task focuses on development and maintenance of core framework software and closely related extensions in response to needs identified by Project participants and community feedback. Related components include test case and framework software architecture specification and implementation, FMU simulation and data management, KPI calculation, forecast delivery, API changes and extensions, online results sharing dashboard, web-service deployment, interface extensions, public GitHub repository management, and continuous integration testing.

Task 3: Test Cases

This task focuses on development and maintenance of virtual building models that serve as test cases. Model development will continue to utilize the Modelica language and Functional Mockup Interface (FMI) standard, particularly open-source libraries that extend from the Modelica IBPSA Library developed through IBPSA Project 1 WP1.1 and continuation IBPSA Modelica Working Group to maintain and extend the IBPSA Modelica Library.

One focus of this task will be maintaining the test cases developed as part of IBPSA Project 1 WP1.2, in coordination with Task 2, including migration to new Modelica compilers and updated Modelica libraries. Another focus of this task will be creating new test cases depending on participant and community interest, as well as consideration for relevant standards and guidelines. Example new applications of interest might include for example:

1. District heating and cooling systems
2. National building stock representation
3. Active thermal energy storage and other distributed energy resource management
4. Electric grid integration
5. Integrated multi-energy district systems

An extension to BOPTEST for evaluation and benchmarking of district-level or aggregated control of multiple buildings has been prototyped as the District Optimization Testing Framework (DOPTEST). The prototype has been described by Arroyo et al. [Arr23].

Task 4: Controller Testing

This task focuses on testing and benchmarking CS developed by both participants in this Project, and also comparison with CS developers external to the Project, using the framework developed in Task 2 and test cases developed in Task 3. The outcome will be results, in the form of KPIs and additional performance details, published in public literature and on the developed online results dashboard, which can be used for informing future directions of new controller development, performance expectations, and policy.

Further information

For further information about IBPSA Project 2 and how to join this joint collaboration, please visit **https://ibpsa.github.io/project1-boptest/ibpsa/index.html**. For more information about BOPTEST and access to software, please visit **https://ibpsa.github.io/project1-boptest** .

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Forthcoming events

Date(s)	Event	Further information
2024		
20-24 January 2024	**2024 ASHRAE Winter Conference** Chicago, Illinois, USA	**www.ashrae.org/conferences/2024-winter-conference-chicago**
May 2024 (TBC)	**IBPSA-Ireland+ ASHRAE Ireland Student Research Symposium** Munster Technological University (MTU), Cork, Ireland	
21-23 May 2024	**SimBuild** **IBPSA-USA Conference** Denver, Colorado, USA	**www.ibpsa.us/simbuild-2024**
05-07 June 2024	**eSIM** **IBPSA-Canada Conference** Edmonton, Alberta, Canada	**https://idobe.engineering.ualberta.ca/esim-2024**
09-11 June 2024	**BuildSim Nordic** **IBPSA-Nordic Conference** Espoo, Finland	**http://ibpsa-nordic.org** **https://buildsimnordic2024.ibpsa-nordic.org**
26-28 June 2024	**Building Simulation Applications Conference 2024** Bozen-Bolzano, Italy	**https://bsa.events.unibz.it**
September 2024 (TBC)	**BauSIM** Vienna, Austria	
September 2024 (TBC)	**BSO 2024: Building Simulation & Optimisation** **IBPSA-England Conference** UK	
November 2024 (TBC)	**uSIM Conference** Scotland, UK	
2025		
04-06 June 2025	**CLIMA World Congress 2025** Milan, Italy	**www.climaworldcongress.org**
24-27 August 2025	**BS 2025** **18th IBPSA International Conference & Exhibition** ***Carbon and Climate Responsive*** Brisbane, Australia	**www.BS2025.org**

Note that the dates in this calendar may, but do not necessarily, include pre and/or post-conference workshop days

20-24 January 2024
Chicago, Illinois, USA
www.ashrae.org/conferences/2024-winter-conference-chicago

2024 ASHRAE Winter Conference

Technical program

1. Key components of **fundamentals** including thermodynamics, psychrometrics, fluid and mass flow, concepts, design elements, and shared experiences for theoretical and applied concepts of HVAC&R design.
2. The development of **new HVAC&R systems and equipment**, improvements to existing systems and equipment and the proper application and operation of systems and equipment.
3. Synergies between the various uses and technologies of **refrigeration systems** from which both industrial and commercial systems might benefit, also, but not only, from the points of view of reducing direct and indirect GHG emissions.
4. As the standards authority for energy usage in buildings in the USA, ASHRAE recognizes that our long-standing initiatives in energy efficiency should be expanded to building decarbonization. This track seeks papers and programs that demonstrate **the industry's decarbonization efforts**.
5. Many different **hydronic systems** are used in the built environment. This track looks at heating hot water, domestic water, chilled water, condenser water, etc.
6. The **interaction of the many parameters involved in design & construction**.
7. The effect on final projects and on each other of **ASHRAE Standards 55, 62 and 90, and Guideline 10**.
8. **Control strategies and their application** within the built environment.
9. The **unique challenges of decarbonizing critical environments** such as laboratories.
10. This track focuses on the necessary considerations for **tall buildings**.
11. **AI and machine learning in HVAC&R** controls & equipment.

