BS 2021
22-25 AUG
BRUGES

GODFRIED AUGENBROE 1948-2021

A tribute from his colleagues, students and friends

BS2021: the activities, the participants, the student modelling competition, and the IBPSA and Fellowship Awards

Contents

President's message

Dear IBPSA Colleagues and Friends

As we move into the autumn season, it would appear that there is a little more certainty around the pandemic and although, with so many remaining unvaccinated, I would hesitate to say that we are getting things under control, they do seem calmer.

For those who attended the Building Simulation Conference BS2021 in Bruges – in presence or on line – I think that we can all agree that it was a great success and a triumph of determination over uncertainty.

We were delighted that the Board was able to support the Organising Committee in making it possible for absent authors to present their work in an online track at the conference. The whole thing was immensely challenging to deliver, and I am extremely grateful to all the Board members who volunteered to chair the online sessions. By doing this, they not only made the conference as inclusive as we could under the circumstances, but gave us the opportunity to test new ideas for the future. One thing I would like us to take forward is the need to strike a balance between having a large-scale event every two years and making it possible for everyone to attend. This is something we will look into for future conferences.

Daily reports from people on site in Bruges confirmed that the conference was well received and that combining live, online and live streaming worked well. The surprise inclusion of screens around the venue showing the online tracks – which people could join via Zoom - and also the provision of spaces where all activities, live streamed and online, were available in one space, was welcomed. This also gave an added sense of safety to those who were less comfortable sitting close to others in a conference room.

So, thank you to IBPSA NVL - in particular to Lieve Helsen, Wim Boydens, and Wim Plokker - and the wider Organising Committee, for all their hard work and for agreeing to work with us on the online elements. Thanks also to the Conference Committee led by Paul Strachan for their coordinating efforts, the IBPSA Board and the joint sub-committee of the Board and OC without whom the online tracks would not have happened.

Success relied on everyone pulling in the same direction – but I would like to give a special mention to Andrea Gasparella and Veronica Soebarto who managed the technical, organisational and communication aspects of the online zoom sessions, and the members of the IBPSA Board who volunteered to Chair the online sessions.

We couldn't have done any of this without the technical team in Bolzano and I have already written to everyone to thank them on our behalf.
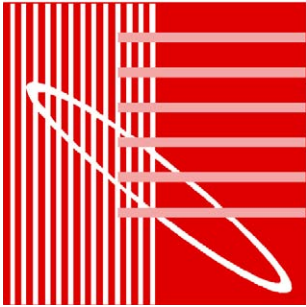
It is now time to leave BS2021 behind and to push on, and I have a couple of ideas on this which I would like to set up a short-term working group to explore, including creating more opportunities on the Board for affiliate representatives who want to remain more involved, and the creation of a board of the future or next generation, mentored by existing board members. We should also look at how we keep the Board fresh, bring on a wider range of voices, and explore options to build capacity, without compromising efficiency.

Although progress on most things over the last year has been slow due to the pandemic and BS2021, some areas have moved forward, which is a positive sign.

Membership numbers are up from 4327 to 4754 – and thanks to BS2021, I feel that we know our members better!

Moving on to the list of things we gave ourselves to do last year, there were many large pieces of work identified and not surprisingly, progress on many of these has stalled, but I think I can say that in three key areas there has been measurable progress:

- We have identified a way forward for a Membership database, which is an important step in better managing who is / is not an IBPSA Member. We have decided to combine this with the long overdue revamp of the IBPSA website.

- Work on virtual educational activities from the IBPSA webinar series to the IBPSA academy is developing for the sharing of new ideas.

- And Rajan Rawal has already begun to liaise with the BS2021 OC regarding sharing the recordings of the keynote addresses to upload on the IBPSA University YouTube Channel.

At the AGM this year, two longstanding Board Members, Veronica Soebarto and Michael Wetter, stepped down to concentrate on other things. We wish them both well and thank them for the huge contribution they made over the years. Their departure meant two vacancies on the Board. I am pleased to say that these have been filled by Clarice Bleil de Souza (IBPSA England) and Carrie Brown (IBPSA USA).

Finally, I cannot allow the passing of one of our longstanding members to go without mention. Godfried Augenbroe was a constant in our field and a great teacher. His legacy lives on in those he inspired.

This has been a difficult year, but one which has ended positively, I think. I hope that you and your families remain well; please keep everyone in your thoughts and stay safe.

Lori McElroy
President IBPSA

# Best of 'Ask a Modeler': Simulation across Space and Time

'Ask a Modeler' is an advice column for the building simulation community. Each month, committee chair Nathaniel Jones and members of the Emerging Simulation Technology subcommittee pose a question submitted by an IBPSA member to recognized experts to get their unique perspectives. Through this column, we hope to expand communication and create a sense of community among practitioners, researchers, and academics at all points in their building simulation careers. Below, we are reprinting some expert advice from the past few months. We hope that sharing these questions and insights will bring value to your work and possibly make you think about building performance modeling from a new point of view.

Sometimes energy modelers and mechanical engineers use different values for details like lighting power density or receptacle loads. How can we maintain better compatibility between models, or do we need to?
— Looking for Consistency

Dear Consistency,

We have been down this path before, especially if you have an involved mechanical or electrical engineer. It is way into a construction document or permit set development cycle, and everyone is anxious to get the documents out the door and know what the energy model is predicting for design EUI or LEED points. That glorious moment when you receive the email from the engineer, who after having examined the energy end use breakdown notices the plug load consumption is far off from their estimates. "Can we set up a GoTo meeting to discuss?" is what usually follows.
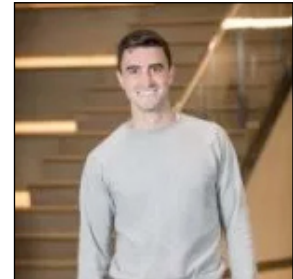
To start, is the model that the energy modeller produces going to inform anything in the mechanical design? Always ask yourself what the purpose of the model is – be it code compliance, LEED documentation or informing design decisions, among others.

Is the modeller simply producing a code compliance report that the authority having jurisdiction (AHJ) is going to see, check the box, and never speak about it again? If that is the case, the simple truth is that it does not matter if those values for lighting power density or receptacle loads align. That is not to say that the model produced for code compliance does not have to align with the installed lighting or equipment design – we know those two things must align. But we also know nine times out of ten the mechanical engineer is not doing space by space lighting power density calculations to inform their load calculations. They know an office building is around 1 W/sqft and if it is a lab, then perhaps the LPD is around 1.6 W/sqft. And the best part is, they are right in doing so.

Build a quick 50,000 square foot office building in your favorite piece of energy modeling software and assign a LPD of 1.0 W/sqft to the building. Then, create an alternate and assign a LPD of 1.6 W/sqft. Check out the results. Did your building peak cooling load or airflow really change to any significant degree? Not substantially; what did change was your annual energy use.

Herein lies the primary difference between the mechanical engineer and the energy modeller that needs to be established. The mechanical engineer is looking at a point in time for peak sizing, the modeller is looking at the full year. The energy modeller cares to be detailed in their lighting or equipment power densities because a 0.6 W/sqft difference (referencing the above 1.0 and 1.6 W/sqft) multiplied over 8,760 hours in a year makes a big difference – at a specific moment in time however, 0.6 W/sqft is minimal.

Would it be nice for those values to align between energy modeller and engineer? Certainly – I appreciate consistency as much as the next person. A great way to maintain compatibility is to simply ask for the mechanical engineer's load calculation file, view the inputs, and then have a dialogue. Or reference the mechanical engineer's basis of design which will elaborate on the design assumptions they have used. Additionally, in the case where the model is used for stringent program compliance, consider identifying end uses that contribute significantly to annual/peak loads for that building/space type, then consult with MEP at early stages of the project to ensure assumptions are appropriate for those specific items. Lastly, ASHRAE research paper 1742 provides updated office plug load values, more accurate than those found in the Fundamentals textbook, and make sure to subscribe to updates from NREL's multi-year effort to develop a database of end-use profiles for current U.S. building stock across climates and building types, set to be complete in 2021.

In a day and age when design is moving faster than ever, always ask yourself what is the purpose of the model you are building, and what impact it will have. By asking these questions, it will dictate the level of detail you need to spend on each element of the model. If the mechanical load file, and your energy model are going to be independent of each other, then do your due diligence to compare LPD and receptacle load values, but otherwise work to improve the level of detail in other areas of the model – like HVAC fan control or daylighting.

Conor Rielly
Building Energy Analyst, CannonDesign

When should I use future weather in building energy modeling, and what climate change model should I use? Is it possible to use future weather files to meet the demands of standards like Title 24 that are based on current climate conditions?
— Forecasting the Future

Dear Forecasting,
It's exciting to me to know that there are forward-thinking building energy modelers out there that care about designing buildings for future climate. Climate change has everything to do with Title 24's standards for "energy conservation, green design, construction and maintenance, fire and life safety and accessibility," as climate affects the yearly profile of meteorological parameters that are input to the models that assess the level of a building's or a neighborhood's ability to meet these requirements.

In 2017, like you, a group of scientists began asking if the climate zones that inform building codes were appropriate for new building construction. They recognized that the American Society of Heating Refrigeration and Air-conditioning Engineers (ASHRAE) Standard 169 "Climate Data for Building Design Standards" defined climate zones based on measurements from world weather stations over the past $8-25$ years, and that the weather that today's new buildings would see over their $30-120$ year lifespan would likely be very different from that of the past due to the rapid changes in climate that the world is already witnessing (New et al., 2017). So they analyzed various methods for redefining

climate zones using projections from two different models that were cited in the most recent Intergovernmental Panel on Climate Change (IPCC) assessment report. The report includes information on how well each model has predicted different meteorological parameters of past climate, so that researchers can determine which model output is best suited to the research they are doing. A good practice for using climate model output for research regarding the future is to use an "ensemble" of output, or output from several reliable models, so that results can be evaluated within the bounds represented by the lowest and the highest values predicted by the model ensemble.

An interdisciplinary group across weather, climate, population and buildings, in which I am involved (Allen-Dumas et al., 2020), hypothesized that the geometry of building placement in neighborhoods might affect the way wind flows through the neighborhoods and sunlight hits different parts of them, and that careful planning by developers along these lines might maximize temperature management in and across neighborhoods leading to more efficient building energy use. That study used a method called "dynamical downscaling," in which a weather model takes climate data averaged at, for example, 32km resolution, and estimates the meteorology at a per-building level (90m resolution) so that the immediate meteorology affecting the energy use of each building can be taken into account. Also included in this simulation was a representation within the model of building heights, footprints and spacing.

To investigate urban heat mitigation during extreme heat events expected with climate change, Vahmani et al. (2019) used a weather model to downscale IPCC climate model output to 1.5 km resolution at hourly intervals. They also included satellite information depicting urban vegetation in the weather model so that they could investigate the interacting effects of cool roofs and other types of green design on a city's ability to cool itself during these events. This group's next investigation will use a similar modelling approach to examine feedbacks between exhaust from building cooling and the natural urban microclimate under extreme heat conditions.

These are just a few examples of how modelers are using climate projections for research into building energy modeling for the future. Most of the model projections (and some useful visualization tools) are available from the Earth System Grid. I hope you will enjoy reading these and related studies and then take them further with your work as you look at additional ways to help meet the Title 24 standards over a variety of geographic locations and neighborhood conditions.

Melissa Allen-Dumas, PhD
Research Scientist, Oak Ridge National Laboratory

Allen-Dumas, M.R., Rose, A.N., New, J.R., Omitaomu, O.A., Yuan, J., Branstetter, M.L., Sylvester, L.M., Seals, M.B., Carvalhaes, T.M., Adams, M.B. and Bhandari, M.S., 2020. Impacts of the morphology of new neighborhoods on microclimate and building energy. Renewable and Sustainable Energy Reviews, 133, p.110030.

New, J.R., Kumar, J. and Hoffman, F.M., 2017. Potential impacts of climate change on the built environment: ASHRAE climate zones, building codes and national energy efficiency. Oak Ridge National Lab. (ORNL), Oak Ridge, TN (United States).

Vahmani, P., Jones, A.D. and Patricola, C.M., 2019. Interacting implications of climate change, population dynamics, and urban heat mitigation for future exposure to heat extremes. Environmental Research Letters, 14(8), p.084051.

We want to hear your interesting, entertaining, or just plain odd questions about life and building performance simulation. Submit your questions at **www.ibpsa.us/ask-modeler** *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* **unmethours.com***. Read our other past columns at* **www.ibpsa.us/ask-modeler-column-archive***. 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**. ■

Notes from BS 2021

"A stimulating post-COVID high level conference that has put our challenges and innovations in the energy domain back on the main stage"

Lieve Helsen and Wim Boydens, Conference Chairs

IBPSA's 17th International Conference was held in the medieval city of Bruges from August 31 to September 3, hosted by IBPSA NVL. The BS2021 Organising Committee created a breeding ground for quality and excellence, embraced by history, industry and policy, in the relaxing atmosphere found in the calm, safe, inspiring and welcoming city of Bruges. Their aim was an experience which is more than a conference, and that's what they realized, in a world full of disturbances and uncertainties, thanks to their positive mindset, their perseverance, their dedication, their energy and flexibility, but above all the dynamic BS community that stood tall in the complex and challenging situation we faced.

Attendees who participated onsite enjoyed social and networking activities as never before: it was the first live conference after a long period of working behind screens. The music competition and BS2021 theme played by the carillon, the welcome reception with typical Belgian flavours, the gastronomic networking dinner, the concert full of power and emotion, the conference dinner with a new zero-carbon travel award and the sunny farewell reception all epitomized the Belgian art of

living, colouring serious and hard work with the joy of meeting, greeting and tasting, a tasteful combination of Food for Thoughts, Food for Body and Food for Soul. Attendee satisfaction was extremely high!

Both the livestream of the onsite presentations and the parallel online track allowed absent attendees to present and to follow the keynote and technical sessions, leading finally to 639 attendees (from 43 different nationalities – 28 onsite and 37 online), despite the extremely difficult situation that was changing all the time. Some key numbers (based on the 635 attendees registered on August 31) are presented below.

presented papers	461
accepted papers	533
papers submitted	605
abstracts submitted	979

