ibpsaNEWS

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Oct 2016

Find out more about building performance simulation and sign up for one of our next educational webinars on

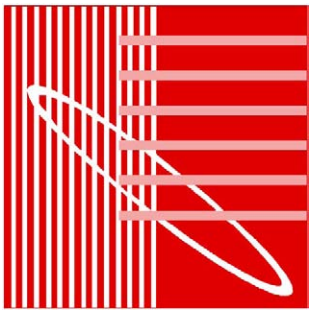
Jan Hensen | Roberto Lamberts | Godfried Augenbroe | Charles "Chip" Barnaby | Drury B. Crawley | ..... | and many more .....

INTERVIEWS with Annie Marston of Baumann Consulting on IBPSA-USA's drive for equality and diversity in construction, and with Ruchi Choudhary and Yeonsook Heo about Cambridge University's work on Bayesian methods, human behaviour, and Energy Efficient Cities

SOFTWARE NEWS about Climate.OneBuilding.Org and DesignBuilder - and a paper from LBL about a new data and computing platform for city and district scale building energy efficiency

GLOBAL COMMUNITY NEWS from IBPSA affiliates in South America, Australasia, England, Norway and Switzerland

CALENDAR OF EVENTS 8 conferences and other events for your diary, and a new series of free webinars based on IBPSA's first book, *Building Performance Simulation for Design and Operation*



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President's message

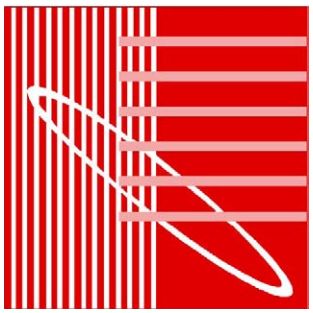
Dear IBPSA Colleagues and Friends,

IBPSA held its Annual General Meeting and Board of Directors meetings in Newcastle upon Tyne, UK in September. The meetings were held in conjunction with IBPSA-England's BSO 2016 conference. The AGM confirmed newly elected directors and approved the financial report for the year ending 30 June 2016. Due to the success of Building Simulation 2015, IBPSA remains financially sound for our current (modest) undertakings.

At its meeting, the Board reviewed on-going activities and discussed ideas for new initiatives. Proposals include publishing a practitioner-oriented magazine, offering professional certifications, and developing training materials. The issue for any effort is finding the resources to get it started. Incremental, low-cost steps are required given our all-volunteer structure. One successful example is IBPSA's current webinar series based on Building Performance Simulation for Design and Operation (see **www.ibpsa.org/?page_id=695**). The material for the presentations leverages existing content and the internet allows no-cost distribution and archiving for on-demand viewing. This furthers IBPSA's educational mission and lays the groundwork for more ambitious IBPSA University training activities. Thanks go to Rajan Rawal (IBPSA-India) and the education committee for organizing the webinars (see **page 11** for further information).

As I discussed in my April 2016 message, the overarching issue for our field is expanding application in routine practice, especially during early design phases. Ideas such as publishing a practice-oriented magazine spring from this concern. The difficulty is that IBPSA, with its largely academic focus, is not immediately capable of undertaking practice-oriented activities. To build in that area, we first need to continue to make the case for building modeling. From our point of view, publicity of that sort is restating the obvious. Clearly, however, the building industry as a whole has not heard the message, so it needs repetition. I urge all of you to promote building modeling whenever you get the chance. For instance, Ian Beausoleil-Morrison gave a compelling BSO 2016 keynote showing that carbon reduction goals cannot be met without more complex energy systems and such systems cannot be designed or operated without sophisticated modeling. We need to be broadcasting that message beyond our own community.

Some practitioners see the same issues from their side. At the ASHRAE/IBPSA-USA SimBuild 2016 conference in August, Kjell Anderson presented a keynote talk titled *So Happy Together: Architects and Energy Modelers Informing Building Design*. He examined the designer/modeler communication disconnects that commonly occur and spoke to the need for developing routine model-guided design processes. IBPSA should seek out practice innovators and encourage their involvement.



Meanwhile, plans for Building Simulation 2017 are shaping up. The conference will be held in San Francisco, August 7–9, 2017. Additional information is found in this edition of *ibpsa*NEWS and at **www.buildingsimulation2017.org**. Consistent with the thoughts presented above, practitioner participation is a key theme. As usual, software training workshops will be offered. One keynote speaker is Anica Landreneau, Director of Sustainable Design at HOK, a major multi-national architecture firm. Further, a major new component of BS 2017 will be non-paper presentations. The intent is to provide opportunities to make oral presentations without having to prepare a full paper. This format is suitable for case studies, debates, panel discussions, and presentation of preliminary research results – all useful for the conference but not appropriate for inclusion in the archival conference proceedings. The detailed call for non-paper presentations will be posted on **www.buildingsimulation2017.org** by mid-October. Please consider joining the discussion by submitting a presentation proposal.

The academic portion of the conference will be similar to prior Building Simulation conferences. More than 800 abstracts for peer-reviewed papers have been received. Full papers for accepted abstracts are due November 30 and will be rigorously double-blind reviewed.

All-in-all, BS 2017 looks to have "something for everyone" and I hope you make plans to come to San Francisco next August. And, as usual, I urge you to become involved with your regional affiliate and volunteer to help grow IBPSA.