Key dates

The deadline for submitting full conference papers has passed.

- Paper accept/revise/reject notifications — 08 November 2023
- Revised papers due — 24 November 2023
- Paper accept/revise/reject notifications — 06 December 2023

For information about speakers, exhibitors, travel, registration fees, the social program and other issues visit **www.ashrae.org/conferences/2024-winter-conference-chicago**

21-23 May 2024
Denver, Colorado, USA
www.ibpsa.us/simbuild-2024

SimBuild 2024 Conference

Celebrating Two Decades of SimBuild

SimBuild 2024 marks the 20th anniversary of the first SimBuild conference, held in 2004. The theme in 2024 is *Celebrating Two Decades of SimBuild*.

SimBuild is the premiere US conference for building performance simulation users, researchers, and developers. IBPSA-USA hosts the conference every other year, in alternation with IBPSA's international Building Simulation conferences. After joint conferences with ASHRAE from 2014 to 2022, IBPSA-USA returns to hosting SimBuild as an independent conference in 2024, in Denver, Colorado.

Denver, known for attracting "architecture aficionados," is the perfect choice of location to celebrate Simbuild's Platinum Anniversary. The town had its beginnings in 1858, and since the Gold Rush era it has evolved to be one of the most exciting urban skylines in the country. From Union Station to the Fredric C. Hamilton Building: Denver Art Museum, we invite you to take a trip through time and discover Denver's history through some of its most striking architecture.

Join us as we commemorate IBPSA-USA's contributions to sustainability and building performance simulation and look toward the future. The program will highlight the work of IBPSA-USA and its members and provide a platform to envision the future of simulation, as we explore emerging technologies, trends, and strategies that will continue to drive building performance excellence in the years ahead.

Sample topics include:

- Climate Resilience and Forecasting
- Intelligent Building Operations
- Workflows and Simulation Case Studies
- Simulation Technologies and Applications
- Human Factors

Key dates

Call for papers closes	30 October 2023
Oral presentation proposals due	January 2024
Early bird registration opens	early 2024

Don't forget to follow us on our website **www.ibpsa.us/simbuild-2024**

For questions, please contact **events@ibspa.us**

We can't wait to meet you at SimBuild 2024! ■

05-07 June 2024
Edmonton, Alberta, Canada
https://idobe.engineering.ualberta.ca/eSim-2024

eSim 2024 Conference

Stimulating Sustainability Together

We are excited to announce eSim 2024, an event that promises to be a continuation of eSim's successful legacy. eSim conferences cover important and arising topics in building performance simulation, including modeling methodologies, design practices, and case studies. eSim 2024 focuses on *Stimulating Sustainability Together*, hoping to engage a wide variety of stakeholders in advancing building performance.

Located at the University of Alberta, Edmonton, eSim 2024 will have in-person presentations and a hybrid audience. Highlights will include:

- Around 100 presentations from industry experts, researchers, and practitioners
- Workshops and tutorials
- A group trip to Jasper National Park after the conference
- Interactive discussions on emerging trends, challenges, and opportunities in building simulation.

We invite you to contribute your research and expertise by submitting an abstract for consideration.

Key dates

Abstract submission deadline	01 November 2023
Notification of acceptance	15 November 2023
Paper submission deadline	15 March 2024
Notification of paper acceptance	15 April 2024
Camera-ready submission	15 May 2024
Early Bird registration	now until 03 May 2024

For updates regarding the conference program, keynote speakers, and additional details, and to register for eSim 2024, please visit our conference website at **https://idobe.engineering.ualberta.ca/eSim-2024**. We encourage you to register early to take advantage of the discounted rates.

If you have any questions or require further information, please do not hesitate to contact us at **idobe@ualberta.ca**.

Thank you for your continued support, and we hope to see you at eSim 2024! ■

26-28 June 2024
Bozen-Bolzano,
South Tyrol, Italy
https://bsa.events.unibz.it

BSA 2024: 6th Building Simulation Applications Conference

IBPSA-Italy and the Free University of Bozen-Bolzano are pleased to announce the 6th Building Simulation Applications Conference, BSA 2024, which will take place at the Free University of Bozen-Bolzano, South Tyrol, Italy on 26-28 June 2024. The official language is English.

Target audience

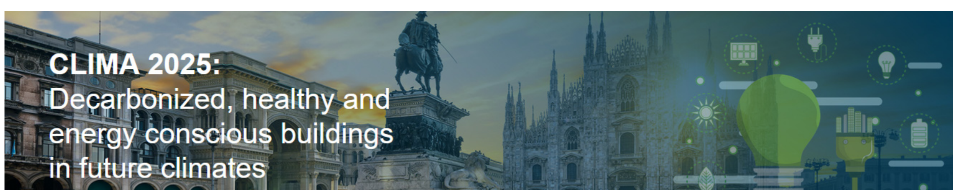
Participation is welcomed from researchers in the general sector of building simulation and energy modelling, policy makers and public agencies & utilities, all sectors of industry, and building designers. International attendance is warmly welcome.