- non-presenting attendees
- presenting attendees

225
410

279   356

331

25

- Online attendees
- Onsite full conference
- Onsite Impact Day only
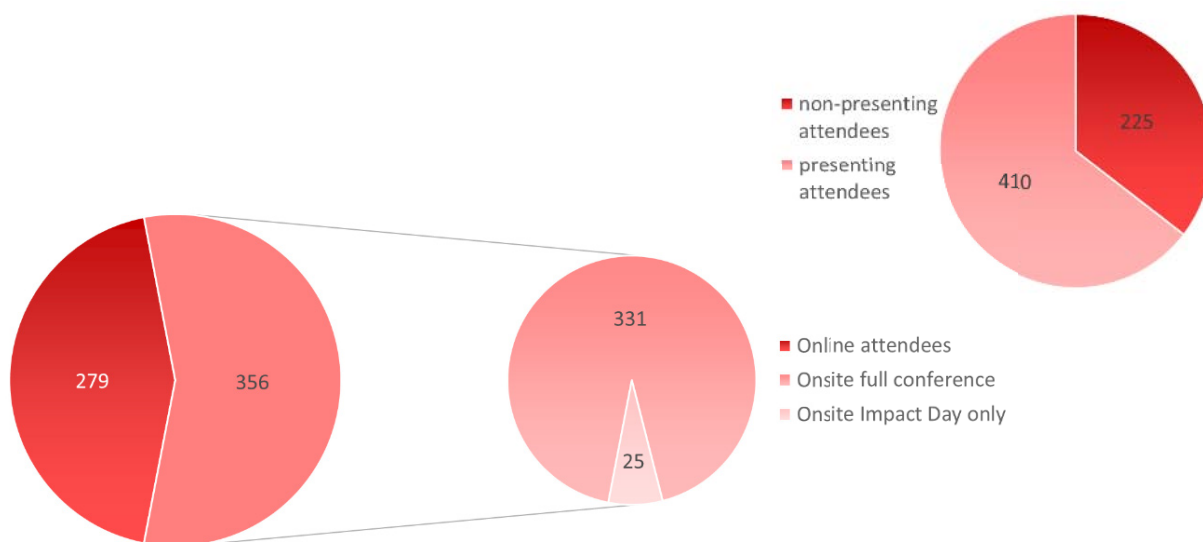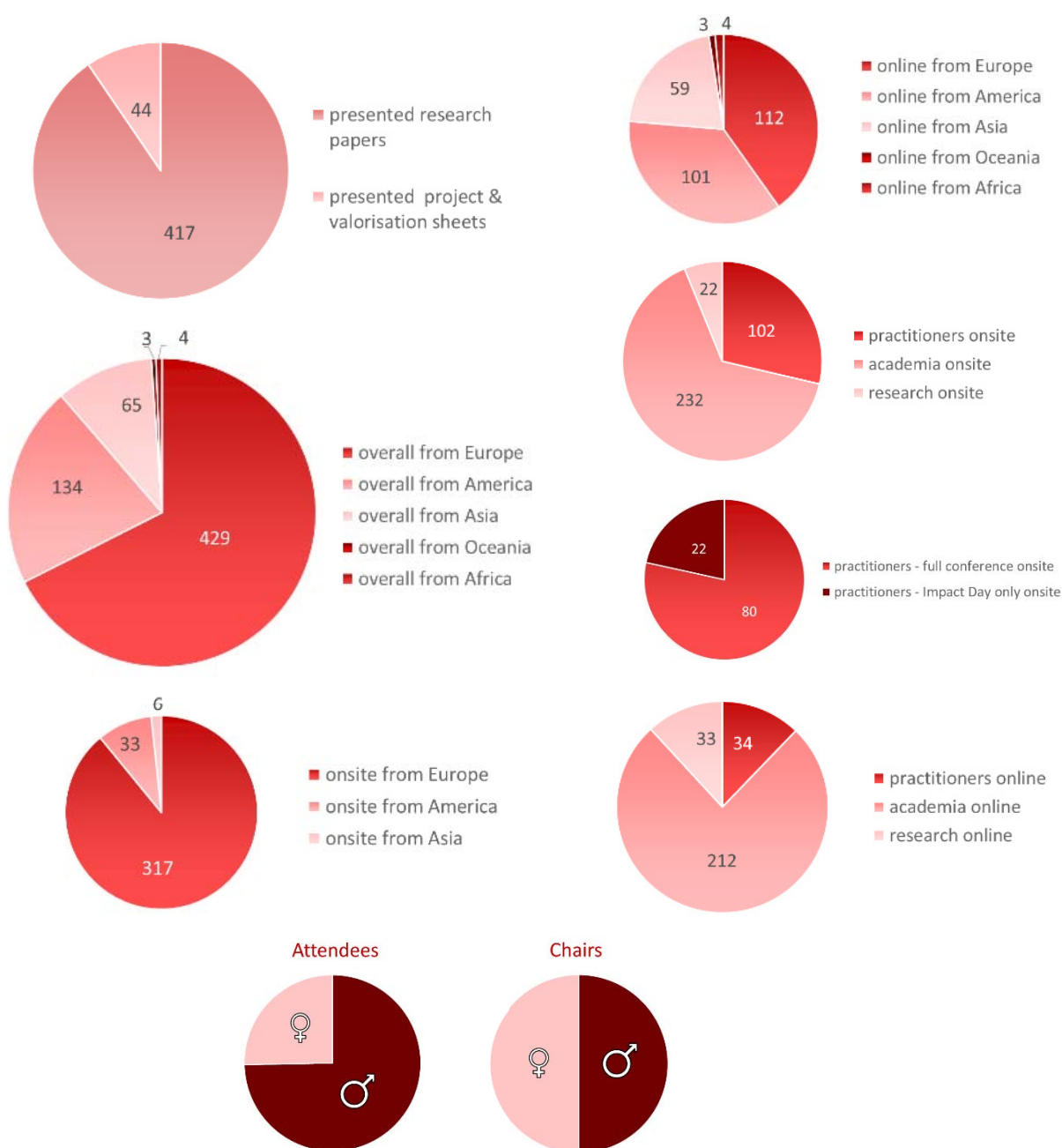
The BS2021 conference included between 4 and 6 parallel sessions onsite at 3 top locations in Bruges (Concert Hall, City Hall at the Belfry, and Crowne Plaza Hotel), and 3 parallel sessions on-line. These were preceeded by 4 successful workshops, 1 technical tour and a music competition.

Keynotes addresses were given by Jos Delbeke (former Director-General of the European Commission's DG Climate Action), Martin Dieryckx (General Manager Environmental Research Center Daikin Europe), Lars Junghans (Associate Professor of the University of Michigan's Taubman), Leonie Assheuer (EU Affairs Manager at Viessmann), Nguyen Hoang Manh (founder of MIA Design Studio, Vietnam) and Daan Ongkowidjojo (Teamleader Energy for Society at

All conference photos © Ineke Schepens

Sweco Belgium). Politicians — a minister and vice-president of the Flemish government, and the mayor of Bruges — spoke warm words of encouragement. Underpinning it all, the financial support of the sponsors and their on-site interaction with our community were crucial to the conference's success.

Dedicated involvement of our young and talented attendees has energized our next generation. The youngsters were coached and inspired by a dedicated presentation skills workshop (before the conference), speed dating (at the start of the conference), young potentials as artists, a meet your peers session (during the conference) and the highly attended student modelling competition (with a related keynote), where collaboration was granted an extra award (Karl Walther).

Numerous people received awards. The student modelling competition award was given to Karl Walther, Isil Kalpkirmaz Rizaoglu, Hale Tugçin Kirant-Mitic and Ghadeer Derbas, the music competition award to Joel Neymark, and the zero-carbon travel award to the RWTH Aachen Team (who travelled 240 km by bike). Cheng Cui and Nina Morozova received IBPSA student travel awards, and Eikichi Ono, Mateus Vinicius Bavaresco, Jiarong Xie, Marie-Hélène Talbot and Eduardo Gascon Alvarez received online registration awards. Best Paper award was given to Bognár Ádám, Roel Loonen and Jan Hensen, and Best Student Paper award to Pang Zhihong, Hu Pingfan, Lu Xing, Wang Qingsheng and Zheng O'Neill. Christiane Berger received the IBPSA Outstanding Young Contributor Award, Per Sahlin the IBPSA Innovative Application Award, and Ian Beausoleil-Morrison the IBPSA Distinguished Achievement Award. Finally, 17 people were recognised for their contributions to the field over many years by being made IBPSA Fellows; some of their achievements and work are summarised on the following pages. Congratulations to all!

The conference was over all too soon, but we believe it will lead to some permanent benefits by creating an environment that encourages the expression of new ideas and sowing the seeds for continuous creation of impact. BS2021 attracted the attention of policy makers, industry, designers and practitioners such as architects, consultants, contractors and stakeholder associations, as well as researchers, generating feedback from society while tackling challenges in energy transition. We are still working on BS2021-related initiatives to broaden awareness raising even more, and on the post event communication of this building simulation conference edition, one to remember and to take us all up to the next gear.

Photos will be soon available on the BS2021 website (www.bs2021.org)
Proceedings will be soon available on the IBPSA website (www.ibpsa.org)

We look forward to meeting and greeting again in 2023 in Shanghai, and hopefully some of you earlier while continuing your great work and outreaching!

We are happy and proud, but also unpretentious and considerate, while facing the road ahead.

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IBPSA Awards 2021

Outstanding Young Contributor Award: Christiane Berger

The Outstanding Young Contributor Award recognizes an individual at the beginning of their career who has demonstrated potential for significant contributions to the field of building performance simulation

> IBPSA
> Outstanding Young Contributor Award
> 2021
> Christiane Berger
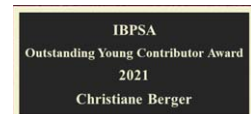
Innovative Application Award: Per Sahlin

The Innovative Application Award recognizes an individual, group or firm, who has made a significant contribution to the effective application and/or advancement of building performance simulation in practice

> IBPSA
> Innovative Application Award
> 2021
> Per Sahlin

Distinguished Achievement Award: Ian Beausoleil-Morrison

The Distinguished Achievement Award recognizes an individual who has a distinguished record of contributions to the field of building performance simulation, over a long period

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New IBPSA Fellows 2021

Fellowship status recognizes members who have attained distinction in the field of building performance simulation and have made significant contributions to this field.

Paul Bannister is Director of Innovation at DeltaQ Pty Ltd. Recognised as an international expert on energy efficiency, he is lead technical developer of the NABERS Energy and Water Ratings scheme for offices, shopping centres, data centres, hotels, hospitals and apartments. He was lead developer of the 2019 update of Section J (Energy Efficiency) of the Australian Building Code, and a member of the ACT Climate Change Council 2019. Paul is an active member of, and has received honours and awards from, many professional organisations. In IBPSA, he has been President of IBPSA-Australasia and an IBPSA Director-at-Large, and is a member of the board directing IBPSA Project 2, the Accredited Building Modeller Scheme.

Oliver Baumann is founder and president of Baumann Consulting offices in the US and Germany, and a pioneer in the field of building simulation with more than 25 years of experience. Through mentoring and support, he has led his team to tackle high-performance projects using diverse analysis techniques including whole-building energy modeling, daylight analysis, CFD, finite element heat transfer analysis, and urban-scale modeling. He has received several awards for outstanding practice, including from IBPSA-USA. Also an educator, Oliver has taught or is teaching courses related to BPS and is a member of IBPSA USA Education committee. He has also participated in research projects, among others through the IEA EBC annexes.

Clarice Bleil De Souza is a Reader in the Welsh School of Architecture at Cardiff University. She is one of the few researchers in the world studying building performance simulation from the user's perspective. She cares about bringing simulation into the real world to solve real problems, and her work on the dynamics at play within design teams is shedding light on barriers to the uptake of BPS in practice. She has received a Best Paper award in JBPS for co-authoring a paper on information presentation for building design decision making, and has been active in IBPSA-England and IBPSA conferences.

Youming Chen is a Professor in the College of Civil Engineering at Hunan University. His research areas include dynamic modeling of opaque and transparent surfaces and Fault detection and diagnosis for HVAC systems, and he he has published more than 200 peer-reviewed scientific articles, developed 16 software applications, and contributed to many IBPSA conferences. His research outcomes were included in the widely-used building simulation software DeST and the commercial software HongYe for air-conditioning design load calculation. He has received ASHRAE's Technology award for his work on Fault detection and diagnosis for VAV systems.

Matthew Eames is a Senior Lecturer in Mechanical Engineering at the University of Exeter, UK. He is widely recognized for his work on climate data, one of the essential inputs for building performance simulation. This has included developing a methodology to calculate the UHI and its additional contribution to climate model projections, and creating probabilistic design weather years from climate model projections. His contributions include the design summer year and test reference year data as well as future weather data used throughout the UK in building performance simulation, work which has won him prestigious awards from CIBSE.

Ala Hasan is Senior Scientist, Smart Energy and Built Environment, at the VTT Technical Research Centre of Finland. He has been involved with building performance simulation for over 30 years, intiated IBPSA Nordic, and has contributed to IBPSA conferences and JBPS. Ala has made a significant contribution to knowledge on building optimisation, including the development of the building performance optimisation tool MOBO. His recent activities include the integration of building flexibility into future energy systems, the design of Net-Zero/Plus Energy Buildings and Districts, and representing Finland on the Executive Committee of the IEA EBC programme. He also teaches postgraduate students and is advisor of PhD students at Aalto University, Finland.

Josef Hraska is a Professor at Slovak University of Technology in Bratislava, Slovakia, a pioneer of building performance simulation in Slovakia, one of the founders and the first chairman of IBPSA Slovakia. He organized the first Central European Regional IBPSA Conference in Bratislava in 2008. His main project at the moment, funded by the European Commission, is to introduce building performance simulation into the curricula of four Slovakian technical universities. Josef is also active in practice, and has played a significant role in the design of several major buildings in the center of Bratislava, where he used simulation to optimize the facades.
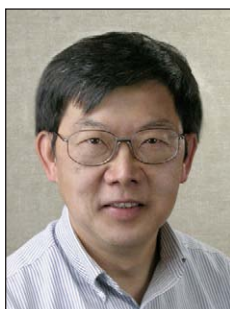
Yu Joe Huang is President, White Box Technologies, USA where he has assembled comprehensive sets of hourly weather files for numerous regions. A staff scientist at Lawrence Berkeley Laboratory until 2007, Yu has contributed to building simulation and allied arts for more than 30 years. He led or contributed to several research projects analysing energy conservation measures, created prototype building models, and contributed to the development of EnergyPlus, DOE-2, and other energy simulation codes. He is an active member of IBPSA, IBPSA-USA and ASHRAE Energy Calculation Technical Committee (TC 4.7) . Yu has received numerous awards, most notably the shared Nobel Prize for his participation in the IPCC 2nd working group.

Ljubomir Jankovic is Professor of Advanced Building Design and Founding Director of the Zero Carbon Lab at the University of Hertfordshire, UK, and a Founding Director of two companies pioneering sustainability innovation, InteSys and Emission Zero R&D. His book *Designing Zero Carbon Buildings Using Dynamic Simulation Methods* was well received. Lubo teaches at undergraduate, postgraduate and professional development levels, and his research has led to new insights into self-learning simulation models and model calibration based on performance monitoring. He holds a US patent for a 'simulation model on a chip', and has provided simulation support to various industical partners involved in new build and retrofit projects. He is a regular at IBPSA conferences.

Qinglin Meng is a Professor at the South China University of Technology in Guangzhou. He has worked for almost 30 years on the modeling of building fabric performance, energy consumption and the urban thermal environment amd published almost 150 papers. He established a simulation method for thermal environment control in high-rise buildings and has studied the optimization of building thermal performance based on the integration of heat and mass transfer control, evaporative cooling, and shading of the building envelope, and developed simulation software. Qinglin's other achievements include contributions to no less than 36 standards and to the design of several major public buildings of China, including the Beijing Olympic Stadium.

Zheng O'Neill is an Associate Professor at Texas A&M University. She pioneered research on uncertainty quantification applied to automated calibration of building energy models and has helped to bridge the gap between simulations of building system controls and the real world. She has over 110 peer reviewed publications, a book chapter and a patent to her name. Zheng has also been active in mentoring graduate students and new researchers, and in disseminating new knowledge through professional society technical committees. She is a member of ASHRAE, IBPSA and the Society of Women Engineers, serves as Associate Editor of the *Science and Technology for the Building Environment* journal, and is on the Editorial Board of the Journal of Building Performance Simulation.

Rajan Rawal is Professor of Building Energy Performance at CEPT university in Ahmedabad, India. An active researcher, he has published papers on natural and mixed-mode ventilation and thermal comfort. Recently he took on the challenge of designing and construction a Net-Zero Energy Building for CEPT. This opened in 2015 and provides a real-world net-zero energy research facility for the work of his Centre and graduate students. Rajan has also pioneered training on building performance simulation for Indian architects and engineers, collaborating with the US Department of Energy and the India Green Building Council. A founding member of IBPSA-India, he has served as chair of IBPSA's Education Committee, helping initiate the webinar programme, which is of particularly high value in regions where IBPSA has less of a presence.

PC Thomas is a founding Director at Team Catalyst in Sydney, Australia and Adjunct Associate Professor in the School of Architecture, Design and Planning, University of Sydney. Team Catalyst apply simulation to both new and existing buildings. They have achieved 5.5 stars certification in the NABERS scheme, which requires proof of building performance from metered data, and some of their retrofit projects were selected as case studies by the NABERS program administrators. PC's personal expertise has been recognised by appointment to an exclusive panel of independent design reviewers. At the University of Sydney he teaches postgraduate students on naturally ventilated buildings and energy simulation, with a focus on code compliance, and he has delivered workshops in this area around the world. He was co-chair for BS2011 in Sydney, and has been active on the IBPSA Education Committee and an IBPSA-Australasia board member for many years.

Christoph van Treeck is a Professor at the Institute of Energy Efficiency and Sustainable Building E3D, RWTH, Aachen University. His early research was in CFD; he is probably best known now for his contributions in BIM and thermal comfort. He leads all BIM R&D in IEA EBC Annex 60 and is co-leader of IBPSA project 1. He has also pioneered the use of BIM with object-oriented equation-based modeling of HVAC systems, and his team has developed a Modelica to BIM translator. Christoph has published several papers on the use of computational techniques for building and systems design support. He was a founder of the German-Austrian chapter of IBPSA, and has been its chairman since 2004.

Peng Xu is a Professor of Mechanical Engineering at Tongji University, Shanghai, China. He has worked on buildings and HVAC systems for more than 20 years, and published over 100 scientific papers about building control optimization, building energy efficiency, building energy analysis and related topics. Peng has developed several building energy prediction methods, fault detection and diagnostics tools and energy efficiency diagnosis algorithms based on building simulation, and applied them to real-world projects in the US and China, winning several awards. He was the chairman of ASHRAE's Technical Committee (TC) 7.5, Smart Building Systems, and co-chaired the first Asia conference of the International Building Performance Simulation Association in Shanghai, sponsored by IBPSA. He has organised a regional conference in Shanghai on the latest building performance simulation research and technology once or twice every year since 2011.

Raymond Yau is General Manager at Swire Properties' Institution of Technical Services & Sustainable Development in Hong Kong. Raymond has been practicing internationally as a professional consulting engineer for over 34 years in the field of designing sustainable buildings and sustainability. He was an early champion of using computational fluid dynamics and dynamic thermal modelling in sustainable built environment applications in the UK, and then in Hong Kong, and has used them in his consulting work on many notable projects including Hong Kong's first zero carbon building and Samsung's Zero Energy House in South Korea. He has been the recipient of several awards, including first-place winner of ASHRAE Technology Awards 2021 in the Existing Building Commissioning category.