Annie Marston, IBPSA-USA:
promoting equality and diversity in construction

IBPSA-USA recently established a new committee dedicated to equality and diversity. Annie Marston of Baumann Consulting, the new committee chair, has been active in IBPSA for the last 5 years and a member of the IBPSA-USA board since 2015. She has been working and studying in the industry for the last 12 years.

Christina Hopfe talked to Annie Marston about the new committee and its aims and future plans.

Christina J Hopfe (CJH): Can you tell us something about IBPSA-USA's new equality group: who is it aimed at? how did it begin/ who had the idea? what is the correct name of the group and its purpose?

Annie Marston (AM): The group is called the IBPSA-USA Equality Committee and our mission statement is to encourage and retain women and minorities in the simulation community. The committee now has 9 members of all genders and ethnicities.

The idea evolved from a discussion I had with the IBPSA-USA board when a talented engineer and modeller in her early 30s had spoken to me about leaving her job and doing something completely different. It wasn't because she didn't enjoy the work; it was because she found the office politics too exhausting. This really resonated with me: I was coming off a hard few weeks myself and was beginning to wonder whether the extra effort was worth the love of the work.

So this is when I started the conversation. I wanted not only to retain talented people within our community but to make sure that the next generation was more mixed - that it was easier for them to pass through their careers without being the only ones in the room, without feeling like another place might suit them better.

The more I talk about this the more I see it isn't only women that are fighting to stay in the community; many talented people mid way in their career are feeling lost and under appreciated in their roles, especially the practitioners who deal with the wider construction industry day to day. I am hoping that we can all learn and help to keep the talent as well as encouraging new talent into our industry without having to worry about gender or ethnicity.

CJH: What is the situation in the US compared with other countries with respect to equality? Do you see a need for other IBPSA affiliations to take up this initiative as well?

AM: I can only really speak to the situation in the US; although educated in the UK, I have worked primarily here in the US. During my education the departments I was in were mixed gender and ethnicity and most of my higher education colleagues are still researching and remain in the academic world (with the exception

of those who are currently taking time off for child care duties). However in my professional role, there are few women and little ethnic diversity. I believe the numbers of women practising as engineers in the US is 10% and minorities closer to 5%. I have frequently been the only woman at the table and had my appearance commented upon, credentials checked publicly on numerous occasions and of course asked if a senior man will be accompanying me to the meeting.

One of the things we are going to do is to collect data on our community; we will send out a survey and display the results on the IBPSA-USA website. This will identify the gender and ethnic make up of our community and give us a greater understanding of where to begin to focus our attention. I would love it if other country chapters did this as well so we could really understand what the size of the problem is and where to learn from others as well as fix ourselves. I think it would be great if all IBPSA affiliates had a similar committee.

CJH: What are your plans (short term and long term) to develop greater equality in the industry?

AM: This year we have several goals:

1. Hold a Q&A session at the ASHRAE and IBPSA-USA Simbuild 2016 conference to introduce ourselves and begin the conversation.
2. Create a webpage on the IBPSA-USA site, which will include some profiles of female and minority simulation professionals
3. Do a market survey to collect data about our industry and its make up and display this on the website
4. Set up a mentoring program
5. The committee itself is going to become more visible on forums answering questions, hopefully to encourage others to do the same
6. Have some kind of Q & A section on the website to answer people's questions if they are having specific issues, to help support them

These are our short term goals; we will see what works and what doesn't. Next year I think we will focus more on getting talent into the industry and ways we can do this.

CJH: That sounds interesting. I wonder if you could tell us a little more about the mentoring program that you want to set up?

AM: We are still working on the details of the mentoring program; however, I think it will work a little like this: Mentors and Mentees will sign up, filling out a short form; we will make sure that the role of Mentor and Mentee is specified before sign up. The equalities committee will then pair up mentors and mentees as best we can. The pairing should last approximately a year. The idea would be for the mentor to introduce the mentee to the community, to discuss issues such as asking for a pay raise, how to deal with internal politics, reviewing resumes and so on. Again these are only rough details; in the next EQ Committee meeting we are going to make more definite steps and start the process rolling.

CJH: If readers would like to know more and/or engage with the group, how would you advise them to go about this?

AM: The best way right now is to join our linkedin group which is called IBPSA-USA Equalities Committee, **www.linkedin.com/groups/12002106**; here we can keep you on our list and make sure you are updated with all the latest information.

If you email me (**anniemarston@hotmail.com** / **a.marston@baumann-us.com**) we will add you to our email list. Once we have the website set up we should have somewhere in there where you can join our email list. One last thing I would like to add; in my time in the simulation community (for approximately the last 12 years), the modellers and simulation professionals I have met have rarely noticed my gender, in other words I have felt very much accepted for my work and talents rather than who I am. I am always incredibly grateful for this and hope I am not alone. There have of course been a very few exceptions but in general I feel our community is really very open and accepting. In the wider industry however I have felt the burden of gender and what I really want to do is take the acceptance of our small community and maintain it, grow this equality and become a role model for the wider construction industry.