Key dates

Abstract submission	31 December 2023
Acceptance communication	31 January 2024
Full paper submission	31 March 2024
Full paper review notification	30 April 2024
Final submission	20 May 2024

Please visit **https://bsa.events.unibz.it** for updates about BSA conferences! ■

04-06 June 2025
Milan, Italy
www.climaworldcongress.org



CLIMA 2025: Buildings for the climate of the future

The REHVA HVAC World Congress CLIMA is a leading event in the field of HVAC. CLIMA 2025 will be organised jointly by REHVA and AiCARR and will take place in Milan, Italy, from June 4th to 6th, 2025.

The theme this time is *Decarbonized, healthy, and energy-conscious buildings in future climates*, a topic that highlights the fundamental importance of the HVAC sector in all its aspects. CLIMA 2025 will offer professionals, academics, and companies in the HVAC sector a unique opportunity for international discussion about these 'hot' subjects.

Achieving the decarbonization of the European building stock by 2050 requires deep energy renovation of buildings and neighbourhoods without compromising indoor health. We need to improve our design approach to reduce the carbon footprint of our buildings to achieve the new aim of Zero Emission Buildings (ZEB), to take account of health and threats such as COVID-19, and to take full advantage of the opportunities increased digitization and sensors are creating to optimize the design, operation, and indoor environmental quality (IEQ) of new and refurbished net-zero buildings (NZEBs).

The COVID-19 pandemic has revealed our lack of knowledge about the transmission of respiratory diseases in buildings. Technically advanced sensor-based measurement and control pose numerous challenges. We know the climate is changing: will more cooling or heating capacity be needed? What energy conservation technologies will be most effective in the future?

For updates on the programme, paper submission, venue, delegate registration and other issues visit **www.climaworldcongress.org** ■

24-27 August 2025
Brisbane, Australia
www.bs2025.org

BS 2025

Following the 2023 Building Simulation Conference in Shanghai, China, Australia will take the reins in hosting the next worldwide Building Simulation Conference, BS 2025.

With the theme *Carbon and Climate Responsive*, the conference will be held in Brisbane from August 24–27, 2025. It will be jointly hosted by the IBPSA-Australasia and AIRAH, and aims to bring together the interests of academics, practitioners, students, and policy-makers from around the world.

BS 2025 will focus on the leading issues that drive the use of simulation in the built environment, including how simulation relates to achieving net zero energy and carbon both now and in the future, without compromising people's health and wellbeing. Scientific research will be presented alongside practical examples and the latest in innovation, exploring how the building simulation community can contribute to the betterment of our world.

In addition to the technical program, the conference will include workshops, site visits, panel sessions, a conference dinner and awards ceremony, social functions and a partner program.

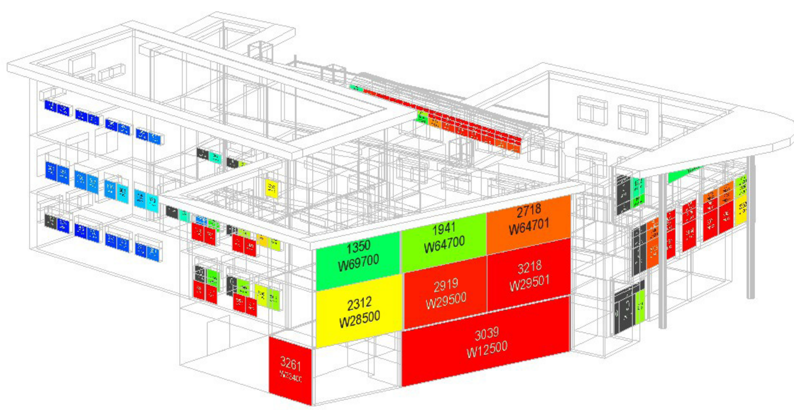
Visit **www.bs2025.org** for more information ■

Software news

DesignBuilder news: v7.3 Beta released, weather data, and ASHRAE Award

In the ever-evolving world of sustainable building design, staying at the forefront of technology and education is essential. This article explores the latest developments from DesignBuilder, including the release of the v7.3 beta version, the significance of high-quality weather data in building performance modelling, and the recent ASHRAE UK Education Award.

DesignBuilder's v7.3 Beta Version: Elevating Modelling Capabilities



DesignBuilder has recently unveiled its v7.3 beta version, promising enhanced modelling capabilities and productivity. This update brings a host of powerful new features that promise to revolutionise the way professionals approach building design and performance analysis.

Detailed HVAC Systems: The inclusion of air and water source plant loop heat pumps, generic unitary AHU, and flexible options for CO2 control empowers modellers to simulate HVAC systems with greater accuracy.