Last in this report on IBPSA's new Fellows but certainly not least **Wangda Zuo** is an Associate Professor at the University of Colorado Boulder and Faculty Director for Smart, Sustainable and Resilient Cities. Wangda is a leading researcher in building system modeling and indoor environmental modeling; over his 20+ year career, he has been the major contributor to many open source building and community simulation programs, including the Fast Fluid Dynamics model for indoor airflow simulation, several Modelica libraries, and the Functional Mockup Interface for EnergyPlus. The Fast Fluid Dynamic models are groundbreaking in that, thanks to their speed, they can be used for conceptual design, one of the most critical phases in the building life-cycle. Using innovations from mathematics and computer science, Wangda developed models which can run in parallel on a computer graphics card and accelerate simulation of the indoor environment by 1,500 times. His FFD model is now a benchmark for fast indoor environment simulation. He has been an active contributor to the building simulation community for many years. He was the Founding Chair of the IBPSA-USA Research Committee, and has been Chair of ASHRAE TC 7.4 Analysis for Sustainable Buildings, Voting Member of TC 4.7 Energy Calculation and a member of IEA Annex 60. He is currently Treasurer and USA Affiliate Director at IBPSA, Chair of ASHRAE TC 4.10 Indoor Environment Modeling, and CU Boulder leader for IBPSA Project 1.

Student Modelling Challenge & Competition

An important part of IBPSA's biennial international conferences, the Student Modelling Competition & Challenge aims to encourage participation in the conference by providing a competitive forum for teams of MSc and PhD students to explore the use of building performance simulation. Several tutors of relevant courses in universities around the world used the BS2021 competition brief as part of their teaching material. The subject this year was Baumslager & Eberle's low-tech project 2226 (**www.baumschlager-eberle.com/werk/projekte/ projekt/2226**), actually located in Lustenau, Austria, but virtually moved to a different location in Belgium for this challenge. Competitors were encouraged to use modelling and simulation to answer the question ''How would you adapt the concept of the low-tech building 2226 if you were to build it in Kortrijk, Belgium? Can you improve the indoor air quality, thermal, visual and acoustical comfort with minimal impact on energy use?'' Several smaller separate sub-questions on specific aspects of the design (such as the building envelope, thermal comfort, acoustics, daylighting, IAQ) and on

different levels (BSc, MSC, PhD) all helped in answering the main question.

This year's competition was expanded from a simple modelling competition into a challenge by making collaboration one of the judging criteria and offering a Collegiality Award as well as the usual awards for high-quality modelling. Participants were encouraged to use the IBPSA network to share information, ask questions and provide solutions, as well as collaborating between themselves and learning from each other. Over 100 active participants made use of a collaboration platform.

The very first IBPSA Collegiality Award was given to …

Karl Walther (Bergische Universität Wuppertal, Germany)

A total of eight team reports were judged. The organisers would like to thank all teams for their submissions in the student modelling competition, especially in this difficult COVID-year. Their active participation and collaboration on the collaboration platform, where many participants helped each other, was much appreciated. Every team who participated in the student modelling competition was given a certificate of active participation. The high quality of the reports — the structure, referencing, graphically strong presentations and high quality English — were also greatly appreciated by the modelling competition panel, who congratulated participants on performing so many different calculations and attempting to synthesise them. However, simulating isn't just calculating: students were guided with questions designed to make them think about the combination of measures on the overall performance of the 2226 building, and to find out how to optimize the concept. Several teams identified the main issues and were able to propose optimizations. Two stood out:

CEPT University, India (team representative Shivangi Singh)
Bergische Universität Wuppertal (team representative Karl Walther)

As the last stage in the competition these two teams were invited to present their work in Bruges and answer questions.

One of the keynote presentations at the conference was linked to the competition: a more detailed explanation of the 2226 building by Lars Junghans, who was engineering designer for the project and carried out the associated simulations. The winner was announced after his talk. The team of CEPT University was judged to have given a very strong presentation, and to have displayed excellent team work in answering questions. However, the team of Bergische Universität Wuppertal impressed the judges with a very strong report which demonstrated a profound understanding of the concept of the building, and was declared the winner of the 2021 Student Modelling Competition and Challenge. The members of the **Bergische Universität Wuppertal** team were:

Karl Walther
Isil Kalpkirmaz Rizaoglu
Hale Tugçin Kirant-Mitic
Ghadeer Derbas

The members of the second-placed **CEPT University** team were:

Divya Mullick
Priyanka K Raman
Sakshi Nathani
Shivangi Singh
Shreya Nigam
Sujitha Subbiah

Their work was only possible by teamwork. And above all, isn't it a good lesson, that the team that was the most collaborative on the platform, achieved the best results?

"Coming together is a beginning
Keeping together is a progress
Working together is success."

Building 2226 on the Test Bench

Simulation study on the relocated 2226 building by Baumschlager Eberle - Student modelling competition

Karl Walther, Isil Kalpkirmaz Rizaoglu, Hale Tuğçin Kırant-Mitić, **Bergische Universität Wuppertal**, Ghadeer Derbas, **Bergische Universität Wuppertal and Forschungszentrum Jülich.**

BUILDING 2226

Source: https://www.baumschlager-eberle.com/en/projekte/projekt/2226/

Modelling in ClimateStudio (daylight & artificial light)

- Low-tech building design for temperatures between 22-26 °C.
- 80cm brick wall, U_{wall} = 0,12 W/m²K.
- No active heating / cooling system.
- No automated shading.
- Automated natural ventilation.

Challenge: "How would you adapt the concept of the low-tech building 2226 if you were to build it in Kortrijk (Belgium)? Can you improve the indoor air quality, thermal, visual and acoustical comfort with minimal impact on energy use?"

Ventilation Strategy

Fixed glazing with openable panels. Automated opening of 2 panels per orientation. 3 opening angles depending on wind speed (indoor air velocities!). Panel opening if (1) CO_2 concentration is above 1000 ppm and (2) indoor temperature is high enough (hysteresis controller). Summer: ventilation prevents overheating.
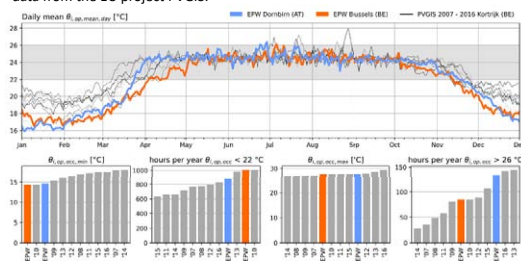

Modelling in IDA ICE (thermal & energy)
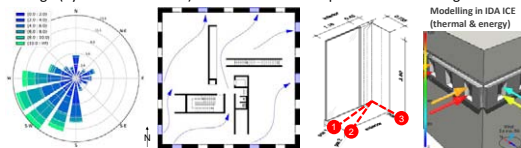
Thermal Comfort & Indoor Air Quality

Summer thermal comfort is maintained but control dilemma in winter: Either the CO_2 concentration is too high or temperatures drop below 22°C with ventilation.
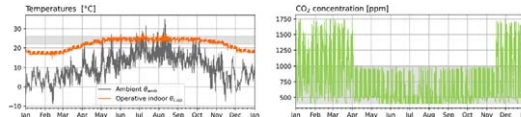

Climate Robustness

Simulation of multiple weather data sets for evaluation of resilience against climatic variations : original location Lustenau (AT), new location Kortrijk (BE) and 10 weather files for historical data between 2007 and 2016 generated based on data from the EU project PVGIS.

Visual Comfort

The depth of exterior walls and the position of the windows create a structural shading effect (see images left column), increasing visual comfort. The existing properties and the dimensions of the windows are already at their limits for visual comfort. Daylight availability is fulfilled, but glare and uneven illuminance are critical.
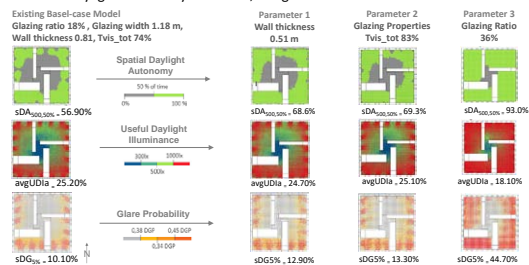
Internal Loads and Occupant Behavior

Lack of internal loads is the main reason for violation of the 22°C criteria in winter. Winter thermal comfort can be maintained with lights always on. Occupant-related assumptions (e.g. stochastic) should be considered from the early design stage.
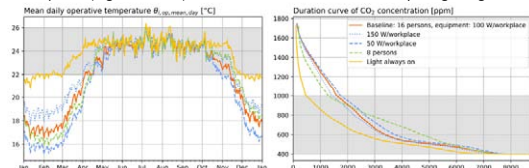
Flexibility & Building Grid Interaction

Introduction of concrete core heating/cooling (CCHC) and heat pump (HP). Flexible operation is applied by including price penalty signal. In the future price decreases as CO_2-free electricity generation increases. At low price signal: water supply temperature ±1-2 K regarding season. This increases the energy consumption (incl. renewable) while improving thermal comfort.
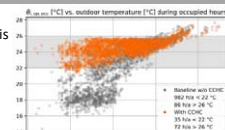
Air Handling Unit & Energy Performance

Optional AHU in IDA ICE for cat. 1/2 (EN 16798). Implementation affects design idea.

CONCLUSION

- Main problem in winter: lacking internal gains → tradeoff between temperature and air quality in ventilation strategy. Both criteria fulfilled with lights always on.
- Design on average climate not sufficient without backup heating.
- Flexibility as new requirement: Introduction of CCHC + HP to maintain design idea.
- Daylight availability is fulfilled, but glare and uneven illuminance are critical.
- Application of different glazing types (T_{vis}) per orientation. Use of blinds.

Bergische Universität Wuppertal
Faculty of Architecture and Civil Engineering
Chair of Building Physics and Technical Services
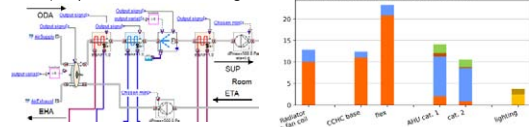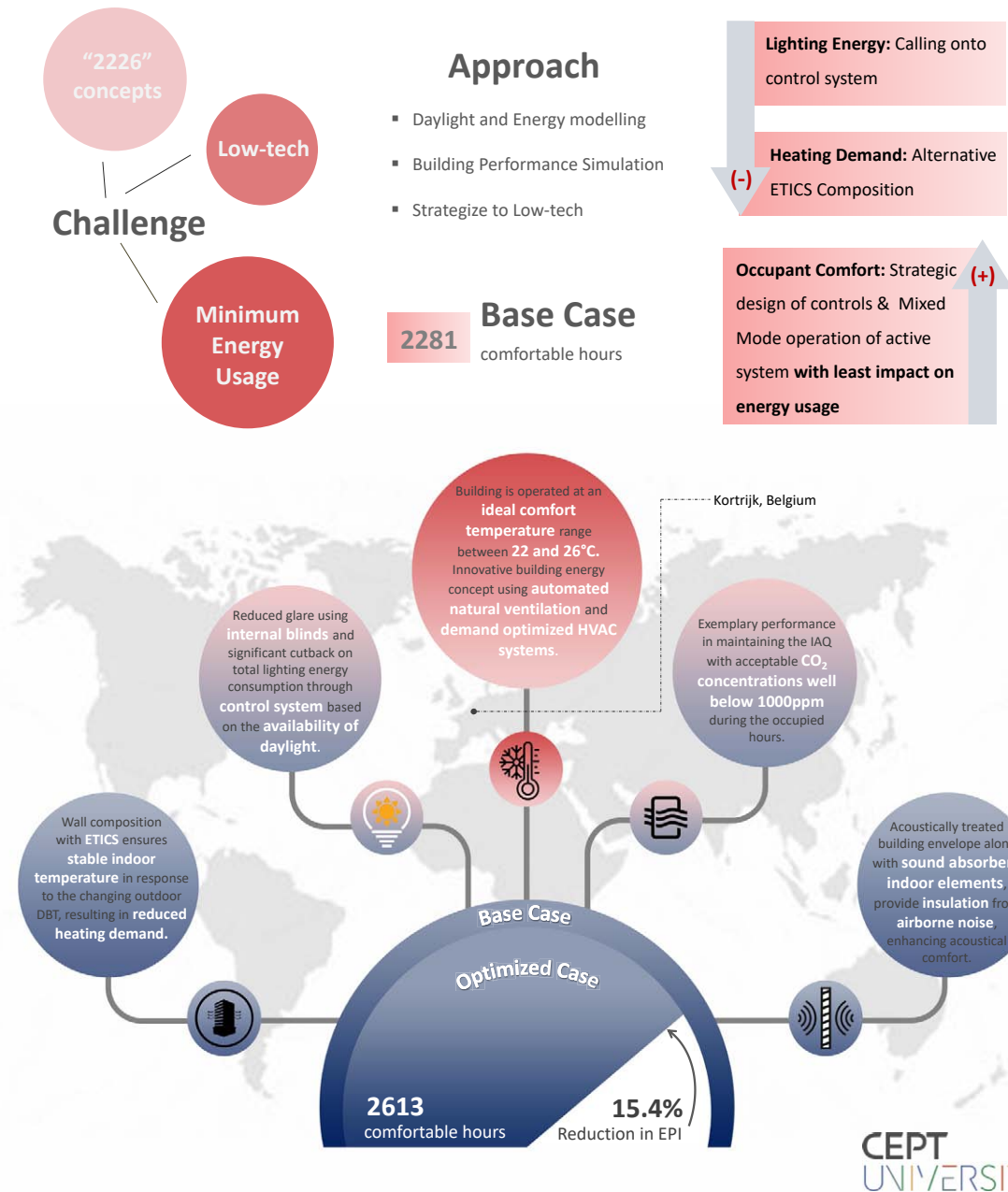Prof. Dr.-Ing. Karsten Voss

Student Modelling Challenge & Competition

Divya Mullick | Priyanka K Raman | Sakshi Nathani | Shivangi Singh | Shreya Nigam | Sujitha Subbiah

"Can we improve **Visual, Thermal & Acoustical Comfort** with minimal impact on energy use?"

"2226" concepts

Low-tech

Challenge

Minimum Energy Usage

Approach

- Daylight and Energy modelling
- Building Performance Simulation
- Strategize to Low-tech

2281

Base Case

comfortable hours

Lighting Energy: Calling onto control system

Heating Demand: Alternative ETICS Composition

(−)

Occupant Comfort: Strategic design of controls & Mixed Mode operation of active system **with least impact on energy usage**

(+)

Kortrijk, Belgium

Building is operated at an **ideal comfort temperature** range between **22 and 26°C.** Innovative building energy concept using **automated natural ventilation** and **demand optimized HVAC systems.**

Reduced glare using **internal blinds** and significant cutback on total lighting energy consumption through **control system** based on the **availability of daylight.**

Exemplary performance in maintaining the IAQ with acceptable **CO_2 concentrations well below 1000ppm** during the occupied hours.

Wall composition with ETICS ensures **stable indoor temperature** in response to the changing outdoor DBT, resulting in **reduced heating demand.**

Acoustically treated building envelope along with **sound absorbent indoor elements** provide **insulation from airborne noise** enhancing acoustical comfort.

Base Case

Optimized Case

2613
comfortable hours

15.4%
Reduction in EPI

CEPT UNIVERSITY

Tribute to Godfried Augenbroe

1948 - 2021

Godfried (Fried) Augenbroe, Professor Emeritus of Building Technology at Georgia Tech, passed away on May 14th 2021 at his home in Tucson, Arizona. He leaves behind his wife, Maria, his three daughters Ellen, Claudia and Anneke, and his granddaughter Mia.

He was born on 15 November 1948 in the Netherlands. Fried earned his Bachelor's and Master's degrees from TU Delft and served as an assistant/associate professor in civil engineering at TU Delft from 1976-1996. In 1997, he moved to Georgia Tech in Atlanta, USA and founded the Building Technology lab, later renamed as the High Performance Building lab. Fried retired in 2019 after 22 years of teaching and research at Georgia Tech, only to be diagnosed with gastric cancer towards the end of the same year. In December 2020, he moved from Marietta, Georgia to Tucson, Arizona for his retirement. Unfortunately, the cancer recurred aggressively soon thereafter and his health declined quickly. Fried passed away at home surrounded by his loving wife and three daughters in the early morning of May 14 2021.

Fried is known as a distinguished scholar in building simulation, building physics, performance theory and process-centric interoperability. In the late 1980's, he developed a commercial building energy simulation tool called BFEP using the finite element method. Since the early 1990's, Fried has coordinated four major EU-funded academic-industry consortia, in the fields of design tool interoperability (most notably COMBINE, 1990-1995), energy performance simulation, outsourcing and project planning (e-HUBs 2002-2004). It is noteworthy that he started to address the concept of interoperability (now called BIM) almost thirty years ago. In the 1990's, Fried realized the importance of normative energy calculation, especially for building energy performance assessment. He identified the need for an objective and transparent performance assessment toolkit. With this in mind, he initiated the Dutch energy performance standard called NEN 2916 which was later adopted as the baseline for the ISO-CEN 13790 method. The philosophy of NEN 2916 was also successfully utilized for the US federal General Services Administration (GSA) as part of the GSA building performance toolkit during 2002-2007. The toolkit was successfully applied to many GSA buildings, Georgia Tech and UPenn campus buildings. It was further modified to become part of the government of Qatar's sustainability assessment toolkit during 2008-2012.