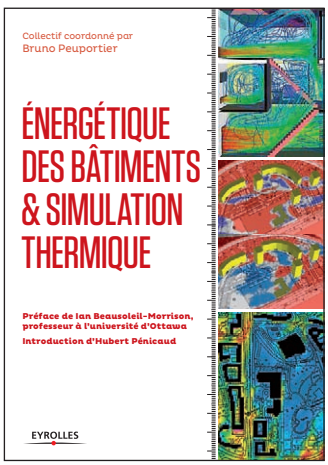
CJH: Thank you Annie. ■

NEW BOOK: Energy performance of buildings and thermal simulation (in French)

Written for all practitioners involved in the design of new energy efficient buildings and in renovation projects – building services engineers and consultants, contractors, architects, teachers and researchers – *Energy performance of buildings and thermal simulation* presents a wide-ranging overview of the field, from the modelling of basic physical processes to the use of simulation in practice and real-world examples. The four chapters cover:

- **Models and main assumptions**: heat and mass transfer, lighting, air flow, systems, renewable energy, life cycle
- **Model validation**: benchmarks, software comparison, experimental validation
- **Performing simulation**: consistency with study objectives, input data, use of simulation and exploitation of results (including uncertainty analysis and optimization)
- **Application examples**: new construction, retrofit, innovative use of simulation, and progress towards an energy performance guarantee.

Edited by Bruno Peuportier and with a preface by Ian Beausoleil-Morrison, the book brings together contributions from many experts from academia and the design professions. It recognises that simulation is considered too complex by some practitioners, and aims to make it better understood and encourage its wider and more effective use. It includes extensive practical advice on topics such as the description of buildings, climate, users' behaviour scenarios, and the exploitation of results. Uncertainty analysis and optimization are also discussed. The last part of the book presents case studies which showcase some practical uses of the tools in the design of new and retrofit projects. It concludes with perspectives on progress towards an energy performance guarantee.



Energétique des bâtiments et simulation thermique, 446p, Ed. Bruno Peuportier, Eyrolles, Paris, 2015. There are further details in a flyer at the end of this issue of *ibpsa*NEWS.

Research at the University of Cambridge:

Bayesian methods, human behaviour, and Energy Efficient Cities

an interview with Ruchi Choudhary and Yeonsook Heo

*In this edition of ibpsa*NEWS*, our regular feature describing the work of research institutes, university faculties and other organisations actively involved with IBPSA-related research visits the UK's University of Cambridge. Christina Hopfe spoke to Ruchi Choudhary, a Reader in the School of Engineering, and Yeonsook Heo, a Lecturer in the School of Architecture.*

Ruchi and Yeonsook will co-organize IBPSA-England's 4th Building Simulation and Optimization (BSO) conference in 2018 at the University of Cambridge.

Christina Hopfe (CJH): First of all, thank you for taking the time to answer my questions for ibpsaNEWS. IBPSA-England has just held its successful third conference, BSO 2016, where it was announced that the fourth conference will be hosted by Cambridge. What are your plans for the next event? Will there be a specific theme?

Ruchi Choudhary (RC, left): We are very pleased to be hosting BSO 18 within both the Civil Engineering and Architecture Departments at Cambridge. We have very good precedents from three successful BSO conferences, and our foremost objective is to uphold the quality of the event in line with past BSO and IBPSA world conferences. At BSO 18 we are keen to welcome new frontiers in building simulation modelling – particularly those at the interface with other sub-areas within Civil Engineering and Architecture – such as structures, geotechniques, sensing, people/behaviour, and urban planning. The theme of the conference is well-defined in its title *Building Simulation & Optimization*, and further sub-definitions may not be necessary.

Yeonsook Heo (YH, right): In terms of conference participation, we very much like that BSO is at a very different scale from IBPSA's international conference, being smaller and a more intimate technical meeting. At the same time, we are fully aware that past BSO's have attracted significant numbers of European delegates, as well as some wider international participation.

We are prepared for and will very much welcome increased participation from international research groups. We also plan to actively seek representation of cross-disciplinary simulation development within BSO.

CJH: You have known each other for quite a while and have previously worked together, prior to your time at Cambridge. Much of your work was in the domain of calibration and uncertainty. Could you explain this a little?

RC: I joined Georgia Institute of Technology (Gatech), Atlanta, US in 2004, as Assistant Professor. It was my first academic position, so I was glad and lucky to have Godfried Augenbroe as a mentor. I have known Fried since my early days as a student, as he is a close collaborator of my supervisor, Ali Malkawi.

Yeonsook was our first shared student at Gatech – first for an MSc, and then as a PhD student. Yeonsook was also a vital bridge once I moved to Cambridge, as she spent significant time at Cambridge in 2009 to work on her PhD. The rest is history!

YH: I have known Ruchi since 2005 when I studied the Masters program at Gatech. During my PhD period, I enjoyed working on various research projects with great support and advice from Fried and Ruchi. This shaped my PhD dissertation on using a Bayesian approach for calibrating simulation models. At Gatech, I also worked on uncertainty quantification of microclimate variables for an NSF-funded project, ''Risk Conscious Design and Retrofit of Buildings for Low Energy''. My current research continues in the realm of uncertainty quantification and model calibration, including extending the current Bayesian calibration framework to handle time-series data coming from sparse measurements.

CJH: What other national and international collaborations have you been involved with, for example with other universities and partners? What are your current projects?

RC: Of course we continue to work closely with Fried (at Gatech). We are also supported by strong industry partnerships within the UK. We are part of the UK TEDDINET network which brings together diverse disciplines including civil and building engineering, informatics, energy systems, governance and geography. In addition, we have a regular bi-directional exchange of international researchers. For example, within the last 12 months I have worked with researchers from University of Tokyo, Aarhus University, University of Melbourne, ENS Cachan, Indian Institute of Human Settlements, and more recently, with National University of Singapore and UC Berkeley.