ASHRAE 90.1 Appendix G 2016: Improvements to Systems #11, #12, and #13 make compliance with energy standards smoother than ever, ensuring that buildings meet regulatory requirements.

LEED v4.1 MEPC Reports: DesignBuilder's commitment to sustainable design extends to providing support for LEED certification, streamlining the reporting process.

Daylighting Calculations: Updates for sDA and ASE annual daylighting calculations, as well as right-to-light BS 8206-2 daylighting reports, enable designers to optimise natural lighting.

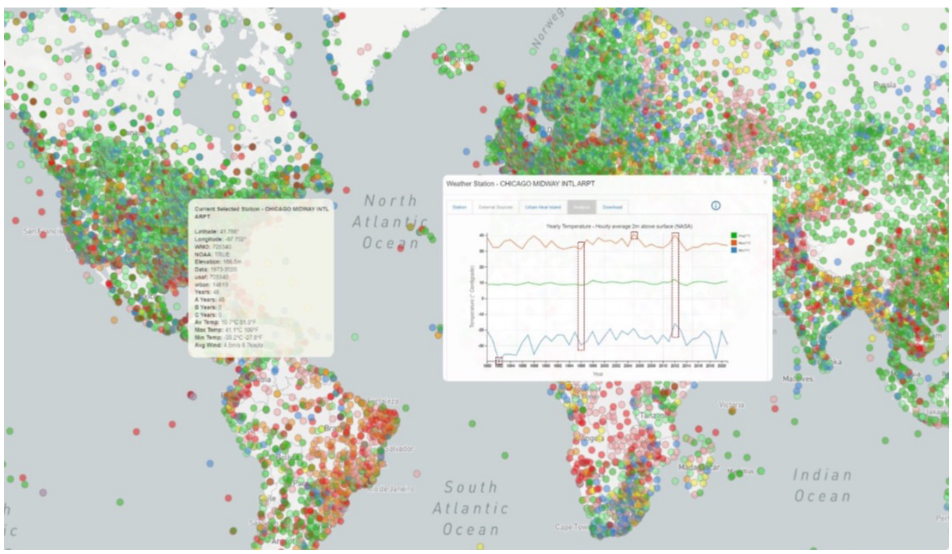
Geometry Modelling Tools: Enhancements to the Boolean, Cutting, and Clone geometry modelling tools improve precision and efficiency in building geometry creation.

IGDB Glazing Database: The updated glazing database simplifies the selection of energy-efficient glazing options.

Linear Thermal Bridging: The addition of graphical linear thermal bridging length visualisation enhances thermal performance analysis.

The new features can be viewed **here**.

Weather Data in Building Performance Modelling: Harnessing Insights



Accurate weather data is the lifeblood of building performance modelling, and a recent virtual round table discussion shed light on this critical aspect. The discussion featured distinguished panellists who shared their insights on the sources, quality, and applications of weather data.

Dru Crawley, Director of Building Performance Research at Bentley Systems, discussed the importance of reliable weather data sources, emphasising the availability of hourly weather files at **https://Climate.OneBuilding.org**.

Andy Tindale, Co-founder of DesignBuilder Software, underscored the significance of tailoring weather data to specific modelling needs. He introduced the DesignBuilder Climate Analytics weather data service, which aims to provide high-quality, customisable weather data to enhance modelling accuracy.

Joe Huang, President and Founder of White Box Technologies, highlighted the offerings of White Box Technologies, including their weather data service, and discussed the sources of high-quality weather data.

Throughout the discussion, various aspects of weather data, including its evolution, future climate considerations, data quality, and matching data to specific applications, were explored. A recording of the session can be viewed **here**.

DesignBuilder Wins ASHRAE UK Education Award: Fostering Sustainable Education

DesignBuilder's commitment to education and sustainability extends beyond software innovation. The company has been honoured with the ASHRAE UK Education Award for its user-friendly interface and comprehensive on-demand training program, which have simplified and accelerated the learning process for students worldwide.

The on-demand training, developed by DesignBuilder's expert technical staff, offers intuitive training videos, interactive quizzes, exercises, models, and supporting content. It complements university curricula and the user-friendly DesignBuilder interface, providing foundational skills and knowledge for sustainable building design. DesignBuilder is dedicated to supporting the next generation of building professionals. As a student, you can take advantage of their affordable student personal license, granting access to all the modules needed for your coursework and research studies. This commitment to education and accessibility empowers students to focus on learning and research without the burden of prohibitive costs.

The ASHRAE UK Education Award stands as a testament to DesignBuilder's collective efforts and their commitment to sustainable education. You can explore the on-demand training content for academia by visiting the **DesignBuilder Online Training** and **DesignBuilder Software For Education** pages on their website. ■

TRACE® 3D Plus meets Spawn: integrating building models with controls

Kaustubh Phalak, Trane Technologies

In 2021, the US Department of Energy, Lawrence Berkeley National Laboratory, the National Renewable Energy Laboratory and other partners released **Spawn-of-EnergyPlus (Spawn)**, a next-generation engine intended to bridge the worlds of

BEM and control workflows. Spawn integrates HVAC and control models developed in Modelica with envelope models from EnergyPlus. After the release of the Modelica package for Spawn in Modelica Buildings Library (MBL), Trane started using Spawn for research-oriented projects. While Spawn unlocks new possibilities, it introduces a hurdle for modellers: the need to write building envelope information in input data files (IDFs). To bridge this gap, we turned to TRACE® 3D Plus (TRACE).