Fried's contribution to IBPSA cannot be summarized quickly. During his 43 years' professorship at TU Delft and Georgia Tech, he taught courses at graduate and undergraduate levels in architecture and civil engineering colleges including theoretical and applied building physics (1978-1996), modelling and simulation (1990-1996), building simulation (1992-2019), and performance-based design methods (1997-2019). Fried supervised 40+ Ph.D. students and 80 MS students to his name. His publications in our domain are immense and influential. He contributed to the first IBPSA-endorsed book ''building performance simulation for design and operation'' and co-edited the book ''advanced building simulation''. He also initiated the second IBPSA-endorsed book ''building performance analysis'' which was completed by Pieter de Wilde. Fried delivered keynote speeches at BS 2001 (building simulation trends going into the new millennium) and BS 2015 (Ten hard questions about model fidelity) respectively. His keynote speech in BS 2001 was later published in the journal of energy and buildings entitled 'trends in building simulation'. The paper is regarded as a key paper in our field. Fried was a founding member of IBPSA and served as an IBPSA-World board member until 2005. Fried also served as the chairman of the scientific committee for BS 2003 and an editorial board member for the journal of building performance simulation from 2008 to 2017. His academic contribution to IBPSA was recognized by IBPSA-USA's lifetime achievement award in 2008, IBPSA fellow in 2013, and IBPSA-World's distinguished achievement award in 2015. Last but not least, Fried's unique contribution to IBPSA is that he significantly expanded our knowledge base by his papers, keynote speeches and book chapters, such as tool interoperability (1990-2005), uncertainty (2002), calibration (2000-2019), process-oriented design support (1995-2005), optimal design and control studies (2000-2015), and risk-conscious decision making (2012-2019).

Fried exhibited excellent leadership in international collaborative research projects. He received major research grants exceeding $20M from the European Commission, NSF, DOE, GSA, Robert Wood Johnson Foundation, SAP, TC Chan center, American Council of Engineering Companies, Reed/Elsevier, Military Health Services, and others. One of the most prestigious grants is NSF EFRI-SEED for risk-conscious design and retrofit of buildings for low energy (2M USD, 2010-2015) where he devoted himself to completing his idea on quantifying uncertainty of building energy in real-life cases.

Fried held visiting professorships or foreign appointments at Hong Kong Polytechnic, TU Delft, University of Newcastle, Loughborough University, CSTB, LBNL, TC Chan center and others. He shaped teaching and research programs at many different universities in the USA, Europe, Middle Asia, and East Asia.

Most importantly, Fried's entire life as a scholar can be best represented in the way that he influenced the life of his students and young researchers. Fried was of excellent character. He was dependable, consistent, friendly, open-minded and he had an ungraspable sense of humour. His unique sense of humour was more than enough to inspire others. Fried dedicated himself to providing sustained support for his students and the younger generation. He always stooped down to listen to the voices of students and young researchers. His intellectual creativity and iconoclastic attitude inspired his students to become independent and critical thinkers. Fried once mentioned that the award he is most proud of is ''outstanding doctoral thesis advisor award'' bestowed by the Georgia Tech in 2017. This shows how Fried defined and valued himself. He wanted to be remembered and remained in the hearts and spirits of his loving students. We selected a few messages that his past students sent to Fried for celebrating his retirement in 2019.

> **Sang Hoon Lee**: *"Prof. Godfried Augenbroe, you are a true professor who can answer questions with deep insights and encourage students with genuine advice. You are the best researcher who can see the fundamental need in research trends and tackle the depth and width to solve the research problem. You are a philosopher who can establish core ideas of important life matters. I am deeply honoured to have you as my advisor and mentor. You are also a gentleman with a warm heart and humour. Whenever I*

think of you, you make me have a gentle smile of appreciation and respect. I already miss you so much."

Fei Zhao: *"Dear Fried—Every time when I make important decisions, I want to ask for your advice and think about what you would say to me. You always encouraged me to push the boundary of my comfort zone. Going to Georgia Tech and becoming your student is a big pride for me. No doubt, you are the best advisor in the world, and always my role model. Congratulations to your retirement and thank you as always!"*

Ji-Hyun Kim: *"During my Ph.D., Professor Godfried Augenbroe raised me as a fighter who keeps looking for answers without giving up, despite the hardship both in research and life. He was someone who could look right through me, figure out what I needed, and give it to me as a professor, a life mentor, and a friend. Fried, I thought there would be plenty of time left for me to discuss my work and life with you and ask for your advice. I miss you so much. I will remember your kind encouragement in everyday life until I meet you again. Thank you so much, Fried!"*

Yuna Zhang: *"Dear Fried, Thank you for your wisdom and guidance and inspiration in my life! Thank you for all the sacrifices that you make for your students! Thank you for showing us how to be a great person and a great teacher! Thank you for bringing so many excellent young researchers to the world! I am so grateful to be your student. Wishing you joy and happiness in life."*

Qi Li: *"Dear Fried, Congratulations on your retirement! Thank you so much for encouraging me to 'explore new options' as a fresh graduate student, and for your continuous support on my way to becoming the person I want to be. Your profound knowledge and valuable insights have nurtured so many people, and I'm sincerely honored to be one of them. Best wishes in your whole new life chapter!"*

Tianyao (Tina): *"Congratulations on your retirement! I am incredibly grateful to have such a knowledgeable and passionate mentor like you, you have sparked so much inspiration and it has been an exhilarating journey under your guidance. Please accept our most sincere and warmest wishes as you embark on an adventurous new chapter of life!"*

Clarissa Sucupira Andrade Lima: *"Dear Prof. Fried, you changed my life in a way that I cannot find the words to describe. I am, and always will be, grateful for what you've done for me. I wish you all the best in this new phase of your life."*

Zhaoyun Zeng: *"Thank you for showing us what it means to be a deep thinker and a pioneer of technology!"*

As these tributes show, Fried's teaching and mentorship, his academic contribution, and his life lessons will be forever lived in all of us. We all are honoured to have known him, studied with him, worked with him, learned from him, and to have been part of his beautiful life. We will never forget Fried.

Cheol-Soo Park, Seoul National University
Pieter de Wilde, University of Plymouth
Ruchi Choudhary, University of Cambridge

Fried received IBPSA's Distinguished Achievement Award at BS 2015. Surrounded by his students and friends. BS 2015. Hyderabad, India.

Group photo of the HPB lab supervised by Fried. 2019.

Pieter and Cheol-Soo paid annual visits to Fried's home between 2012-2019. Mrs. Augenbroe kindly cooked Sancocho, a traditional Dominican Republic food. May 1 2019

Birthday wishes presented to Fried by his students. Nov 15 2019

Fried's retirement party hosted by his past students. August 10 2019

BauSIM 2020 Roundtable Discussion

There is greater public and political awareness of accelerating global change now than ever — not least because of the imminence of COP26, which starts at the end of this month — and still much to do in order to tackle the challenges this poses for building simulation: more so when we consider the time-horizon in the context of a predominantly static building stock.

With this in mind, BauSIM 2020 included a roundtable discussion with leading experts in the field of building performance simulation on the topic of "challenges and future endeavors". Participants for this discussion were Professor Joe Clarke (Professor Emeritus, University of Strathclyde, FIBPSA), Professor John Grunewald (Professor and Chair of Building Physics, TU Dresden), Dr Per Sahlin (CEO EQUA Simulation AB, FIBPSA), Dr Michael Wetter (Deputy Leader Simulation Research Group, Lawrence Berkeley National Laboratory (LBNL), FIBPSA), and Andrew Corney (Product Manager at Trimble - SketchUp and Sefaira, UK; FIBPSA).

This article is a second extract from the discussion. The first was published in the previous newsletter, April 2021.

Each of the participants was asked to provide a short statement in advance of the discussion, and Christina Hopfe (TU Graz, FIBPSA), the moderator, used these as the basis for the questions which she put to the panel.

The second part of the discussion started by considering Per Sahlin's statement:

> **"** *We need to collectively promote the advantages of a model-based design process, where design decisions are made by experiments on the current state of an evolving holistic dynamical model. Mandatory requirements of monthly calculation methods must be phased out, as must silo model building to fulfil the requirements of a specific standard* **"** (Per Sahlin)

Christina Hopfe (Christina): Per, what evidence is there actually that more sophisticated, dynamic tools or techniques actually result in better buildings? Surely the folks of the Passive House Institute in Germany would argue that their simple spreadsheet model results in better buildings than many designed using very sophisticated tools. So, who actually benefits from the added complexity?

Per Sahlin (Per): I think the Passive House approach is interesting because it puts things on the spot. I think it's exactly those sorts of buildings, with large glazed areas and very well insulated - very far from the sort of 60s and 70s types of constructions - that prove that you really need dynamical methods, because overheating is very difficult to look at in a monthly context. And I just don't understand how you can avoid overheating problems in such buildings. There are plenty of examples that I've seen where people buy an apartment for a huge amount of money and then in the summer it's 60 degrees centigrade in there; it would have been super simple to spot this problem had it been simulated before.

These things still happen quite often. I don't think we need to convince ourselves in this group whether or not that simulation is meaningful, or to debate the merits of monthly methods. But in the marketplace it's a reality, especially in the DACH countries (Germany, Austria, Switzerland) - especially in Germany I would say; since there's a mandatory requirement to perform a monthly energy study for every building that you put up, it's

going to take quite some ambition to go beyond that in a project. Most people will just be happy with that energy model and rely on it, and won't do anything more. They have a similar system in Denmark and in Austria. In the U.K, I don't know what fraction of buildings are computed with this monthly SBEM tool, but I think quite a few. In Europe we're stuck in the tradition of relying on these tools from the age before computers, and they just need to go as I see it; we need to work towards removing them and using at least dynamical models instead.

And in the countries where there is quite a lot of simulation, much of it is done just to pass a specific standard. Many, many simulation models are made by different groups for the same object, with the purpose of just passing the building code or getting some LEED certificate or something similar. And these groups are quite often developing their own model and their own favourite tool; there's no model following the design throughout the design process. That's another thing I think we can change.

There is evidence that simulation can be really good, and that it is possible to encourage the development and use of excellent models. Sweden is a very good example. Unfortunately, I have nothing to do with this development in Sweden! I think it may have been mostly by mistake that it was put in place. But we've had a building code since 2007 which is outcome based. In Sweden, a building only becomes legal after two years. You have to measure your energy consumption for two years, and after that period, if it's low enough, the building becomes legal. That's a quite mind-boggling system. And in principle, you're allowed to do any sort of energy modelling you want. There are no particular requirements on the tool to be used or certification of the users or tools or anything like that. But this has fostered fantastic simulation skills in practice in Sweden because people are so scared of missing that target. So, they're actually genuinely concerned with designing buildings that meet the code. I wouldn't say the gap's gone in Sweden, but it's certainly greatly reduced.

And skilled modellers get to within five or ten percent of how the actual building is going to perform, so the gap is not an issue. This is a good example of how it could be happening and it's happening here. I don't think this reaches beyond Sweden, but it's certainly a good example.

Christina: So, you actually have evidence that more complex simulation tools result in happier occupants?

Per: Yes; the whole purpose of building design, aside from aesthetics, is to provide comfort at the lowest possible energy cost, and this is certainly achieved.

**Christina**: John, would you like to add something to that?

John Grunewald (John): Yes, the situation in Germany is a pity; we were maybe a little bit too quick with our German standards. DIN 18599, which focuses on this monthly calculation method, is still widely used in Germany. And most of the commercial software producers design their products just after regulations are issued, because it's mandatory in practice. This is actually a big obstacle for building simulation in Germany. I think the situation in other countries is better and it would be good if we could move in this direction in Germany as well. From my point of view, building simulation has great advantages over monthly calculations. There are many effects that cannot be captured by simple monthly calculations. It's not just overheating of buildings. It's all use of renewable energy; everything depends on time and the time management of all these energy flows. You cannot capture these effects, you cannot optimise your building or its operation, and you cannot even optimise strategies in the planning phase before the building is built, without looking at all the causes of energy flows and all the other physical quantities which play a role. And therefore, it's a pity that the German situation is lagging so far behind. But I believe the general perception in Germany now is that this situation is no longer satisfactory, and we have to do something. So, I have a feeling that something will change, and possibly – I hope - soon.

Per: We're looking forward to that!

Christina: Joe, Scotland is doing much better, isn't it?

Joe Clarke (Joe): Always, always! I'm very pleased to say this! I agree totally, unreservedly, with Per's statement. I think we must do away with these simplified methods. Simulation-integrated design process offers such fantastic opportunity for the future that we have to help our professions understand how they could move to that in a cost-effective manner, in a way that they can commercialise. When you mention things like Passive House and isn't Passive House better, passive houses are great standards – that's not a problem. We spend a lot of our time simulating passive house designs to help people achieve them. But then I point out to you the complexities in a passive house design, and also the fact that when you go to a group of passive houses and they are all communicating and they're all integrated renewables and they're trying to put that to local substations and you move the burden onto the network, etc., that needs to be simulated so that you end up with an overall good solution. That's very important. So I agree totally with Per's statement at the beginning.
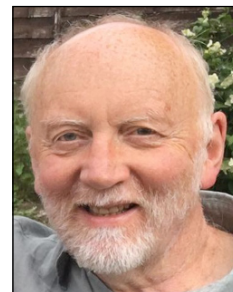
Christina: In Germany and Austria, for example, simulation, in particular dynamic simulation, is not very popular, so what can we do to integrate these models earlier in the design process?

Joe: I guess we're already doing it. We have an organisation called IBPSA. We have our biennial conferences. We have a conference like this. And as long as the message continues to get out, it will encourage simulation. However, I will say again something I said earlier: we need to move the emphasis away from just the computational aspects of simulation towards the application aspect. As Per said, at the moment you can simulate almost anything if you've got the right team doing the simulations. Simulation is pretty powerful at the moment - more powerful than I think people realise - and we can simulate these things. But the future can't be just a bunch of simulation gurus doing the modelling and simulation. I want to say something later about how I think we might manage to do that, to move the focus away so that people can, on a routine basis, without any specialist knowledge, get access to simulation. I think it's within our grasp.

Christina: John, you had a question.

John: Well, I think there is a big obstacle in using these simulation programs due to the complexity of the user interfaces and the lack of knowledge of the people who are using these tools. We are running a research project in Germany at the moment about this. It's called SIM quality. We recruited people from various companies and research institutions who are supposed to be experts in the field of simulation. And they used various tools including IDA ICE, EnergyPlus, TRNSYS, our own tools, and Modelica. We gave them common exercises and compared the results in a very basic way. We started by simplifying the exercises so that we could really figure out the reason for differences, and then we added more and more complexity. We refer to simple cases and complex cases, but the main source of error was human - the person who did the simulation, not the simulation tool itself – because of misunderstanding all these complex parameters.

This leads me to the conclusion that we need much more education, and also, we need much better user interfaces - maybe a kind of standardised user interface. In my car I know where the brake is and I know where everything is because every car works in the same way. So it's very easy to drive a car. I think building simulation should be made much easier and should address different user groups, different audiences. And maybe we need to standardize our models in some respects in order to sell them to the target groups.

Per: Well, of course, we can develop simplified user interfaces to enable less expert users to use the tools. And this works in many instances. But when it comes to making a fully-fledged whole building model with systems and controls and shadings and glazings and all of these things, this is going to remain an expert activity. We will not be able to hide that complexity behind smart user interfaces and get rid of it. The underlying technical

object in itself is this complex, and the simulation model cannot be significantly simpler because then we will lose the flexibility we need in order to accommodate all of the different functions that you find in a building. So, I believe that going down the path of stripping down user interfaces in order to make them simpler is useful for some applications, for some stages, but it's absolutely not useful for simulating fully complex whole buildings.

Secondly, you need skilled simulation experts that are very experienced not just in building simulation models, but also in looking at the measurements from the buildings that have resulted from their designs. I believe building simulationists should spend a very significant part of their time looking at measurement signals from the buildings that they have designed. And I think this is quite rare today. Most designers just create their design and leave somebody else to worry about the results. One way of closing the loop is just to get building simulationists involved in the practicalities of looking at how the building actually operates later on. I think this is a truly complex thing and there's no way for us to simplify that by technology. We just have to accept the complexity and we have to build the expertise and the different niches of expertise that are necessary for doing this.

If you look at more industrialised businesses like the car industry (and we work quite a lot in panels also where there's more money for each project), the models that you use for building a car are not simple at all. They're maintained by hosts of experts. And it's going to have to be the same for buildings, but on a different timescale because our project budgets are by necessity much lower.

The other thing I wanted to say is with respect to standardization. Sven (Moosberger) spoke this morning about a new European standard that basically prescribes a detailed dynamical model for buildings. I think this is entirely the wrong way to go because standardising the models themselves is a hopeless venture. I feel strongly about that, because that's going to stifle development really badly. These models are aiming for some level of accuracy that's gone from monthly methods to very simplified hourly methods and now somewhat more detailed hourly methods, but still simple in many ways. I think this is a dangerous road to go down because it's very difficult to try to improve the standard of models if there is a standard model that is accepted by all the authorities and so on.

Christina: Michael, what's your take on this?