YH: As a new faculty member and a newcomer to the UK, I am looking for opportunities to collaborate with other universities and partners. Through one of the EU networking programmes, I have collaborated with Dr Corgnati's research team at Politecnico Di Torino and co-supervise one PhD student together with him.

CJH: You work in different schools at Cambridge, Yeonsook in Architecture and Ruchi in Engineering. Could you please explain a little bit about the unique flavour of the two different schools and your research group(s)?

RC: Belonging to two different Departments within the University is a great benefit to us. It gives us access and exposure to a wider set of research areas as well as resources. It is extremely easy for us to share students, teaching, and research resources as the two Departments run a number of collaborative programs: the Interdisciplinary Design for Built Environment (IDBE) Program, the Centre for Smart Infrastructure & Construction (CSIC), the Centre for Doctoral Training in Future Infrastructure & Built Environment (FIBE). We also do shared teaching – a joint module called Architecture Engineering brings together 60-70 students from both Departments each year. In addition, Yeonsook regularly supervises graduate students from the Engineering Department, and is as such, formally part of the Civil, Structural, Environmental Engineering Teaching group within Engineering. Of course, the fact that our buildings are back-to-back also leads to multiple coffee meet-ups within a day.

YH: Within the Architecture Department, I lead the Behaviour and Building Performance group, together with two colleagues who specialise in thermal comfort, sustainable design, and energy policies. Research in this group has more emphasis on the interrelationships between people and the built environment for sustainable development and wellbeing. Our website, which is currently being updated, is at **www.martincentre.arct.cam.ac.uk/research/behaviour-and-building**.

CJH: Could you provide an example of current research in the field of modelling and simulation? What is your current focus in this field?

YH: We jointly lead the built environment strand of the multidisciplinary Energy Efficient Cities initiative (EECi) at the university; there is more information about our projects at **www.eeci.cam.ac.uk**. One example of our current research is urban-scale simulation modelling. As part of our ongoing research, we are refining the development of a high-resolution city energy model to compute energy use, emissions, and air quality at the city-scale. The first phase of this work was presented at BS2015. A second key project, called Bayesian Building Energy Management (B-bem), is on uncertainty quantification of input parameters in simulation models, with a specific focus on parameters pertaining to operation of non-domestic buildings.

CJH: What do you think is or are your greatest asset(s)?

RC: My super-fantastic colleagues of course. In the end though, what makes me look forward to a day at work are the students. I don't think my colleagues or students would like to be described as 'assets' though – it would be more precise to say that they are by far the most important part of my work life.

YH: Well, I would say my greatest asset is the work experience I have had with researchers in our field as well as other fields. I have had opportunities to work on various research projects and collaborate with researchers in building simulation, other simulation domains, statistics, and spatial morphology. I look forward to more collaboration.

CJH: Thank you for a very informative interview.

If you would like more information about the departments of Engineering or Architecture at Cambridge, or are interested in collaboration or knowledge exchange, please contact Ruchi Choudhary at **rc488@cam.ac.uk** or Yeonsook Heo at **yh305@cam.ac.uk**.

If you would like to publicise the work of your faculty or research group in a future *ibpsa*NEWS interview please contact Christina Hopfe (**C.J.Hopfe@lboro.ac.uk**). ■

Forthcoming events

Date(s)	Event	Web site
2016		
24-28 October 2016	**Scientific School: New Generation Building ENergy SIMulation Tools (GENSIM)** Porticcio, Corsica, France	www.ibpsa.us/gensim-scientific-school-porticcio-france
27-29 November 2016	**ASIM** Jeju, South Korea	www.ibpsa.kr/asim2016
07-09 December 2016	**ASA Conference** Adelaide, Australia	www.architecture.adelaide.edu.au/asa2016
2017		
28 January - 01 February 2017	**ASHRAE winter conference** Las Vegas, Nevada, USA	www.ashrae.org/membership--conferences/conferences/2017-ashrae-winter-conference
08-10 February 2017	**BSA 2017: Building Simulation Applications - 3rd IBPSA-Italy conference** Bolzano, Italy	http://bsa.events.unibz.it
05-06 April 2017	**CIBSE ASHRAE Technical Symposium 2017: Delivering Resilient High Performance Buildings** Loughborough, UK	www.cibse.org/symposium
22-24 May 2017	**SimAUD 2017: Simulation for Architecture and Urban Design** Toronto, Canada	www.simaud.org/2017
11-14 June 2017	**NSB, 11th Symposium on Building Physics** Trondheim, Norway	www.ntnu.edu/web/nsb2017/about
24-28 June 2017	**2017 ASHRAE Annual Conference** Long Beach, California, USA	http://ashraem.confex.com/ashraem/s17/cfp.cgi
07-09 August 2017	**BS17, Building Simulation 2017** San Francisco, California, USA	http://buildingsimulation.org www.buildingsimulation2017.org

IBPSA webinars

IBPSA has organised a series of free webinars based on the Association's first book, *Building Performance Simulation for Design and Operation*, which provides a uniquely comprehensive overview of Building Performance Simulation for the whole building life cycle from conception to demolition. The 30 minute webinars are kindly being conducted by chapter authors, followed by Q & A. The first event, on chapter 1, was held in July 2016; future events on chapters 5-17 are provisionally scheduled between 17 November 2016 and 21 September 2017 as shown on the next page. These dates may change; refer to the website for changes and alterations.