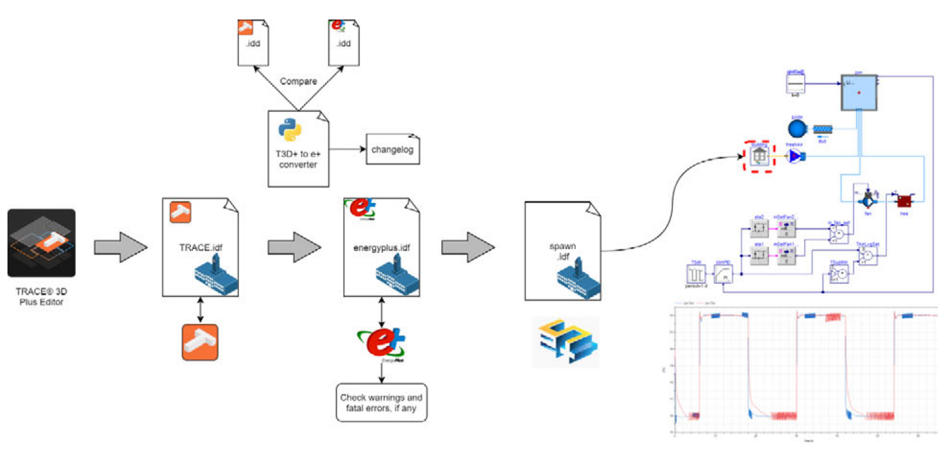
TRACE is built on a modified version of the EnergyPlus engine, with additional features based on industry experience. These additional objects, fields, and control options, differentiate its IDF and input data dictionary (IDD) files from EnergyPlus and therefore we cannot directly use the IDF from TRACE with Spawn.

In 2022 Trane developed a workflow that integrates the building envelope models created in TRACE seamlessly with HVAC systems and control models built in Modelica and Simulink, and with other control-modelling tools used at Trane, but this is exclusively for internal use.

Prior to Spawn, we explored and used solutions like the Building Controls Virtual Test Bed (BCVTB) and EnergyPlusToFMU for hard-coupling of controls with TRACE models. These were satisfactory for the specific projects for which they were created, but usability and complexity limited their adoption for other projects. As our needs evolved to encompass the co-simulation of building models with Modelica-based refrigerant system models and controls, we sought innovative solutions to bridge this gap.

TRACE to Spawn

To meet co-simulation requirements more effectively, we devised a solution that converts TRACE IDFs into Spawn-compatible IDFs. This uses a Python conversion script to compare TRACE and EnergyPlus IDD files, remove additional fields from a given IDF, and replace them with EnergyPlus-compatible alternatives, if needed. While this process may entail sacrificing certain TRACE features, it ensures seamless compatibility. The flow diagram below illustrates this conversion process and shows a SingleFamilyHouse.AirHeating model from MBL with its IDF replaced by a similar model created in TRACE:

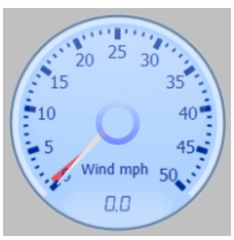


Unlocking new applications

In addition to addressing the use of HVAC with controls, this workflow simplifies the export of Functional Mockup Units (FMUs) from TRACE building models. Causal wrappers for Spawn can be developed in Modelica, enabling effortless TRACE building export as FMUs. These FMUs have proven invaluable for model sharing and facilitating testing of AI and ML-based controls.

Acknowledgments

We are grateful to Michael Wetter, Scott Munns, Matt Biesterveld, Nagappan Chidambaram, Jim Spielbauer and the TRACE development team for their invaluable support. The work was presented at American Modelica Conference 2022, and our paper can be download at **https://2022.american.conference.modelica.org/documents/02_presentations/namodelica2022_Presentation_29.pdf** ■



Updated Canadian and Uruguay Climate Datasets published on Climate.OneBuilding.Org

We have updated to the latest version of CWEC 2020 on our web site with 564 Canadian locations, with data through 2017, including 72 northern locations which incorporate satellite solar radiation data. This update includes both TMY and TDY for data through 2017. (**https://collaboration.cmc.ec.gc.ca/cmc/climate/Engineer_Climate/CWEC_FMCCE**) . These include:

- Typical Meteorological Years using the TMY/ISO 15927-4:2005 methodologies.
- Typical DNI (direct normal insolation) Years with 100% weighting on DNI solar data (TMY weights solar 40%)

Also updated was the AMTUes v 2.5 (Año Meteorológico Típico para aplicaciones de Energía Solar) data for 5 locations in Uruguay: **https://les.edu.uy/en/products/typical-meteorological-year-v2/** .