Michael Wetter (Michael): I think we need to clearly separate between simplified models and simplified user interfaces.

John: Yes

Michael: Typically, users need to have a simplified user interface which is often adequate enough for most of the building. Underneath, there should be a detailed engine that actually captures a fact, like overheating as was mentioned before. So, you can have a simple interface with some high-level parameters, and underneath that the dynamic simulation that actually flags up if the building really overheats, which monthly calculation would not capture. And once we make this separation, we can work with templates. For example, for a specified HVAC system and specified controls, we can have a template with a predefined control sequence that can be detailed enough to really represent what's happening during the operation of the building, and then approach the application of the simulation not only for informing design - which is very important, don't get me wrong on that - but, also to reuse the simulation model in a digitised, building delivery process and in the operation of the building. I believe we need different views of the model, so we may start with a detailed model to make sure we capture all the physical and dynamic effects that's needed and that we can actually do, and that we are not missing out physical phenomena. I would argue most simulation users are not really aware if they start using a simulation in an area where the physics that is important for that application is just not part of the model.

And then depending on how you use the model, you may extract, for example, a control sequence and port that directly on a machine to machine translation of the building automation system for model predictive control. You may not use the full detailed simulation model, but you can extract the simplified, reduced automodel out of that detailed model, or train a data-driven model or machine learning based model out of it to bootstrap that based on a detailed simulation model. And then you have different instantiations of those simplified models that are built to answer certain questions and have properties that are much easier to satisfy with a simplified approach. For example, real-time training is very hard with a very detailed model of the level of complexity of EnergyPlus, IDA ICE, TRNSYS model, because there are too many degrees of freedom. So, you basically need to reduce the number of unknown parameters to a simplified model representation, and then use this model for the particular purpose. Users ask "Can I use Tool X to do a simulation?", and often we have to ask them two or three times "What question do you want to answer with that model?" People often use a simulation model just to do a simulation without first asking "What's the question, what's the underlying physics, what dynamics need to be represented?". And that should tighten up the choice of the model or the choice of the parameters in a simplified tool. So, you can have, for example, a completely mixed air room volume that may be adequate for some ventilation systems that have a high air flow rate. But, if your office is a large open space, you may need a more detailed model of that. So, we need to be able to provide engines that allow users to select, or maybe even select automatically for the user, what detailed physical resolution is needed; it's a detailed model, but a simple user interface. And we should look at the application of simulation not only in terms of informing the design, but also consider how can we reuse the model to make sure that what is installed and operated is performing at very high efficiency, and provide all the script services and all the new requirements that are needed.

To round off this part of the discussion, Christina quoted the prepared statements from John Grunewald and Andrew Corney, which had essentially been covered in the foregoing:

> **" The possibilities for designing the energy efficiency of buildings are greatest at the beginning of the design process. To date there are no adequate tools available that efficiently support architects in their design decisions. It is therefore important to involve them in the development of the building performance simulation "**
> **(John Grunewald)**

> **" Should the future of building simulation be in the hands of specialist consultants or more all-round practitioners? " (Andrew Corney)**

Christina: I think we've spoken about this now; does anyone else want to chip in before I move on to, Joe, applications?

Joe: With regard to some of the points that came up: if you gather together a group of specialists, experts in applying simulation, you'll find they don't actually want a user interface. They like to get to the core of the model and specify the model in the way that they want to. They don't need glorious interfaces. We're really talking here about getting the power of simulation to the industry in general.

I'd like to tell you about a project we have just been working on - I won't promote it here, but it is complete now. We worked with industry to look at how you might bring the power of simulation to the industry without them having to understand physics or acquire a program and so on. And this is how it works, in outline:

You require the user to specify a proposal using a standard CAD system. It doesn't matter how complex the building or the community is, whether it's got shading devices and complex glazing and so on, they're able to specify the physical reality in some way.

A simulation environment then takes in that physical model - let's say in future, it's totally BIM-ed, or it will be in the IDA ICE format or whatever. And then it's possible for experts like ourselves to agree the rules of generating the virtual constructs, things like gridding the CFD domain, or generating an airflow or electricity network, or choosing a sky discretization type. These are things you really need the user to do. They are virtual constructs so they can be automated, and that's what's been demonstrated here.

It is then possible to take the integrated model and send it off for perpetual simulations. Reality doesn't stop. Reality is not a week or a month or whatever. Reality goes on. And as you do those simulations, you then probe the results, transform them repetitively into performance criteria that we've agreed with the industry, and then you apply those performance results, and then you apply acceptability criteria.

So, you only stop the simulation when the design has been shown to be compliant in some way. So, you're doing a resilience test. And the beauty of that is you can also impose systems tracers. If it's a passive house design, you could make the ventilation heat recovery system fail for a few days and you can see the consequence of that and maybe have relaxed testing to check whether that is OK.

At the end of a process, you then can issue a compliance certificate and store the model alongside the compliance certificate. So now we can begin to close the gap. Users of such a service - perhaps buying it from Per's company - do not to have to acquire a program, or to employ people who are simulation gurus. They are simply sending a design, a proposal, off for one of many standard assessments.

It's possible, as proven, to agree with industry what these standard performance assessments should be for different building types and energy system types. And it's also possible to agree what the performance criteria and acceptability criteria should be. So, you're starting to standardise the whole. Look in future toward CIBSE in the UK because they'll be taking this idea forward in the coming couple of years to consult with the industry more widely. And I'd like to see the industry being more proactive in demanding these things from our community. That they want it to be regulated and harmonized and so on. That doesn't stop people taking raw simulation and applying it any way they want. That's a phenomenal learning tool, phenomenal, but it's not how we should be pursuing the rank and file design applications. And it's relatively easy to do this.

Christina: Andrew, can you comment on this?

Andrew Corney (Andrew): Going right the way back to what Per said about how in Sweden they've adopted these performance-based measures that had driven people to do better simulation because of the codes and the requirements, I think if you look across all the countries where simulation is commonly used, the skills and capabilities of the simulators reflect the codes and standards that are asked of them. So in the United States people are very good at doing ASHRAE 90.1 baseline on proposed buildings. If you look in the UK, unfortunately people are very good at gaming Part L calculations. And then if you look in Australia, which is a bit more like Sweden, the building gets assessed based on its operational energy and you get approval based on the operational target that you're working towards, and people are better at simulating, at predicting how much energy a building is likely to use.

And so trying to tie up the thread here, Christina, I think that what we should be doing is lobbying codes and standards to adopt methodologies that move away from imagined simulation solutions and towards outcomes-based simulation - methodologies that are as simple as possible, that provide as much flexibility as possible and that are enforced by the eventual use of the building or the operation of the building, either through taxation or through fines for excessive use of energy or whatever. I think that would drive a much more mature and professional group of people using simulation.

To be continued … ■

Forthcoming events

Date(s)	Event	Further information
2021		
01-03 December 2021	**52nd International HVAC&R Congress and Exhibition** Belgrade, Serbia	**https://kgh-kongres.rs**
2022		
29 January - 02 February 2022	**ASHRAE Winter conference** Las Vegas, Nevada, USA	**www.ashrae.org/conferences/ashrae-conferences**
21-24 June 2022	**eSim** Ottawa, Ontario, Canada	**https://www.carleton.ca/esim22**
25-29 June 2022	**ASHRAE Annual Conference** Toronto, Ontario, Canada	**www.ashrae.org/conferences/ashrae-conferences**
June 2022 (date tbc)	**Building Simulation Applications (BSA)** Italy (city tbc)	
July/August 2022 (tbc)	**IBPSA-Australasia Conference** Brisbane & online, Australia	**www.ibpsa-australasia.org**
03-05 August 2022	**International Radiance Workshop** Toronto, Ontario, Canada	
20-23 August 2022	**BuildSim Nordic** online	**http://ibpsa-nordic.org**
14-16 September 2022	**SimBuild 2022** Chicago, Illinois, USA	**www.ashrae.org/conferences/topical-conferences**
20-22 September 2022	**BauSIM** Weimar, Germany	**www.bausim2022.de**
22-23 September 2022	**International HVAC+R Technologies Symposium (IBPSA Turkey)** online	
24-25 November 2022	**U-Sim'22** Glasgow & online, Scotland, UK	
2023		
04-06 September 2023	**BS 2023** Shanghai, China	

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

**21-24 June 2022
Carleton University,
Ottawa,
Ontario, Canada**
www.carleton.ca/esim22

eSim 2022
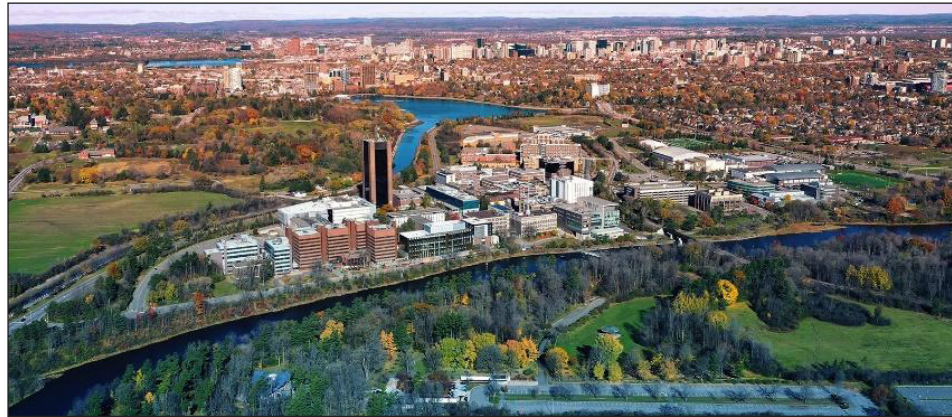
IBPSA-Canada is pleased to invite the world to the 12th biennial eSim Building Simulation Conference on 22-23 June 2022, and workshops on 21 and 24 June, with the theme ''Simulating Buildings for the New Normal''. These dates were selected to precede the ASHRAE Conference in Toronto (25-29 June 2022). The conference consists of two days with typically over 75 peer-reviewed paper presentations, as well as two days of theory and software workshops, a technical tour, and a banquet. The eSim conference is well-established and continues to grow, this year expecting to have over 200 delegates. Visit us at **www.carleton.ca/esim22** for updates.

- ■ Abstract Registration: 30 October 2021
- ■ Paper Submission: 15 February 2022
- ■ Paper Notification: 01 April 2022
- ■ Camera Ready Submission: 15 May 2022

Carleton University is in the Nation's capital city, Ottawa, and is scenically surrounded by the Rideau River and the Rideau Canal, a UNESCO World Heritage Site. The Rideau Canal is also the largest skating rink in the world. However, typical June weather sees highs of 25°C, so hikes along the Canal and in the nearby parks systems would be more seasonal! Ottawa is a city of 1.2 million diverse residents, world-class museums, and has direct flights to most Canadian cities and

European and American hubs. It is also a short train ride away from Montreal, Toronto, and Quebec City.

Please direct questions to eSim 2022 Chair, Burak Gunay, **burak.gunay@carleton.ca** ■

August 2022
Brisbane, Australia
www.ibpsa-
australasia.org

IBPSA-Australasia regional conference

IBPSA-Australasia will be hosting a regional conference in August 2022 in sunny Brisbane, Australia. The conference themes will centre on real world outcomes from simulation applications.

We are looking for papers and presentations focused on delivery and results, as well as how industry can learn and evolve to improve climate responsive design outcomes. This will be a hybrid conference with some content and participation available online. We invite submissions from around the region as well as internationally. Please check our website **www.ibpsa-australasia.org** or follow us on LinkedIn to be notified about the call for papers. ■

BuildSim Nordic 2022
22-23th August
Copenhagen, Denmark

IBPSA NORDIC
International Building Performance Simulation Association

CALL FOR ABSTRACTS
Deadline 1st of October 2021

Additional information at:
http://ibpsa-nordic.org/
Contact info.:
masak@byg.dtu.dk
jerik@byg.dtu.dk

Background Image: Cockle Bay Park, Sydney Australia
© Henning Larsen

DTU

BuildSim Nordic 2022
22-23th August
Copenhagen, Denmark

CALL FOR ABSTRACTS
Deadline 1st of October 2021

BuildSim Nordic 2022 conference is to be held on the 22-23th August 2022 hosted by Technical University of Denmark, Department of Civil Engineering, Denmark, organized in cooperation between the Danish chapter of IBPSA. The conference programme includes a technical tour and a dinner at a secret place. The purpose of the event is to create a platform for exchanging ideas, issues and research findings, in the field of building performance simulation. It facilitates national & international collaboration, and the meeting of minds between practitioners, researchers and students.

Participants
The event is open for members and non-members of IBPSA-Nordic. Any research related to building simulation, including system design, HVAC, energy production/use, indoor climate and environmental issues, is eligible to be presented at the event.

Topics
- Building acoustics
- Building Information Modelling (BIM)
- Building physics
- CFD and air flow
- Commissioning and control
- Daylighting and lighting
- Fenestration systems
- Developments in simulation
- Education in building performance simulation
- Energy storage
- Heating, Ventilation and Air Conditioning (HVAC)
- Human behavior in simulation
- Indoor Environmental Quality (IEQ)
- New software developments
- Optimization
- Simulation at urban scale
- Simulation vs reality
- Solar energy systems
- Validation, calibration and uncertainty
- Weather data & Climate adaptation
- Zero Energy Buildings (ZEB)
- Emissions and Life Cycle Analysis

Background Image: Cockle Bay Park, Sydney Australia
© Henning Larsen
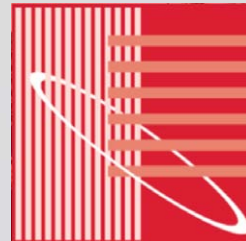
IBPSA NORDIC

International Building Performance Simulation Association

Abstracts
The abstracts should be
- Written in English;
- No more than one A4 page in size;
- A template will be made available;

Language
The event will be held in English.

Submission process
All authors whose abstract is accepted will be invited to submit a full paper. All accepted papers will be invited to give an oral or poster presentation at the event.
The papers accepted for oral presentation will be published in the conference proceedings published by:
SINTEF Akademisk forlaget: https://www.sintef.no/byggforsk/sintef-akademisk-forlag2/
SINTEF Proceedings is an Open Access publication accepted as Level 1 publication in Norway, Denmark and Finland.

Key dates
1st October 2021	Abstract submission
1st December 2021	Acceptance of abstracts
1st February 2022	Submission of full paper
15th April 2022	Acceptance of full paper
1st June 2022	Submission of final paper

Additional information at:
http://ibpsa-nordic.org/
Contact info.:
masak@byg.dtu.dk
jerik@byg.dtu.dk

Software news
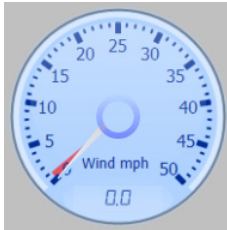
New Global Simulation Climate Data Set from Climate.OneBuilding.Org

In September 2019, Climate.OneBuilding.org completed a worldwide data set with more than 13,500 TMY (Typical Meteorological Years) locations for building performance simulation with data through 2018.

In September 2021, the entire data set was updated with weather station meteorology data through 2020 and corresponding solar radiation from the ERA5 reanalysis data set (www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era5). The ERA5 data, courtesy of Oikolab (https://oikolab.com/), provides a comprehensive, worldwide gridded solar radiation data set based on satellite data. With more than 1500 new locations (>10% increase), this brings the total to more than 15,000 locations.

These TMYx are derived from hourly weather station meteorology data through 2020 in the ISD (US NOAA's Integrated Surface Database) and ERA5 reanalysis gridded solar data using the TMY2/ISO ISO 15927-4:2005 methodologies. There may be two TMYx for a location, e.g., Washington Dulles Intl AP, VA, USA: USA_VA_Dulles-Washington. Dulles.Intl.AP.724030_TMYx and USA_VA_Dulles-Washington.Dulles.Intl.AP.724030_TMYx.2006-2020. In these cases, there's a TMY for the entire period of record and a second TMY for the most recent 15 years (2006-2020). Not all locations have recent data.

With this update, Climate.OneBuilding.org now provides TMYx climate data at no cost for more than 15,000 locations worldwide and another 3,200 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.

Each climate location .zip contains: EPW (EnergyPlus weather format), CLM (ESP-r weather format), and WEA (Daysim weather format) along with DDY (ASHRAE design conditions in EnergyPlus format), RAIN (hourly precipitation in mm, where available), and STAT (expanded EnergyPlus weather statistics).

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

City Energy Analyst 2021 user projects worldwide

Started at ETH Zürich in 2013, City Energy Analyst (CEA) open-source software has enabled architects, urban designers, and engineers worldwide to perform energy simulations and conduct research and design on multiple scales, from neighborhoods to cities. Thanks to the transparent database structure and user-friendly interfaces, CEA

has been picked up by users worldwide to work on case studies, including their own analyses. From Lisbon to Amsterdam, Vancouver, and Singapore they have identified strategies to decarbonize cities using CEA's simulation toolboxes.