Please visit **www.ibpsa.org** to register for upcoming webinars or view recordings of past webinars on the IBPSA University YouTube channel. IBPSA would value feedback from participants. Please email your comments to Prof Rajan Rawal, CEPT University, Ahmedabad, **rajanrawal@cept.ac.in**.

Date	Chapter	Author
2016		
17 November 2016 08:00 US Central Time	**Ch. 5: Thermal Load And Energy Performance Prediction**	Jeffrey D. Spitler **spitler@okstate.edu**
15 December 2016 09:00 US Eastern Time	**Ch. 6: Ventilation Performance Prediction**	Jelena Srebric **jsrebric@umd.edu**
2017		
19 January 2017	**Ch. 7 Indoor Thermal Quality Performance Prediction**	Christoph van Treeck **treeck@e3d.rwth-aachen.de**
23 February 2017	**Ch. 8: Room Acoustics Performance Prediction**	Ardeshir Mahdavi **amahdavi@tuwien.ac.at**
23 March 2017	**Ch. 9: Daylight Performance Predictions**	Christoph Reinhart **tito_@mit.edu**
tbd	**Ch. 10: Moisture Phenomena In Whole Building Performance Prediction**	Jan Carmeliet **carmeliet@arch.ethz.ch** **Jan.Carmeliet@empa.ch** Bert Blocken **b.j.e.blocken@tue.nl** **bert.blocken@bwk.kuleuven.be** Thijs Defraeye **defraeye@arch.ethz.ch** **thijs.defraeye@empa.ch** Dominique Derome **Dominique.Derome@empa.ch**
tbd	**Ch. 11: HVAC systems performance prediction**	Jonathan Wright **j.a.wright@lboro.ac.uk**
20 April 2017	**Ch. 12: Micro-cogeneration system performance prediction**	Ian Beausoleil-Morrison **ian_beausoleil-morrison@carleton.ca**
18 May 2017	**Ch. 13: Building simulation for practical operational optimization**	David E. Claridge **dclaridge@tamu.edu**
22 June 2017	**Ch. 14: Building simulation in building automation systems**	Gregor P. Henze **gregor.henze@colorado.edu** Christian Neumann
20 July 2017	**Ch. 15: Integrated resource flow modelling of the urban built environment**	Darren Robinson **Darren.Robinson@nottingham.ac.uk**
24 August 2017	**Ch. 16: Building simulation for policy support**	Drury B. Crawley **Dru.Crawley@bentley.com,** **dbcrawley@gmail.com**
21 September 2017	**Ch. 17: A view on future building system modeling and simulation**	Michael Wetter **MWetter@lbl.gov**

24-28 October 2016

Porticcio, Corsica, France

www.ibpsa.us/gensim-scientific-school-porticcio-france

and

https://ibpsa.github.io/project1/meeting/news/2016/10/24/gensim.html

Scientific School: New Generation Building ENergy SIMulation Tools

The increasing integration of buildings to reduce energy and peak power demand, and to increase occupant health and productivity, is posing new challenges for engineers using building simulation programs to support product development, building design, commissioning and operation.

Organized by IBPSA France and IEA EBC Annex 60, the GENSIM School will offer workshops, presentations and hands-on training in Modelica, Functional Mockup Interface-based co-simulation, and BIM to Modelica translations.

It will be suitable for simulation and modeling specialists in building/district energy and control systems, whether they have no, basic, or medium-level knowledge of the Modelica language. By the end of the School, participants can expect to be able to use the Modelica libraries, build systems on their own, debug the Modelica models, and run simulations.

The School will also outline new trends and new R&D needs for the computational simulation of energy flows and demands at the building and district levels based on Modelica, FMI and related BIM/GIS translators: new software tools, design methods, performance evaluation, and efficient workflows. In particular, it will discuss the R&D needs which will shape IBPSA's first R&D project. Focusing on BIM/GIS and Modelica framework for building and community energy system design and operation, this is due to start in summer 2017.

The official language will be English.

For more information, please contact Mohamad Ibrahim at **mohamad.ibrahim@cea.fr** or visit one of the two websites shown above. ■

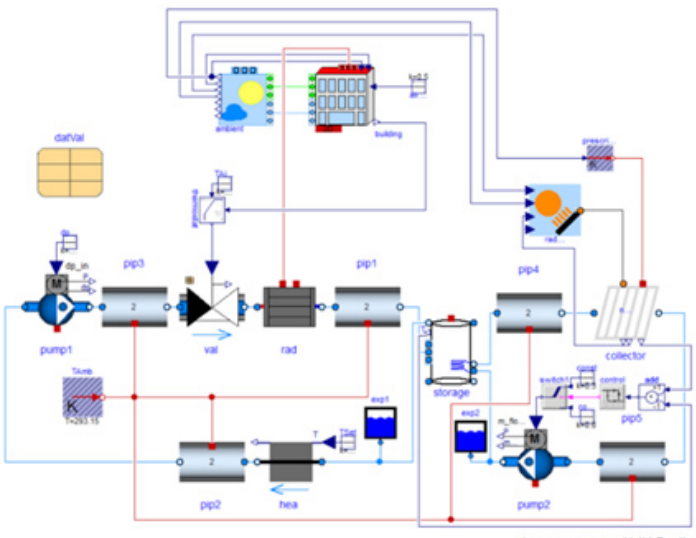


Image source: UdK Berlin

27-29 November 2016
Jeju, South Korea
www.ibpsa.kr/asim2016

ASIM 2016: 3rd IBPSA Asia conference

IBPSA-Korea will host the 3rd IBPSA Asia conference (ASIM 2016) on 27-29 November 2016 in Jeju (Cheju) island, South Korea. The conference is being organized by IBPSA-Korea, and co-organized by IBPSA-China and IBPSA-Japan.