To see a list of the newly available data, visit **https://climate.onebuilding.org/WMO_Region_4_North_and_Central_America/CAN_Canada** and **https://climate.onebuilding.org/WMO_Region_3_South_America/URY_Uruguay** or view the KMLs (**https://climate.onebuilding.org/WMO_Region_4_North_and_Central_America/Region4_Canada_EPW_Processing_locations.kml** or **https://climate.onebuilding.org/WMO_Region_3_South_America/Region3_South_America_EPW_Processing_locations.kml**) in Google Earth, Google Maps, or other mapping tools.

With this update, Climate.OneBuilding.org now provides TMYx climate data at no cost for more than 16,100 locations in more than 250 countries and another 21,000 files from other data sources. All data have been through extensive quality checking to identify and correct data errors and out of normal range values where appropriate.

For more information or to download any of the climate data (no cost), go to **https://Climate.OneBuilding.org** ■

Oikolab's ERA5 Reanalysis data

Since 2018, Oikolab (**https://oikolab.com**) has been providing historical weather datasets to the building energy simulation community. In 2022, Climate One Building (**https://climate.onebuilding.org**) published updated TMY EPW files for 16,100 locations around the world using solar and other meteorological data derived from ERA5 Reanalysis data provided by Oikolab data service.

Reanalysis is a process of 'cleaning' noisy observation data to produce a consistent, gap-free, analysis ready dataset. This is done by correcting for observational noises and gaps using the latest advances in atmospheric science and all available sources of data, from ground station measurements to aircraft, weather balloon, and satellite measurements. This approach of combining observation data with atmospheric physics allows a complete re-construction of the state of the atmosphere for any given time and location that represents the latest scientific understanding of atmospheric physics. For building model simulations, this brings many advantages including the derivation of parameters not typically provided by ground observation data, such as the short-wave and long-wave radiation data needed to construct an EPW file. It also corrects any observational bias in the weather station.

The latest generation of reanalysis data published by the Copernicus Climate Change Service (C3S) at the European Centre for Medium-Range Weather Forecasts (ECMWF) is called ERA5. This dataset is also used by the Intergovernmental Panel on Climate Change (IPCC) to track global warming. This year, Oikolab's Weather Data Downloader (**https://weatherdownloader.oikolab.com**) has been updated to create EPW files on the fly for any location and for any year from 1940, using either ERA5 data or a TMY file based on the latest 15 years (180 months) of data. EPW files are also programmatically accessible via an API. ■

IBPSA on social media

IBPSA has several internet presences on social media in addition to its main web site, its webinars, and affiliates' sites. Thanks to Mike Barker for collating the list below:

Main IBPSA web site	www.ibpsa.org
*There is a wealth of material on the main web site, including past editions of ibpsa*NEWS *back to 1988 and* ***links to affiliates' web sites at:***	www.ibpsa.org/affiliates

Linkedin:	
IBPSA	www.linkedin.com/company/ibpsaworld
IBPSA Group	www.linkedin.com/groups/75552
IBPSA - Daylighting & BIPV & Fenestration	www.linkedin.com/groups/78517
IBPSA - EnergyPlus + Modelica	www.linkedin.com/groups/2085105
JBPS	www.linkedin.com/company/journal-of-building-performance-simulation

YouTube (IBPSA University)	www.youtube.com/@IBPSAUniversity

X (Twitter)	https://twitter.com/IBPSA?s=20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** IBPSA-DACH brings together three German-speaking countries: Germany, Austria & Switzerland*

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For additional information about IBPSA, please visit the Association's web site at **www.ibpsa.org**. **For information on joining, contact your nearest regional affiliate.**

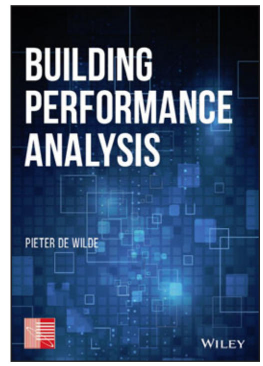
Members can subscribe to the IBPSA mail list (and, if desired, unsubscribe or edit) via a web interface which is available at **http://lists.onebuilding.org/listinfo.cgi/bldg-sim-onebuilding.org**. Note that this mailing list is solely for IBPSA-related notices and to ensure that you receive future important IBPSA updates (including the election process and announcements of IBPSA News releases).

For any other purposes, please use the BLDG-SIM list. BLDG-SIM is a mailing list for users of building energy simulation programs worldwide, including weather data and other software support resources. BLDG-SIM is intended to foster the development of a community of those users. Experienced and inexperienced users of building energy simulation programs are welcome and are expected to share their questions and insights about these programs.