Example analyses on one district from energy demand, solar potential, to district heating network design and operation. Result visualizations on the CEA graphical user interface

In 2021 we have collected some of the most impressive projects, which can be found on our website **https://cityenergyanalyst.com/user-projects**:

- Lisbon - Vale de Santo António
- Weimar - Bauhaus 2050
- Vancouver - Wesbrook Village
- Amsterdam - Buiksloterham
- Singapore - Digital Urban Climate Twin

Interested in building your own case studies using CEA? Simply head to **https://cityenergyanalyst.com/try-cea**.

CEA and its functionality are regularly reviewed by external researchers. Recent reviews include:

Ferrando, Martina, Francesco Causone, Tianzhen Hong, and Yixing Chen. "Urban Building Energy Modeling (UBEM) Tools: A State-of-the-Art Review of Bottom-up Physics-Based Approaches." Sustainable Cities and Society 62 (November 1, 2020): **https://doi.org/10.1016/j.scs.2020.102408**.

Sola, Alaia, Cristina Corchero, Jaume Salom, and Manel Sanmarti. "Multi-Domain Urban-Scale Energy Modelling Tools: A Review." Sustainable Cities and Society 54 (March 1, 2020): **https://doi.org/10.1016/j.scs.2019.101872**.

Johari, Fatemeh. "Urban Building Energy Modeling: A Systematic Evaluation of Modeling and Simulation Approaches," 2021. **http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-428021**. ■

Modelica Buildings Library · BERKELEY LAB

LBNL released the Modelica Buildings Library versions 8.0.0 and 7.0.1

Version 8.0.0

Version 8.0.0 is a major release that contains the first version of the Spawn of EnergyPlus coupling that has been developed by LBNL and NREL in collaboration with Modelon and Objexx Engineering.

The following major changes have been done in Version 8.0.0:

- The package **Buildings.ThermalZones.EnergyPlus** contains the first version of the Spawn of EnergyPlus coupling that is being developed at **lbl-srg.github.io/soep**. The Spawn coupling allows users to model HVAC and controls in Modelica, and graphically connect to EnergyPlus models for thermal zones, schedules EMS actuators and output variables. This enables, for example, modelling HVAC systems, HVAC controls and controls for active facade systems in Modelica, and using the EnergyPlus envelope model to simulate heat transfer through the building envelope, including heat and light transmission through the windows for the current control signal of the active shade.
- The package **Buildings.Experimental.DHC** contains models for district heating and cooling systems that are being developed for the URBANopt District Energy System software.
- The new media **Buildings.Media.Antifreeze.PropyleneGlycolWater** allows modeling of propylene-glycol water mixtures.
- A new cooling coil model **Buildings.Fluid.HeatExchangers. WetCoilEffectivenessNTU** has been added. This model is applicable for fully-dry, partially-wet, and fully-wet regimes. In contrast to **Buildings. Fluid.HeatExchangers.WetCoilCounterFlow** and to **Buildings.Fluid. HeatExchangers.WetCoilDiscretized**, this model uses the epsilon-NTU relationship rather than a spatial discretization of the coil. This leads to fewer state variables and generally to a faster simulation.
- New simplified door models for bi-directional air exchange between thermal zones are implemented in **Buildings.Airflow.Multizone**.
- Various other models have been improved or added, in particular for modeling of control sequences using the Control Description Language that has been developed in the OpenBuildingControl project at **obc.lbl.gov**.

For a detailed list of changes in version 8.0.0, see the **8.0.0 release notes**.

Version 7.0.1

Version 7.0.1 is a bug fix release that is compatible with 7.0.0.

The following changes have been done:

- Corrected memory violation on Windows for weather data file with long header lines.
- Corrected various misplaced, or missing, declarations of the ''each'' statement.
- Corrected access to protected classes.

- Reformulated replaceable class to avoid access of components that are not in the constraining type.
- Added missing parameter declarations for records.

For a detailed list of changes in version 7.0.1, see the **7.0.1 release notes**.

Both versions have been tested with Dymola 2021 and 2022, JModelica (revision 14023), and OPTIMICA (revision OCT-stable-r12473_JM-r14295).

For download, go to **https://simulationresearch.lbl.gov/modelica** ■

DesignBuilder Solar Decathlon India 2020-21 Challenge

DesignBuilder is proud to have sponsored the Solar Decathlon India 2020-21 Challenge. The event enabled participating student teams to explore affordable building solutions that are innovative and forward-looking. The participants were tasked to design resilient net-zero-energy-water buildings for real building projects by partnering with industry. The designs were then evaluated on the following ten criteria: Energy Performance; Water Performance; Resilience; Affordability; Innovation; Scalability and Market Potential; Health; Architectural Design; Engineering and Operations; and Presentation. The participant teams used DesignBuilder Software for annual energy and daylight simulations and design optimisation.

In the 2020-21 Challenge, 103 academic institutions from 51 cities participated in multidisciplinary teams. The winners impressed the jury members by presenting state-of-the-art Net-Zero and climate-resilient designs that had the potential for scale-up, accelerating the transition to a Net-Zero future. The Division Winners of the 2020-21 Challenge were Team Skanders Family, Team Archons, Team Sparikam and Team Stellar. Teams effectively used passive and active strategies to meet cooling demand and demonstrate adaptability, paying attention to building operation and maintenance. The Division Winners of the 2020-21 Challenge pitched their project to the Grand Jury and competed for the Grand Prize. The grand prize winner of the event was Team Archons. Professor Gunjan Kumar was given the Outstanding Faculty Award for his support, guidance, and inspiration to the students of Team Nivas in the 2020-21 Challenge. In the Solar Decathlon India 2021-22 Challenge, 93 teams with over 1100 students will

compete in one of the following six Divisions:

1   Multi-family housing
2   Single-Family Housing
3   Education Building
4   Office Building
5   Community Resilience Shelter
6   On-site construction worker housing

All participating students will have access to a suite of performance analysis tools provided by DesignBuilder Software, enabling them to simulate and test the performance of their designs. More details about the event can be found at **https://solardecathlonindia.in** ∎

IES news and call for IESVE 2022 beta testers

IES is inviting energy modellers to test its soon-to-be-released IESVE 2022. If you'd like to participate in the IES beta testing programme, please complete the online form at **https://go.iesve.com/ve2022-beta-tester**.

IESVE 2021 Feature Pack: A major upgrade for high-performance building design in California

IES has provided a major upgrade to the construction industry in California with the release of IESVE 2021 Feature Pack 2 Software (**www.iesve.com/ve2021**).

This new software design tool combines two energy-conscious perspectives for new construction buildings:

◼ Building Design – this uses the Actual Design of the building, as design intended.

◼ Building Energy Code Compliance (Title 24) – this compares two building derivatives; (1) "Proposed Design" against (2) "Standard Design". Neither of these two derivatives represent the Actual Design.
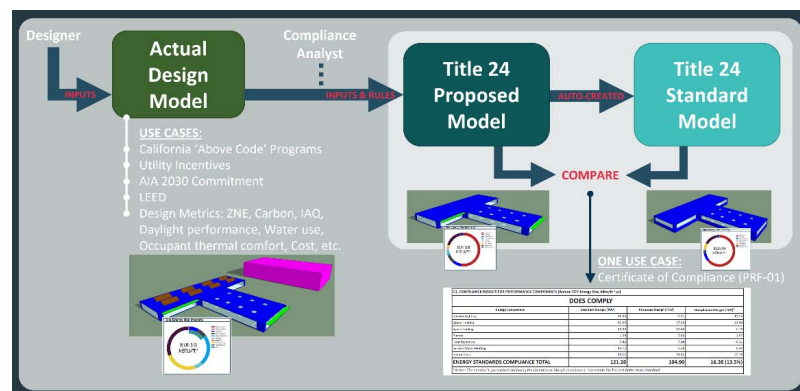
IES VE Software is the only Approved Title 24 tool that Integrates a THREE-model approach for design & compliance: (1) Design, (2) Title 24 Proposed and (3) Title 24 Standard with:

- Real 3D architecture
- ASHRAE Loads Calculations for Mechanical Design
- An energy model for Design, using flexible design inputs.
- Support for carbon neutrality by linking energy model results to the AIA 2030 Commitment

Find out more at www.iesve.com/discoveries/article/17921/major-upgrade-for-high-performance-building-design-in-california.

Free Title 24 Training Course

Pacific Gas & Electric (PG&E) is hosting a free 1-day IES training course on November 17th, 2021 - Title 24 Compliance Modeling & Decarbonization with IESVE Software

Please visit https://pge.docebosaas.com/learn/course/external/view/webinar/1161/title-24-compliance-modeling-decarbonization-with-iesve-software for further information and to sign up.

VE Gaia: Early stage design analysis – free give away until 7th Jan 2022

Buildings are responsible for 39% of energy related CO2 emissions. Now, as COP26 brings together world leaders in a collective response to climate change, this is our moment - as building performance modellers - to play our part. By integrating building performance from the earliest stages of design, alongside creativity and vision, it is possible to significantly reduce the energy and environmental impacts of our buildings to make a real impact.

As part of IES's commitment to COP26, we want to aid as much as possible in decarbonising the built environment. We are pleased to be offering VE Gaia for FREE until 7th January 2022. To get started, visit www.iesve.com/software/trial/ve-gaia .

What you need to know about NABERS UK

Following the 2020 launch of NABERS UK, BRE's new energy efficiency rating system for office buildings, IES Divisional Head of Consultancy (UK) and resident Design for Performance and NABERS expert, Phil O'Loughlin, explains key points to know about the new scheme and what is entailed in pursuing certification in an article at www.iesve.com/discoveries/blog/18374/nabers-uk-what-you-need-to-know .
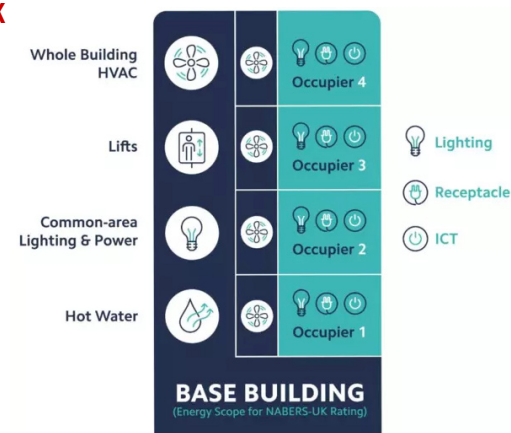
Understanding and minimizing unmet load hours – a user guide
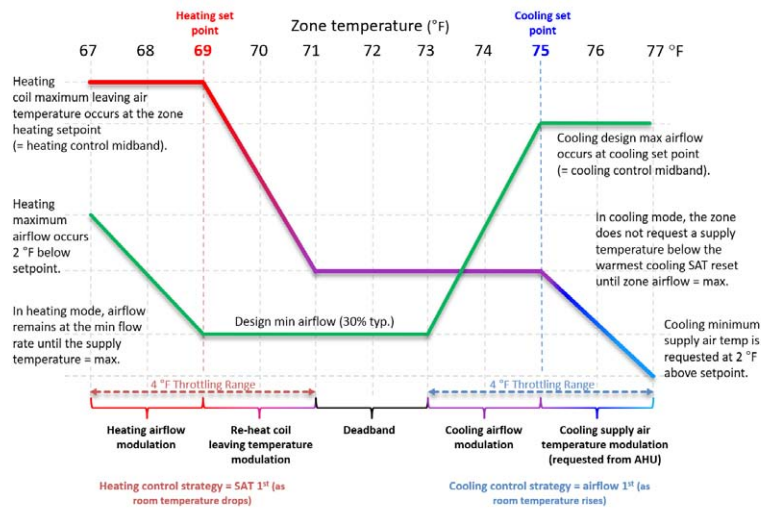
In this guide, Part 1 of our Unmet Load Hours series, we dive into the fundamentals of UMLHs—much more so than the usual one-paragraph definition. If you already have a truly strong understanding of UMLHs, you may want to skip this part; however, you may also find it informative in some unexpected way! The guide is available at **www.iesve.com/discoveries/article/16769/unmet-load-hours-part-1** .

Events

IES are sponsoring and presenting at the annual IBPSA-USA Houston's Chapter: Performance Huddle: **https://ibpsausahouston.com/2021-conference-info/**

IES will be sponsoring & exhibiting at the ASHRAE Building Performance Analysis Conference, November 10-12 2021 in Denver: **www.ashrae.org/conferences/topical-conferences/2021-ashrae-building-performance-analysis-conference**.

IES Exhibited at Greenbuild in San Diego, September 22nd. You can learn more about what we shared this year: **www.iesve.com/discoveries/event/18717/greenbuild-2021** . ∎

Benchmark Dataset Development and Applications

Tianzhen Hong, Na Luo, Lawrence Berkeley National Laboratory, USA
Lieko Earle, National Renewable Energy Laboratory, USA
Piljae Im, Oak Ridge National Laboratory, USA
Vikas Chandan, Chitra Sivaraman, Pacific Northwest National Laboratory, USA

Introduction

Research-grade datasets from real buildings can address essential gaps that limit our present data analytics capabilities. Buildings are responsible for 40% of primary energy consumption in the U.S. (about one third globally). With today's technologies (e.g., energy efficiency, sensors and advanced controls) there is potential to reduce energy use in buildings by up to 50%. Reducing energy waste in buildings and optimizing building operations require access to a diverse and integrated set of data. However, it is currently time-consuming and hard to find datasets that have adequate data coverage (e.g., indoor and outdoor environmental parameters, occupant parameters, energy end uses, building system operational parameters), good data quality, and clear documentation (e.g., metadata description).

In an ideal world these data would be securely collected at little cost with high temporal and spatial fidelity and include every attribute relevant to building performance and occupant comfort. The use cases of such datasets are myriad. They can establish the ground truth of a building's operation. Correlations in the data can suggest least-cost pathways to accomplishing tasks like nonintrusive load monitoring, virtual sensing, building energy model calibration, forecasting, benchmarking, control optimization, fault detection, and many others. Analyzing down-sampled data (at lower temporal or spatial fidelity) can help us quantify the capabilities and limitations of lower resolution datasets.

Of course, measuring ground truth at high resolution in all buildings is impractical. As such, there is a need to collect, curate, and make publicly available high-resolution data from a small number of buildings that have broad applicability to a variety of high-impact use cases. This effort can help determine the level of resolution required for most effectively optimizing building operations through advances in data analytics and control technologies. It can also provide a common, high-quality benchmark against which competing algorithms can be fairly compared.

To fulfil such needs, the Building Technologies Office of United States Department of Energy has funded this research project, Benchmark Dataset Development and Applications, which is jointly led by the authors.

Project Goals

The project aims to characterize major use cases for building datasets, define an appropriate data infrastructure, inventory existing building datasets to identify resources that can be used/shared, and develop an experimental plan for a subsequent multi-year effort to collect and curate high-

quality, well-calibrated datasets of building operations through robust instrumentation. Monitoring efforts will address equipment health, sub-metered energy use, environmental variables (e.g., temperature, humidity, air quality, irradiance), and occupancy parameters (e.g., occupant presence, interactions with building systems). Parameters most valuable for a variety of use cases, including load forecasting and baselining, virtual sensing, building energy modeling, building performance benchmarking (at the whole building and system levels), and non-intrusive load monitoring, will be identified.

The project is collecting and curating high-resolution, well-calibrated time series of building operational and indoor/outdoor environmental data, which are crucial to understanding and optimizing building energy efficiency performance and demand flexibility capabilities as well as benchmarking energy algorithms. Data are being sourced from both existing and new building data collection efforts. The curated datasets are being made open access through a public data portal.