ASIM 2016 is expected to be geographically diverse. We look forward to welcoming many participants from Europe, North and South America as well as from other Asian countries. The ASIM 2016 venue, Jeju (Cheju) island, is one of the most attractive sightseeing places in Korea for foreign tourists and is a UNESCO world heritage site.

Conference topics will include:

- Building physics
- Simulation and real performance
- Simulation in design practice
- Simulation for regulation/code compliance and certification
- Software/Interface development, test and validation
- Simulation to support commissioning, controls and monitoring
- Case studies of building simulation application
- Community/Urban scale modelling and simulation
- Occupant behavior in buildings
- Research on indoor environment (thermal comfort, IAQ, lighting, acoustics, etc.)
- Optimization: control, design
- BIM and BEM
- Uncertainty and sensitivity
- Machine learning and data-driven models

The early registration deadline has now passed, but registration is open until 9 November 2016 at **www.conftool.com/asim2016**.

For more information, please visit **www.ibpsa.kr/asim2016**. ■

07-09 December 2016
Adelaide, Australia
www.architecture.adelaide.edu.au/asa2016

ASA: International Conference of the Architectural Science Association

Fifty years later: Revisiting the role of architectural science in design and practice

The School of Architecture and Built Environment at The University of Adelaide is proud to host the International Conference of the Architectural Science Association (ANZAScA) on 07-09 December 2016, in Adelaide, South Australia — one of the top 5 most liveable cities in the world in the Economist Intelligence Unit's 2015 ranking. The 2016 ASA Conference will mark a very important achievement as it will be the 50th conference of the Association. It was in Adelaide that the first meeting took place in 1963.

The Conference invites architectural science and design researchers, educators, students and practitioners to present and exchange ideas that will contribute to the betterment of our environment. All papers are double blind refereed. Papers are

expected to address the following challenges and opportunities arising from contemporary issues such as:

- What are the contemporary issues that architectural science researchers and educators should focus on?
- What are the real impacts of applying the knowledge explored in architectural science as implemented in various design advice, building codes and standards, on the quality of our built environment?
- How should architectural science researchers and educators respond to increased urbanisation, higher density living, and increased awareness of sustainable living?

These issues will be explored in a number of specific themes or topics, such as:

- Theory, philosophy and methodology in architectural science
- Architectural science and society
- Architectural science and urban design / landscape architecture
- Architectural science and building design
- Architectural science and historic preservation
- Architectural science and design education
- Architectural science and digital design
- Architectural science and design assessments
- Architectural science and modes of production
- Architectural science and space quality (thermal, visual, aural)
- Architectural science, construction and technology
- Architectural science, practice and industry

For more information about the conference, including key dates, program, venue and accommodation please visit **www.architecture.adelaide.edu.au/asa2016**. ■

08-10 February 2017
Bolzano, Italy
http://bsa.events.unibz.it

BSA 2017: 3rd IBPSA-Italy Building Simulation Applications Conference

IBPSA-Italy and the Free University of Bozen-Bolzano, with the endorsement of ASHRAE, are pleased to announce BSA 2017, IBPSA-Italy's 3rd Building Simulation Applications Conference, which will take place in Bozen-Bolzano, in Italy's picturesque South Tyrol region, on 8-10 February 2017.

The conference is aimed at:

- Public and private researchers in the general sector of building simulation and energy modelling
- Public agencies, public utilities and policy makers
- Private firms: Manufacturers, management companies, utilities, software houses
- Professionals: building designers (architects, engineers, etc.)

The official language is English, and international attendance is warmly welcomed.

Topics are expected to include:

- Building physics: envelope and system components:
  - Heat and mass transfer modeling in buildings
  - Building envelope systems and facades, and innovative building materials
  - Air flow, natural ventilation and mixed mode cooling
  - HVAC components and systems
  - Building control systems
- Integrated performance:
  - Building acoustics
  - Lighting and daylighting
  - Indoor environmental modeling: visual and thermal comfort, indoor air quality
  - Net-zero energy building
  - Retrofit/refurbishment of existing buildings
  - Renewable energy technologies for buildings, district heating and CHP generation
- Methodologies, regulation, calculation and simulation tools:
  - Model validation, sensitivity analysis and optimization techniques
  - Building codes and regulations, simplified methods versus detailed simulation
  - New simulation tools and improvements in existing simulation tools

- Integration, interoperability, web-based techniques, software development, open source initiatives
- Advances in teaching and education, eLearning

There will be a particular focus on modeling buildings' micro-climatic and physical context, including aspects such as weather data, radiation models, and the urban context of buildings and how these elements need to be represented in simulation models of individual buildings (not on simulation at an urban or regional scale). The intent is to produce a special issue in the Journal of Building Performance Simulation (JBPS), and selected papers will be invited to undergo a full review by the journal, after being expanded and developed.

The deadline for submission of abstracts has passed; full papers based on accepted abstracts will be due on 31 December 2016, and final acceptance will be notified by 08 January 2017.

The preliminary programme includes workshops for PhD and graduate students on the first day, Wednesday 08 February, with a city tour in the afternoon and a welcome reception in the evening; parallel technical sessions all day on 09 February, with a student session competition in the afternoon and a social dinner in the evening; parallel technical sessions in the morning on 10 February, followed by the award ceremony, a closing luncheon, and an open round table with practitioners and companies; and a social event featuring winter in the South Tyrol on Saturday 11 February.