If you have any questions with respect to the BLDG-SIM, please contact the list owner:
Jason Glazer at **jglazer@gard.com** or +1 847 698 5686. This list is made possible courtesy of GARD Analytics, Inc., Ridge Park, IL, USA. For further information about this list server, see the web page located at **http://lists.onebuilding.org/listinfo.cgi/bldg-sim-onebuilding.org**. ■

Books by IBPSA Fellows

Building Performance Analysis (Wiley, 2018)



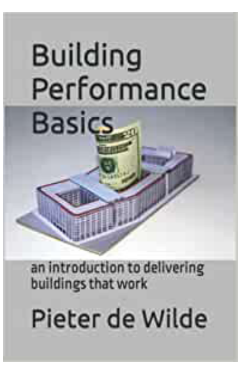
Building Performance Analysis is the go-to resource for those who want to have a deep understanding of what building performance is. The book is endorsed by IBPSA.

Offering a comprehensive and systematic overview of the concept of building performance analysis, *Building Performance Analysis* brings together many existing notions and ideas in one title. A substantial book, it has 11 chapters, 600 pages, and cites over 1600 references. Part I deals with the foundations of building performance, Part II deals with performance assessment, and Part III with the impact of applying of building performance analysis throughout the building life cycle. The book concludes with an epilogue that presents an emerging theory of building performance analysis.

Written for the building science community, it aims to make the following contributions to the field:

1. It reviews the significant body of knowledge on building performance that already exists.
2. It emphasizes that building performance has many aspects, and challenges the community to address those that get less prominence in the literature.
3. Going beyond simulation as a tool for building performance analysis, it also discusses physical measurement approaches, expert judgment, and stakeholder evaluation. It offers a review of the many analysis approaches available in each of these categories.
4. The emergent theory in the epilogue is intended as a key resource for researchers seeking to develop questions and hypothesis. This is intended as matter for discussion, debate, and deeper exploration. ■

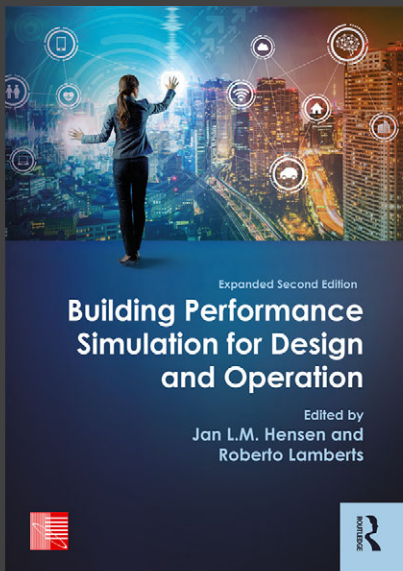
Building Performance Basics (Amazon KDP, 2022)



Building Performance Basics is a short book intended as an introductory text for students at BSc and MSc level, a primer for those entering the industry, and a refresher for those who are already in practice but want to sharpen their view. As *Building Performance Analysis* (above) is rather encyclopaedic, this booklet has been written with a different tone and set-up: short and cheerful, published with Amazon KDP in order to be quick to market, brief and to the point, and more persuasive in order to champion the importance and role of building performance.

Building Performance Basics deals with core questions about building performance: Why is it important? What exactly is it? Where does it play a role? Who should champion building performance? How do we quantify it? And how much performance should we aim for?

Building Performance Basics aims to provide a solid foundation for further professional development and learning about building performance, and for claiming leadership about building performance in practice. In academic courses, it provides context to modules that introduce students to hands-on performance quantification efforts using simulation, measurement and occupant surveys. In industry, this book can be used at any time where there is a wish to refresh a role as building performance champion. ■



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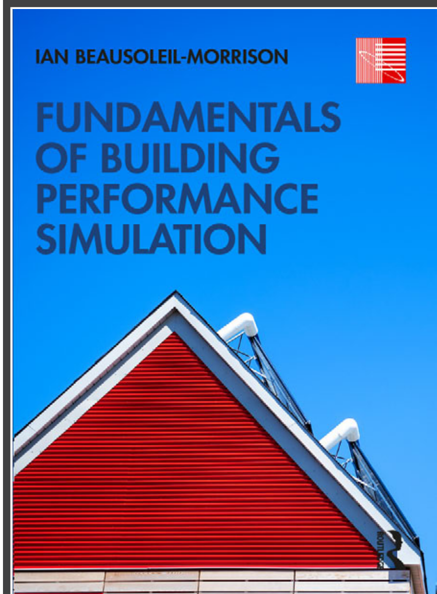

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64 illustrations

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eBook: 978-1-003-05527-3

Fundamentals of Building Performance Simulation

Ian Beausoleil-Morrison, Carleton University
Ottawa, Ontario, Canada

Fundamentals of Building Performance Simulation pares the theory and practice of a multi-disciplinary field to the essentials for classroom learning and real-world applications. Authored by a veteran educator and researcher, this textbook equips graduate students and emerging and established professionals in architecture and engineering to predict and optimize buildings' energy use. Each subject is introduced without reference to particular modelling tools while problems at the end of each chapter provide hands-on experience with the tools of the reader's choice.