Approaches

The project is organized into five tasks (Figure 1), including four technical tasks and one outreach task. The four-lab team works together on all five tasks in collaboration with the DOE project manager and the Technical Advisory Group (TAG). Through a survey and interview process of 33 researchers from the four participating laboratories, the project team identified and defined 14 use cases. An iterative scoring process was done to prioritize high-impact use cases.
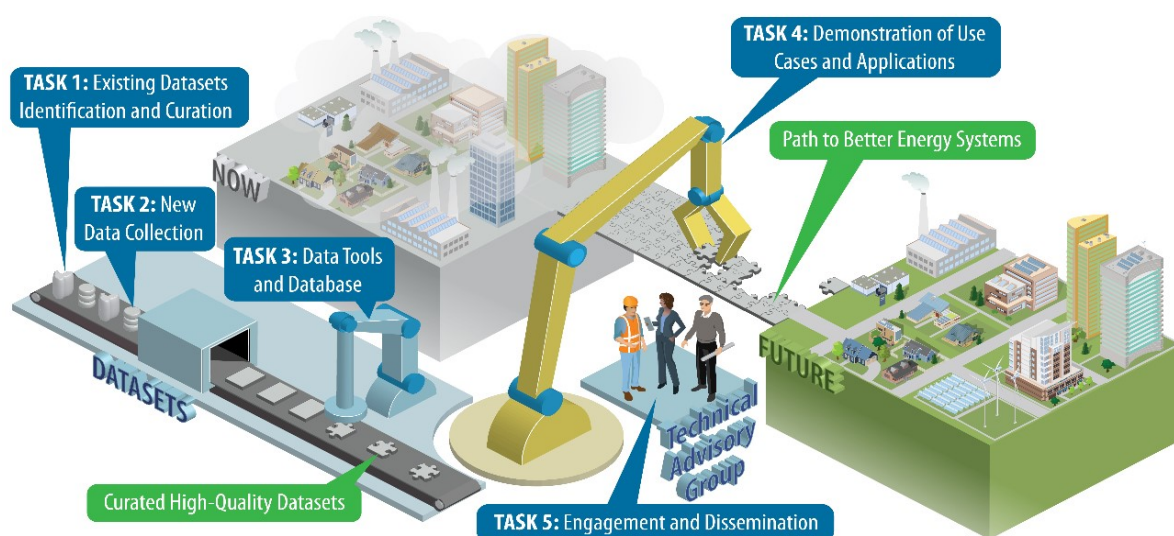
Figure 1. The Five Tasks of the Project

Task 1: Existing data collection and curation

This task is examining the catalogue of existing data sources to select field- and/or laboratory-based building system datasets that are best suited to addressing our list of high-impact use cases. The selected existing datasets are being curated as shown in Figure 2, including the process of

data cleaning, gap filling, anomalies smoothing, and data anonymization, to make sure they are in a consistent and useable format for inclusion in the database tools (e.g., data schema, data portal) that will be refined and developed in Task 3.
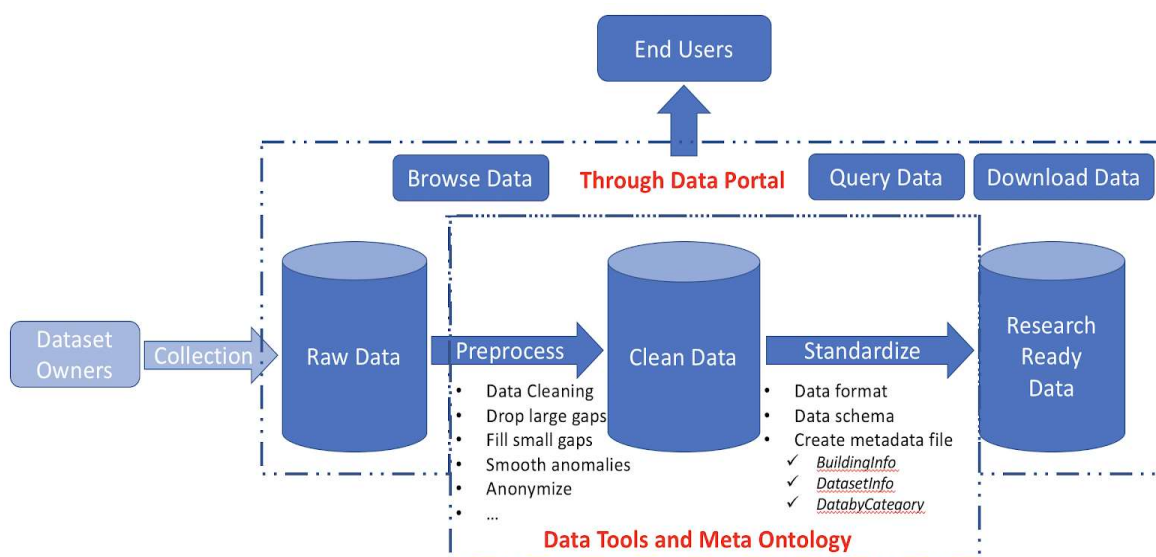
Figure 2. Schematic workflow of the data curation process

Task 2: New data collection

This task is identifying potential data collection sites based on (1) applicability to selected use cases, (2) type and quality of data needed, not provided in existing datasets, and (3) availability of buildings for instrumentation and data collection. This also involves obtaining permission from the building owner or manager and negotiating data use as shown in Figure 3. A detailed design and experiment have been developed for each new data collection effort.
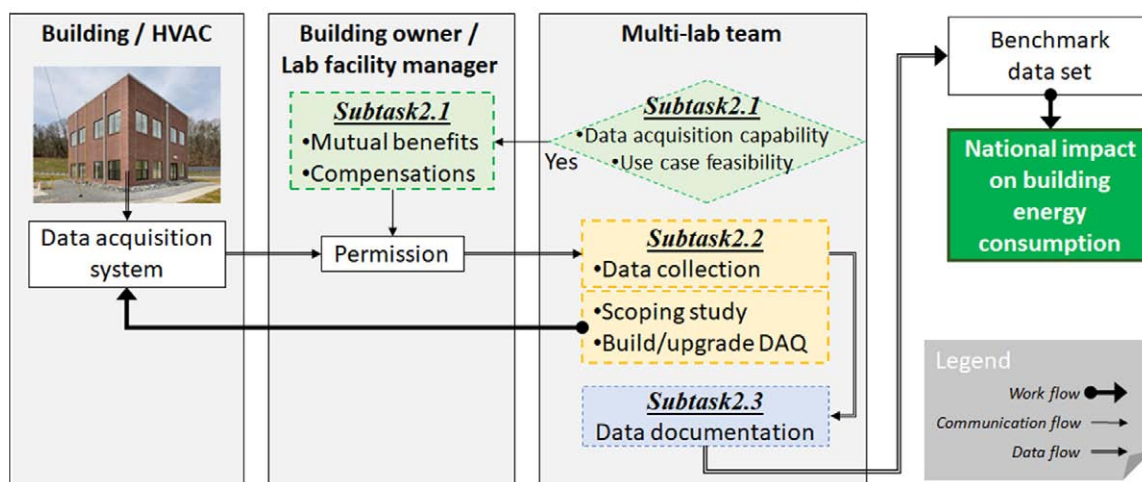
Figure 3. Illustration of new data collection efforts

Task 3: Data tools and data portal

This task focuses on enhancing existing data tools to store, query and retrieve the data and metadata collected in Tasks 1 and 2, as well as developing a data portal to host and share the curated datasets for open access use. This task tackles the challenge of the common data representation standard by defining a common metadata schema and developing database tools to standardize the way data are represented, through identifying and enhancing existing data tools, rather than developing brand new data tools. The development and enhancement of the data portal and data tools in this task will finalize the data curation process as shown in Figure 2.

Task 4: Demonstration of use cases

This task involves defining and executing a set of illustrative analyses that demonstrate how one or more datasets curated through this project can address a data gap or challenge historically faced by building stakeholders. The selection of the use cases is informed by the identification and prioritization of the list of use cases, the mapping matrix between use cases and data needs, as well as the list of datasets collected and curated in preceding tasks. The following use cases are preliminary examples of analysis that could be considered.

- Building performance benchmarking
- Building energy model development and calibration
- Evaluation of load-shaping technologies for a Grid-Interactive Efficient Building (GEB) use case
- Control optimization
- Impact of COVID-19 pandemic on building energy use and occupancy

The outcome of each analysis will be documented in a technical report that includes a discussion of the analysis objective, the use case supported by the analysis, the results that are enabled by the curated dataset, and how the analysis would have been less accurate, less effective, or infeasible without the new dataset.

Task 5: Engagement and dissemination

This task informs stakeholders and communities about the project and obtain their feedback. The project has covenanted a technical advisory group (TAG) comprising subject-matter experts with broad representation from both industry and academic. This task includes the outreach to key stakeholders, preparing and participating in the annual DOE BTO peer review, as well as participating and presenting project outcomes in national conferences such as ASHRAE, ACEEE, and IBPSA-USA.

Outcomes

Curation of a dozen datasets

The project team aims to curate twelve datasets and has delivered six datasets based on the curation workflow shown in Figure 2. For each dataset, the missing values and outlier values

were first identified and filled/modified using multiple statistical and machine learning algorithms for different sizes of the gaps. The missing rate and outlier rate of the processed datasets are significantly reduced compared with the original raw dataset. A technical report summarizing the cleaning strategy and the corresponding data quality is provided with the processed dataset. Then, a dedicated Brick[1] model was generated for each dataset to describe the metadata of the building, systems, and sensors and meters. Finally, a structured metadata JSON file is generated to provide high-level contextual information of the dataset and to illustrate application perspectives.

The published six datasets cover commercial and residential building types, three climate zones (3C, 4A, and 5B based on the IECC climate zone map[2]), and support at least three use cases.

Enhancement of existing data tools

A review of 24 existing data tools was conducted on term standardization, metadata representation, as well as data storage and management. A survey was designed on the capability and limitation of each tool, and collected feedback from 32 data experts in four participating national laboratories. The main findings of this review include the capability (e.g., data coverage, application stage of the building life cycle, flexibility and extensibility, etc.) of these 24 commonly-used data tools, general gaps for each data tool category, as well as an in-depth review about the unique features and limitations for certain prioritized data tools. Details of the review were published in a journal paper[3].

Based on the review, the project team proposed to enhance the BRICK schema to represent metadata of occupants and their sensing as well as human-building interactions. This is a collaborative effort with the BRICK community. Figure 4 illustrates the proposed extension to the BRICK schema, which includes four aspects: (1) adding a new class "Occupant" to represent occupants' demography (e.g., age, gender, and country) and behavioral pattern (e.g., thermal preference and energy use style); (2) adding new subclasses under the Equipment class to represent envelope system (e.g., window and door) and personal thermal comfort devices (e.g., ceiling fan, portable fan, and portable heater); (3) adding new subclasses under the Point class to represent occupant-related sensors and status (e.g., Wi-Fi APs, window status); and (4) adding auxiliary properties for occupant interactable equipment (e.g., thermostats, windows, and personal devices) to represent the level of controllability for each equipment by occupants (e.g., no access/locked, operable, manual/automatic). The extension is implemented in the Brick schema and has been tested using multiple occupant datasets from the ASHRAE Global Occupant Database project. The extension enables BRICK schema to capture diverse types of

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[1] https://brickschema.org

[2] https://basc.pnnl.gov/images/iecc-climate-zone-map

[3] Luo, N., Pritoni, M., & Hong, T. (2021). An overview of data tools for representing and managing building information and performance data. Renewable and Sustainable Energy Reviews, 147, 111224. https://doi.org/10.1016/j.rser.2021.111224

occupant sensing data and their metadata for FAIR (findable, accessible, interoperable and reusable) data research and applications.
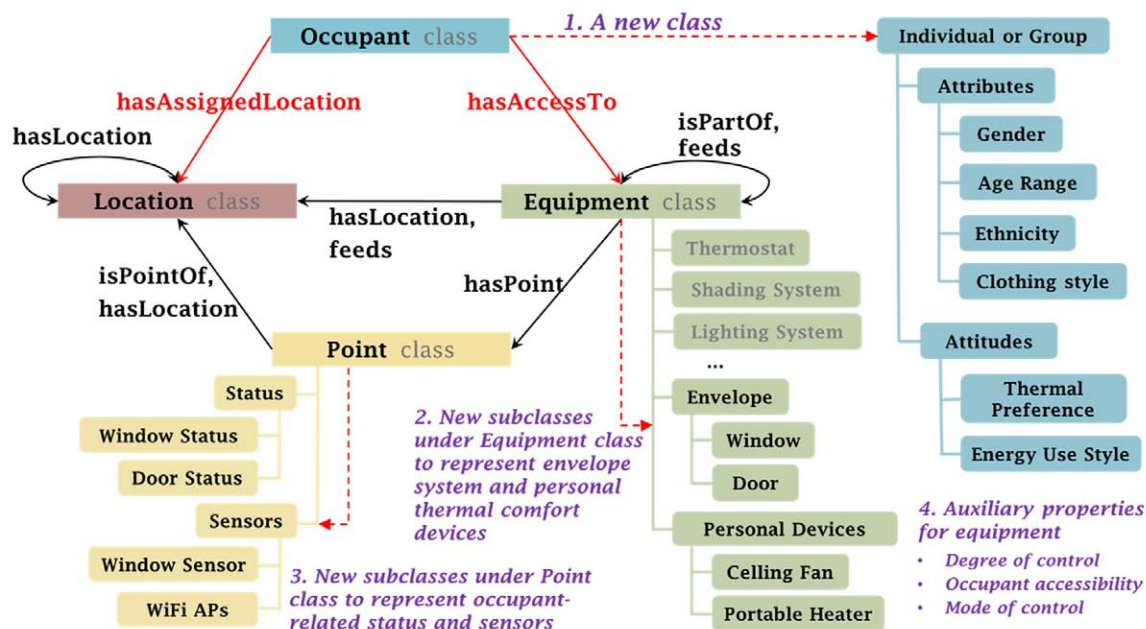
Figure 4. Illustration of the Brick schema extension

Data portal development and dataset publishing

The project developed the Building Benchmark Dataset (BBD) portal[4], which provides the ability to collect, store, curate, catalog, standardize, preserve, and disseminate the building datasets. The portal is built upon the DOE Office of Energy Efficiency & Renewable Energy-(EERE-) supported Livewire data platform and Wind Data Archive and Portal—a signature capability in data management that includes collection, storage, curation, cataloging, preservation, discovery, and dissemination of large volumes of data (including real-time streaming data), spanning multiple application domains such as wind and energy mobility systems. The platform is built on FAIR principles, is scalable, easy to maintain, and deploy; and provides the ability to track usage and download metrics. The project team carefully selected, ranked, and prioritized 40 building features to guide the development of the data portal. These features can be categorized into six categories – data collection, dataset curation, metadata features, data discovery, data security, and data download.

So far, six datasets are published and hosted at the data portal. Each published dataset contains both the raw data and the processed data, as well as metadata documentations. Figure 5 shows the search facets and six datasets on the portal. The search facets were customized for the buildings domain which is a unique capability and contain features of state, climate zone, building type, HVAC system type, fuel type, data category, floor area, and vintage. This can facilitate the users' navigation when exploring the appropriate datasets for their specific use

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[4] https://bbd.labworks.org/

cases. The project team plans to curate and publish the remaining six datasets by September 30, 2022.
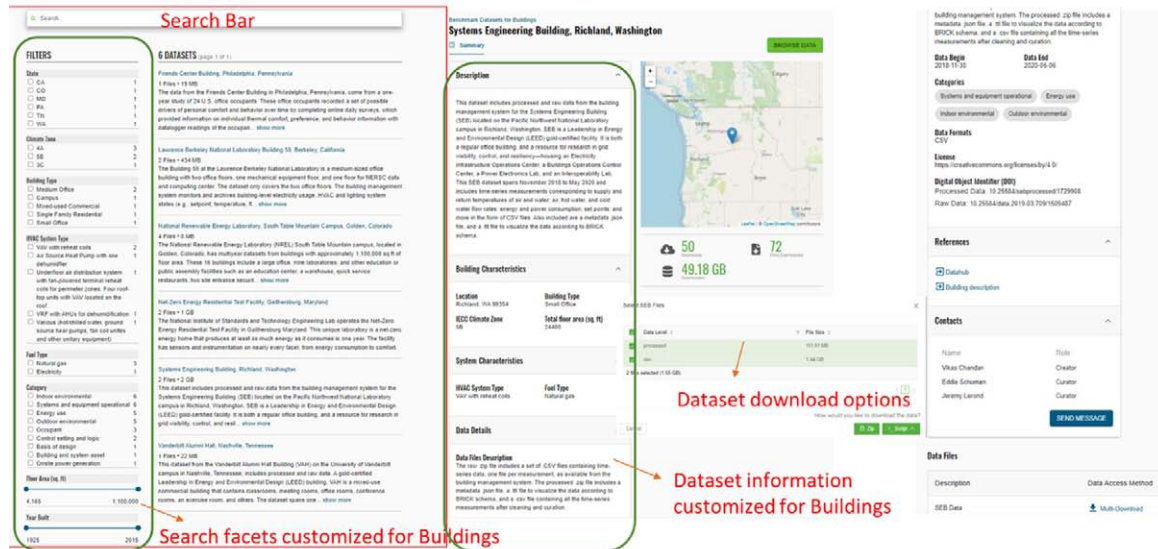
Figure 5. Search facets and dataset page of the data portal (https://bbd.labworks.org)

Demonstration of use cases

The project team will select four prioritized use cases, and execute a set of illustrative analysis for each use case to demonstrate how the curated datasets can provide insights into building operation, performance and improvement opportunities. So far, two case studies have been conducted.

- **Case study 1 – Evaluation of methodologies for development and calibration for building energy models**
  A grey box (RC) model was developed using the high-quality measured data from the National Institute of Standards and Technology (NIST) Net-Zero Energy Residential Test Facility (NZERTF) located in Gaithersburg, MD, to demonstrate the evaluation of methodologies for development and calibration for different types of building energy models (e.g., black box, grey box, high fidelity models, etc.) to understand building operation, controls, and performance. The developed gray box model demonstrated that it could predict the zone temperatures within 1°C of the measured data. The results show that the high-quality measured dataset from a building could be effective for creating an accurate gray box model that can be used in building controls such as model predictive control (MPC).

- **Case study 2 – Energy and occupancy analytics to improve understanding and efficiency of building operations**
  This case study demonstrates that various types of analysis can be conducted on the collected time series data of occupancy, energy use, and HVAC operation to provide

insights on patterns of energy demand, energy use, correlation between energy use and influencing factors. The dataset was collected from Building 59, located in LBNL main campus in Berkeley, CA. Sub-metered energy use data can help us understand changes to energy use and driving factors before and during the COVID-19 pandemic. Data from the existing IT infrastructure, e.g., Wi-Fi connected device count, is a valuable data source to infer occupancy and people count, which helps us diagnose operations of HVAC, lighting, and MELs to identify deficiencies that can be corrected for saving energy and utility costs, as well as reducing associated carbon emissions. The case study also reveals the energy use of buildings during the COVID-19 pandemic was strongly driven by health and safety policies (rather than occupancy level) that changed building operation hours and ventilation requirements, which significantly influenced the energy performance of buildings.