For further information, visit the events page on IBPSA-Italy's web site, **www.ibpsa-italy.org/en/eventi-3/convegni/157-bsa-2017-en.html**, and the conference web site at **http://bsa.events.unibz.it**. ■

05-06 April 2017
Loughborough, UK
www.cibse.org/symposium

CIBSE-ASHRAE Technical Symposium 2017

Delivering Resilient High Performance Buildings

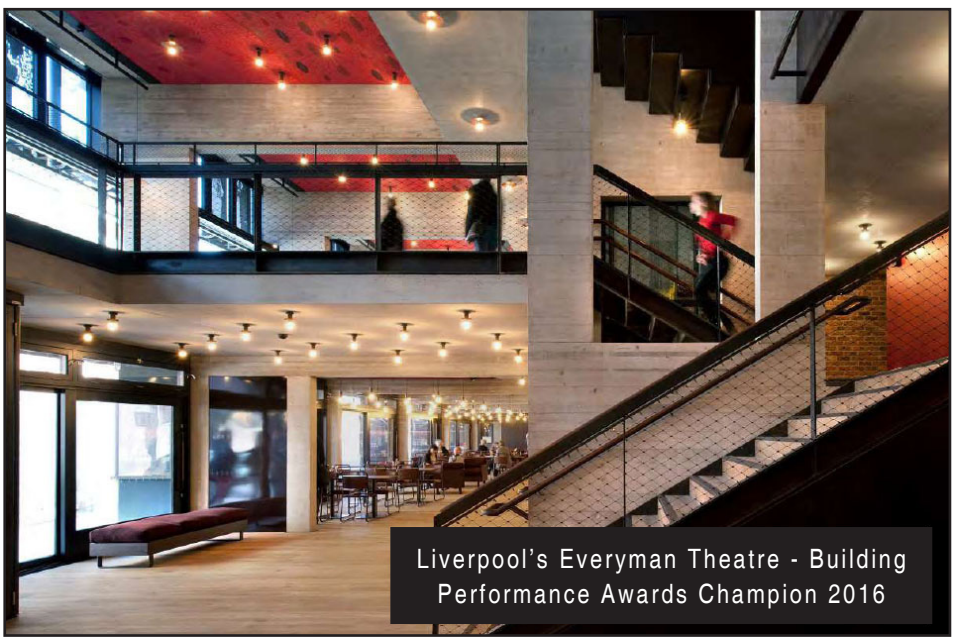
The theme of the CIBSE-ASHRAE 2017 Technical Symposium, *Delivering Resilient High Performance Buildings*, is inspired by this year's ASHRAE and CIBSE presidential themes, respectively *Adapt Today to Shape Tomorrow* and *Improving Performance*. The aim of the symposium is to provide evidence of the successful adoption of resilience in the design and operation of buildings.

The seventh annual Technical Symposium looks to encourage the participation of both young and experienced industry practitioners, researchers and building users to share experiences and develop networks. It is not just for academics: it is aimed equally at practicing designers, contractors, consultants, commissioning engineers, controls engineers, building operators and building maintainers, and it is expected that there will be informal presentations of case studies from practitioners, with slides and brief keynotes, as well as formally reviewed papers.

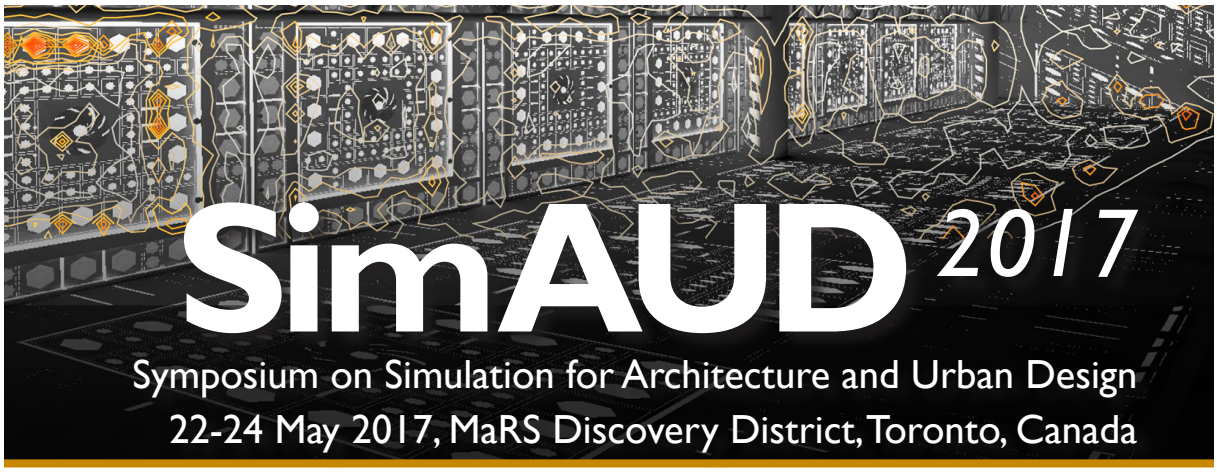
Topics are expected to include:

- Establishing the essential engineering requirements for a 'resilient' built environment
- Global responsibilities and connections for resilient living
- Development of intrinsically 'low carbon' built environments with minimal environmental impact
- Adapting design and operation to meet the changing role of buildings
- The future role and responsibility of engineered indoor environments
- Developing system solutions to meet future fuel scenarios
- Maintaining and improving occupant health and wellbeing
- Measuring and assuring whole life building performance
- Affordability and life cycle cost of future built systems
- Payback of innovative engineering solutions
- Assuring building resilience through benchmarks, standards and regulations
- Educating tomorrow's professions and users for resilient buildings
- Labelling and certification to establish and maintain sustainable buildings
- Determining the true 'building bottom line'
- The reality and future of integrating 'services' and 'architecture'
- Eroding and eradicating the design performance gap
- Development and application of knowledge based tools
- Tools to deliver integrated design, construction, commissioning, operation and maintenance.