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Journal of Building Performance Simulation

Official journal of the International Building Performance Simulation Association (IBPSA)

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Publishes international research on building performance simulation including modelling and simulating thermal processes, energy conversion and weather data.

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Current calls for papers:

Special Issue: Machine Learning meets Simulation

Special Issue: The Energy Performance Gap

Special Issue: Methods for climate-resilient building performance simulations under impacts of changing climate

Recently published articles *(since previous IBPSA News)*

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Hugo Geoffroy, Julien Berger, Benoît Colange, Sylvain Lespinats & Denys Dutykh (2022) The use of dimensionality reduction techniques for fault detection and diagnosis in a AHU unit: critical assessment of its reliability, Journal of Building Performance Simulation, 16:3, 249-267
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Muhammad Zeeshan, Zaib Ali, Muhammad Sajid, Majid Ali & Muhammad Usman (2022) Modelling the cooling effectiveness of street trees with actual canopy drag and real transpiration rate under representative climatic conditions, Journal of Building Performance Simulation, ahead-of-print
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Journal of Building Performance Simulation

Official journal of the International Building Performance Simulation Association (IBPSA)

Call for Papers

Special Issue: Machine Learning meets Simulation

Manuscript deadline: 31 January 2024

Context:

Contributions are invited for a Special Issue on the topic of Machine Learning meets Simulation. This builds on a previous Special Issue 'Data-driven approaches to building simulation for enhanced building operation and grid interaction'. This time the scope is shifted from operation to design, including surrogate modelling and related topics that apply machine learning to aid in simulation at the design stage.

Topics:

- Surrogate modelling (a machine learning model fitted to simulation outputs to approximate the performance of the detailed model)
- Applications of surrogate models or other ML-related methods, including in the areas of building stock modelling, design exploration tools and modelling of existing buildings.
- Physics-informed machine learning, where physical constraints are incorporated into machine learning algorithms directly
- Calibration or optimization of simulation models using machine learning approaches (note that pure optimization using e.g. genetic algorithms with simulations directly are not in scope)
- Any other ways of combining machine learning with more traditional physics-based simulations
- Developments in machine learning to aid in integration with simulation tools, for example in time series modelling
- The challenges of integrating machine learning with simulation, including assessing model accuracy, concerns of bias and gaining confidence from users

Special Issue Editor:

Ralph Evins, University of Victoria **revins@uvic.ca**

Instructions for authors:

https://think.taylorandfrancis.com/special_issues/machine-learning-meets-simulation

Special Issue: The Energy Performance Gap

Manuscript deadline: 31 January 2024

Context:

Typically predictions of building energy performance that stem from simulation tools do not fully map measured energy performance from these buildings once constructed and in use. Whilst some discrepancy can be expected, often the difference is significant, with some authors reporting a magnitude of 2 or 3. This difference between predicted and measured energy performance is named the 'energy performance gap', and has been the subject of significant research efforts over the past decade.

Underlying the challenge of the energy performance gap are questions about the quality, credibility and ultimately utility of building performance modelling and simulation. In order to support the design and construction of buildings that meet quantified ambitions, to maintain customer confidence and credibility of the building engineering community, and to continue as a serious discipline, the building simulation community needs to reduce the energy performance gap to manageable dimensions, and be able to explain discrepancies between predictions and measurements. This is especially important if we move towards long term predictions with significant uncertainties, such as the performance of buildings subject to climate change. A good grip of the energy performance gap is also required for simulation to play a role in energy performance contracting.

Aims:

This Special Issue intends to bring together recent developments that quantify the energy performance gap, explore underlying causes, and suggest approaches to reduce the magnitude of this gap. It will do this while taking into account that there are different types of energy performance gaps, such as a design performance gap, procurement gap, or regulatory performance gap, and that the magnitude and behaviour of these gaps may differ with different socio-economic contexts.

Topics of interest:

Original research on the energy performance gap, aligned with the aims and scope of JBPS, focussing on:

- Status and magnitude of the energy performance gap: work that assesses the current situation and developments in the field, developing the evidence base and deeper assessment of the challenge.
- Underlying causes for the energy performance gap: studies that explore the root causes of the energy performance gap, helping to capture and manage the different factors that lead to the gap.
- Model validation, verification and calibration: efforts in modelling and simulation that help to manage the gap, and which provide tools to manage the gap within the domain of scientific computing
- Novel approaches to reduce the energy performance gap: work that aims at managing the performance gap which sits outside the more traditional validation, verification and calibration efforts, for instance quality control on site, new legislative frameworks and similar
- District and urban energy performance gaps: studies at other spatial resolution levels
- Performance gaps in other domains than energy performance: work that looks at other domains where there is a discrepancy between predicted and measured performance, such as lighting, acoustics or indoor air quality.

It is important to highlight that the following topics are outside the journal's scope and will not be considered: case studies involving the routine application of commercially available building performance simulation tools that do not include validation or aspects that make a novel contribution to the knowledge base.

Special Issue Editors:

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Cheol Soo Park, Seoul National University **cheolsoo.park@snu.ac.kr**

Instructions for authors:

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