Next Steps

This project is continuing into 2022 to:

- Streamline and semi-automate the data curation workflow
- Complete new data collection and curation, and publish the datasets
- Conduct another two case studies using the curated datasets
- Explore opportunities to continue advancing the data portal as a resource serving the community
- Outreach to key stakeholders through publications, seminars and community engagement

Acknowledgments

BS 2023:

18th IBPSA International Conference & Exhibition

Dates & venue

IBPSA-China is honored to host the Building Simulation 2023 conference in Shanghai, China. BS 2023 is scheduled at the beginning of September 2023 (currently planned for 04-06 September), when local weather is pleasant and the crowded summer tourist season recedes.

BS2023 will see the return of the IBPSA conference to China after 16 years. Tongji University (Shanghai) and Tsinghua University (Beijing) will co-host this international conference with the support of IBPSA-China. Both universities are among the top Chinese institutes in the field of Building Science and Civil Engineering. IBPSA-China is a regional affiliate of IBPSA, and has successfully hosted BS2007, ASim2012 and ASim2018 since its foundation in 2007.

Shanghai, known as "The Pearl of Asia" and "The Paris of the East", is one of the foremost economic, financial, cultural, and technological innovation centers in Asia and the world. Featuring several architectural styles such as Art Deco and shikumen, the city is renowned for its Lujiazui skyline, museums and historic buildings, including the City God Temple, Yu Garden, the China Pavilion and buildings along the Bund. The huge number of new and existing buildings (more than 1000 mega-tall) in Shanghai provides great potential for the application of building performance simulation. BS2023 will be held in downtown Shanghai, where most tourist attractions and transport hubs are located.

Highlights

Key features and highlights of BS2023 will include:

- ■ Ensuring **academic quality**: Strict peer-review process & 6 high-quality keynote speeches.
- ■ Facilitating **effective discussion**: Interactive sessions, face-to-face workshops, seminars on hot topics; technical tours, software demos, training courses and other social events.
- ■ **Paperless**: The Conference4me (C4me) application will replace traditional paper guidebooks, while electronic screens will replace traditional paper posters.
- ■ **Low carbon**: Free transit pass for both subways and buses in Shanghai; a mobile phone App will facilitate the rental of shared city bikes.
- ■ **Hospitality**: All the participants and accompanying persons will be treated with the greatest hospitality.

Organisers
Chair: Professor Yiqun Pan

Professor Yiqun Pan from Tongji University will be in charge of the conference organization committee with Da Yan from Tsinghua University acting as co-chair. Preparation – supported by sponsor companies, local associations, and IBPSA regional affiliates – has begun following the official announcement. Shanghai sends a warm welcome to all practitioners in building simulation related areas to join this inspiring event!

Yiqun Pan is a full professor in the School of Mechanical Engineering, Tongji University, China, and is now co-chair of IBPSA-China and an IBPSA Fellow. At IBPSA, she has served as member of the Editorial Board of the

Journal of Building Performance Simulation since 2013 and a member of the Education Committee since 2017. At IBPSA-China, she has been a member of the Board of Directors since 2012. In 2012, she served as the Chair of the 1st Asia conference of IBPSA (ASim2012) hosted in Shanghai, China, and as the Vice-President of the Chinese Society of HVAC Simulation Special Committee. She is the author of five books as first/chief author and over 110 scientific journal papers, leading the development of a co-simulation model of occupant behavior, IAQ and building energy – subtask 2 of the kernel development of whole building performance simulation platform (China National Key R&D Plan).

Co-chair: Professor Da Yan

Professor Da Yan is a tenured Associate Professor in the School of Architecture, Tsinghua University, China, and serves as chair of IBPSA-China and is an IBPSA Fellow. Since 2000, he has devoted his efforts to the development of the building energy simulation tool DeST (Designer's Simulation Tool). In 2007, he was the secretary-general of the International Building Performance Simulation Conference, Beijing; In 2008, he won the second national prize for scientific and technological progress of China. He is the operating agent of IEA EBC Annex 66 with more than 100 participants from more than 20 countries. Since 2016, he has been the president of the Association of Simulation in Heating and air conditioning of China, the co-chair of ASHRAE MTG.OBB and the chief editor of the International Journal of Building Simulation. He is also a journal referee for Automation in Construction, Applied Energy, Energy Policy, Energy and Buildings, Building and Environment, Renewable Energy, Energy Research & Social Science, and the Journal of Building Performance Simulation. ■

News from IBPSA affiliates

IBPSA affiliates are asked to submit a report to the IBPSA Board each year to keep Board members informed about their activities and membership. These are too detailed to include in ibpsaNEWS, so affiliates have been asked to make their latest annual report available through their web sites, and this section includes only selected, recent news. Other news from affiliates may be available from their websites; the URLs for these are available on the IBPSA Central web site at www.ibpsa.org/?page_id=29.

IBPSA-Brazil

In 2020, the IBPSA-Brazil Chapter started organizing a series of one-hour webinars under the title ''Conversando sobre simulação'' (in English, ''Talking about Simulation'') with the following topics:

1 NBR 15575: a new Standard procedure for the simulation and analysis of the thermal performance of residential buildings (04 March 2020). Lecturers: Marcelo Salles Olinger, Amanda Krelling, Leticia Eli. Webinar video at **https://attendee.gotowebinar.com/recording/8264161804730877959** .
2 An Insight into Future Trends of Hydrothermal and Energy Simulation of Buildings (08 April 2020). Lecturer: Prof. Nathan Mendes. Webinar video at **https://attendee.gotowebinar.com/recording/3759583612786013968** .
3 Simulation of Water-Cooled Air Conditioning systems (06 May 2020). Lecturer: Ricardo Gomes
4 INI-C: new procedures for thermal and energy simulation for commercial buildings in Brazil (10 June 2020). Lecturer: Prof. Ana Paula Melo.
5 Simulation of split systems (08 July 2020). Lecturer: Prof. Alberto Hernandez Neto.
6 Simulation of natural ventilation (05 August 2020). Lecturer: Prof. Marieli Azoia Lukiantchuki.
7 CpSimulator: a cloud-based platform to predict wind pressure coefficients on buildings (09 September 2020). Lecturer: Facundo Bre.
8 ASHRAE Standard 205P: Standard Representation of HVAC Performance Data (16 September 2020). Lecturer: Chip Barnaby.

The links for the videos of the webinars can be found at **www.ibpsa.org.br** .

We are also organizing two more webinars during 2021:

1 Simulation of day lighting (13 October 2021). Lecturer: Fernando Pereira. Webinar link: **https://bit.ly/3D3k1xe** .
2 Professional certification (04 November 2021). Lecturer: Tim Kline, Kimberly Cowman and Fernando Dutra. Webinar link: **https://bit.ly/37TruAM** .

There are plans to organize further webinars in 2022 with the aim of improving knowledge of building simulation in Brazil. ■

Building Performance Analysis

Building Performance Analysis is the go-to resource for those who want to have a deep understanding of what building performance is, before moving on to simulate it. Building Performance Analysis is endorsed by IBPSA.

Obviously, the key topic of the book is building performance. While a lot has been published on the subject of simulation, the application area is often taken for granted within the IBPSA community. Yet to do meaningful simulations, one of the hardest challenges is to define the question that is to be answered. The answer to deep questions about building performance may be gained by simulation, but there are other approaches available as well, especially in the realm of physical measurement. These are also covered in the book; hence the use of the word analysis in the title.

Table of Contents:

Building Performance Analysis offers a comprehensive and systematic overview of the concept of building performance analysis, bringing together many existing notions and ideas in one single title. It consists of three main parts. 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. Building Performance Analysis is a substantial book: it has 11 chapters, 600 pages, and includes over 1600 references.

Building Performance Analysis is written for the building science community, both from industry and academia. Amongst others, it aims to make the following contributions to the field:

1   It reviews the significant body of knowledge on building performance that already exists, offering a point of entry to this complex subject matter for those who are new to the field.
2   The book emphasizes the fact that building performance deals with a wide variety of performance aspects. In doing so it challenges the community to address some of the aspects that get less prominence in the literature.
3   The book goes 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 those wishing to do further work in the field and needing to develop research questions and hypotheses. The emergent theory is very much intended as subject matter for discussion, debate, and deeper exploration.
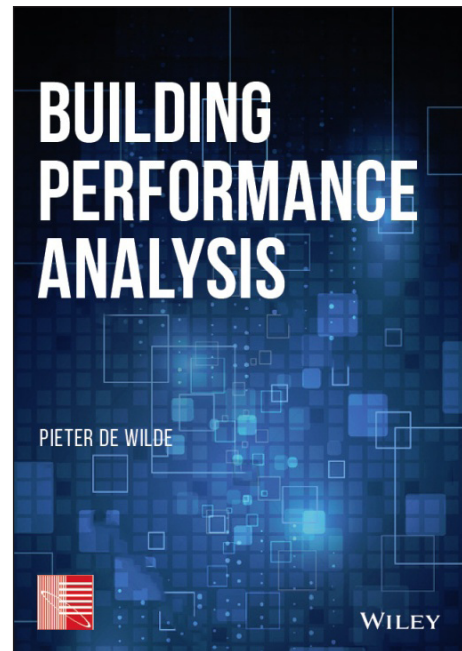
The book has a foreword by Godfried Augenbroe, long-term mentor of the author. The endorsement by IBPSA is written by Malcolm Cook, chair of the IBPSA Publications Committee. Further endorsements stem from colleagues who have helped by reviewing drafts of the work: Georg Suter, Wei Tian, Cheol-Soo Park, Dru Crawley and Ruchi Choudhary.

The book can be purchased directly from the publisher, via the major online retailers, and of course via your local bookseller. For questions and feedback, please email the author at **pieter@bldg-perf.org**. ■

New from Routledge!

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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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.
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Journal of
Building Performance Simulation

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

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https://doi.org/10.1080/19401493.2020.1838612

Astrid Tijskens, Hans Janssen & Staf Roels (2021) The impact of a reduced training subspace on the prediction accuracy of neural networks for hygrothermal predictions, Journal of Building Performance Simulation, 14:1, 20-37

https://doi.org/10.1080/19401493.2020.1832148

Alexander Murray, Thomas Schütz, Guanru Pan, Dirk Müller & Veit Hagenmeyer (2021) On modelling effects in the battery and thermal storage scheduling problem, Journal of Building Performance Simulation, 14:1, 38-51

https://doi.org/10.1080/19401493.2020.1838611

Mina Ishac & Wafaa Nadim (2021) Standardization of optimization methodology of daylighting and shading strategy: a case study of an architectural design studio – the German University in Cairo, Egypt, Journal of Building Performance Simulation, 14:1, 52-77

https://doi.org/10.1080/19401493.2020.1846618

Mariam Itani, Dalia Ghaddar, Nesreen Ghaddar & Kamel Ghali (2021) Model-based multivariable regression model for thermal comfort in naturally ventilated spaces with personalized ventilation, Journal of Building Performance Simulation, 14:1, 78-93

https://doi.org/10.1080/19401493.2020.1850865

Allison Bernett, Katharina Kral & Timur Dogan (2021) Sustainability evaluation for early design (SEED) framework for energy use, embodied carbon, cost, and daylighting assessment, Journal of Building Performance Simulation, 14:2, 95-115

https://doi.org/10.1080/19401493.2020.1865459

Bart Merema, Dirk Saelens & Hilde Breesch (2021) Analysing modelling challenges of smart controlled ventilation systems in educational buildings, Journal of Building Performance Simulation, 14:2, 116-131

Marie-Hélène Azam, Julien Berger, Sihem Guernouti, Philippe Poullain & Marjorie Musy (2021) Parametric PGD model used with orthogonal polynomials to assess efficiently the building's envelope thermal performance, Journal of Building Performance Simulation, 14:2, 132-154

https://doi.org/10.1080/19401493.2020.1868577

Andrea Alongi, Adriana Angelotti & Livio Mazzarella (2021) A numerical model to simulate the dynamic performance of Breathing Walls, Journal of Building Performance Simulation, 14:2, 155-180
https://doi.org/10.1080/19401493.2020.1868578

V.P. López-Cabeza, F.J. Carmona-Molero, S. Rubino, C. Rivera-Gómez, E.D. Fernández-Nieto, C. Galán-Marín & T. Chacón-Rebollo (2021) Modelling of surface and inner wall temperatures in the analysis of courtyard thermal performances in Mediterranean climates, Journal of Building Performance Simulation, 14:2, 181-202
https://doi.org/10.1080/19401493.2020.1870561

Nicholas Long, Fatema Almajed, Justus von Rhein & Gregor Henze (2021) Development of a metamodelling framework for building energy models with application to fifthgeneration district heating and cooling networks, Journal of Building Performance Simulation, 14:2, 203-225
https://doi.org/10.1080/19401493.2021.1884291

Matthieu Labat, Ion Hazyuk, Matthieu Cezard & Sylvie Lorente (2021) Indoor thermal behaviour of an office equipped with a ventilated slab: a numerical study, Journal of Building Performance Simulation, 14:3, 227-246
https://doi.org/10.1080/19401493.2021.1905714

Melanie Jans-Singh, Rebecca Ward & Ruchi Choudhary (2021) Co-simulating a greenhouse in a building to quantify co-benefits of different coupled configurations, Journal of Building Performance Simulation, 14:3, 247-276
https://doi.org/10.1080/19401493.2021.1908426

Sandhya Patidar, David Paul Jenkins, Andrew Peacock & Peter McCallum (2021) A hybrid system of data-driven approaches for simulating residential energy demand profiles, Journal of Building Performance Simulation, 14:3, 277-302
https://doi.org/10.1080/19401493.2021.1908427

R. M. Ward & R. Choudhary (2021) A tool for generation of stochastic occupant-based internal loads using a functional data analysis approach to re-define 'activity', Journal of Building Performance Simulation, 14:3, 303-327
https://doi.org/10.1080/19401493.2021.1919209

Weilin Li, Liu Yang, Jiayin Zhu & Ruixin Li (2021) A pre-processing method of internal thermal mass for building energy simulation software, Journal of Building Performance Simulation, 14:3, 328-342
https://doi.org/10.1080/19401493.2021.1917665

Sang woo Ham, Panagiota Karava, Ilias Bilionis & James Braun (2021) A datadriven model for building energy normalization to enable eco-feedback in multi-family residential buildings with smart and connected technology, Journal of Building Performance Simulation, 14:4, 343-365

Silke Verbruggen, Marc Delghust, Jelle Laverge & Arnold Janssens (2021) Evaluation of the relationship between window use and physical environmental variables: consistency, seasonality and diversity, Journal of Building Performance Simulation, 14:4, 366-382
https://doi.org/10.1080/19401493.2021.1942209

Omid Asvadi-Kermani & Hamidreza Momeni (2021) A constrained distributed time-series neural network MPC approach for HVAC system energy saving in a medium-large building, Journal of Building Performance Simulation, 14:4, 383-400
https://doi.org/10.1080/19401493.2021.1951841

Ruchi Choudhary, Cheol Soo Park & Pieter De Wilde (2021) Obituary Professor Godfried (Fried) Augenbroe, Journal of Building Performance Simulation, 14:4, 401-402
https://doi.org/10.1080/19401493.2021.1950400

Pil Brix Purup & Steffen Petersen (2021) Characteristic traits of visualizations for decision-making in the early stages of building design, Journal of Building Performance Simulation, 14:4, 403-419
https://doi.org/10.1080/19401493.2021.1961864

Sang Woo Ham, Panagiota Karava, Ilias Bilionis & James Braun (2021) Realtime model for unit-level heating and cooling energy prediction in multi-family residential housing, Journal of Building Performance Simulation, 14:4, 420-445

https://doi.org/10.1080/19401493.2021.1968495

Carlos Prieto & Massimo Cimmino (2021) Thermal interactions in large irregular fields of geothermal boreholes: the method of equivalent boreholes, Journal of Building Performance Simulation, 14:4, 446-460

https://doi.org/10.1080/19401493.2021.1968953

Shanshan Wang, Nianxiong Liu & Jingyu Zhang (2021) Thermal performance optimization for housing unit design in a cold region of China, Journal of Building Performance Simulation, 14:5, 461-479

https://doi.org/10.1080/19401493.2021.1970811

Á. Bognár, R.C.G.M. Loonen & J.L.M. Hensen (2021) Calculating solar irradiance without shading geometry: a point cloud-based method, Journal of Building Performance Simulation, 14:5, 480-502

https://doi.org/10.1080/19401493.2021.1971765

Yun-Dam Ko & Cheol-Soo Park (2021) Parameter estimation of unknown properties using transfer learning from virtual to existing buildings, Journal of Building Performance Simulation, 14:5, 503-514

https://doi.org/10.1080/19401493.2021.1972159