For more information, visit the conference website, **www.cibse.org/symposium**. ■



Liverpool's Everyman Theatre - Building Performance Awards Champion 2016



Symposium Chairs
Michela Turrin and Brady Peters
M.Turrin@tudelft.nl and Brady.Peters@daniels.utoronto.ca

Scientific Chairs
William O'Brien, Rudi Stouffs, Timur Dogan

To respond to the increasing complexity of cities and buildings, computer simulations for the built environment are not only required to support both specific disciplinary expertise and interdisciplinary collaborations, but also address all scales of the built environment, from exploring new urban configurations to the design of building components. Consequently, innovation in computer simulations questions disciplinary boundaries and derives from the convergence of knowledge from different fields. The 8th annual **Symposium on Simulation for Architecture and Urban Design (SimAUD)** tackles the interdisciplinary aspects of the development and use of simulations to measure, predict, assess, comprehend and manage the performances of buildings and cities, in regard to their technical and non-technical requirements. SimAUD offers the opportunity to present innovative simulation methods and techniques and to discuss their roles in urban planning, architecture, engineering, construction, and management. This year event will be held at the *MaRS Discovery District* and at the *University of Toronto* in Canada, in the heart of one of the largest urban innovation hubs.

In past years, attendees have included researchers and practitioners in the fields of urban planning and design, architecture and building science, visualization and construction, as well as software developers, managers, educators, and business professionals. We highly encourage you to take advantage of the free downloads of previous years' *proceedings*. We invite you to submit and present an original contribution for SimAUD2017. All submissions are peer-reviewed and considered for selection by the Scientific Committee. All accepted full papers will be published in the ACM Digital Library. All accepted submissions (full and short papers) will be published in SimAUD's proceedings. Please observe submission types and deadlines on the *Symposium website*. SimAUD is run collaboratively with *ACM/SIGSIM* and is sponsored by *The Society for Modeling and Simulation International*.

Areas of Interest

- Simulation-based Design Generation and Exploration
- Simulation-Based Collaborative Design
- Simulation-Based Design Tools and Methods
- Multidisciplinary Design Optimization
- Simulation Performance and Scalability
- Building Comfort and Energy Performance
- Simulation of Occupant Behavior
- Simulation of Building Control
- Physics-Based Simulation in Design
- Visualization of Simulation Data
- Urban-Scale Modeling
- Design Agency &Multi-Agent Systems
- Intelligent Buildings& Building Lifecycle Management
- Sensor Networks &Building Performance Monitoring
- Interactive Environments
- Responsive Facades
- Robotic Fabrication in Design

Submissions Types

- Full Papers (Archived at the ACM Digital Library)
- Short Papers(Not archived at the ACM Digital Library)
- Invited Papers(Archived at the ACM Digital Library)
- Posters & Videos (Not archived at the ACM Digital Library)

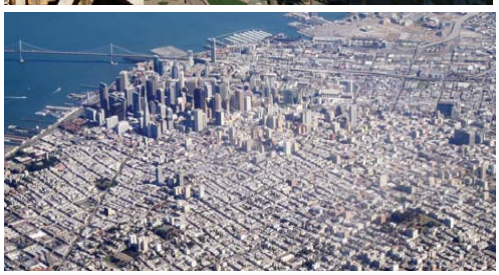
Note: All submissions published in SimAUD's Proceedings.

Important Dates

Abstracts Submission (optional):	September 19, 2016
Papers/Posters Deadline:	December 5, 2016
Acceptance Notification:	January 23, 2017
Camera-ready Deadline:	March 6, 2017
Conference:	May 22-24, 2017

Building Simulation 2017 will bring together practitioners and researchers from around the world to share information about simulation tools and applications and to discuss new developments. The conference will feature updates on new research to improve simulation capabilities for advanced low-energy building systems, case studies from successful projects that demonstrate the key role that simulation plays, and ongoing efforts to enable compliance and building rating software to support energy efficient systems

www.buildingsimulation2017.org



The Program

Presentations on research and advanced practice

- Keynote speakers linking simulation to policy and design
- Debates and panel discussions
- Software demos and exhibition
- Design team group presentations
- Tours of state-of-the-art buildings and research facilities
- Simulation competitions
- Software training

Peer-reviewed papers due November 30

Non-paper presentations: see web site

Conference Hotel *Hyatt Regency Embarcadero*

- Central San Francisco waterfront location
- Walk to shops, restaurants, and attractions
- Easy public transportation from airport

Potential Tours

- Lawrence Berkeley National Laboratory: FLEXLAB
- Silicon Valley: NASA Ames Sustainability Base / Stanford
- Autodesk: Located in downtown San Francisco
- Alcatraz, Napa Valley, Monterey, Yosemite

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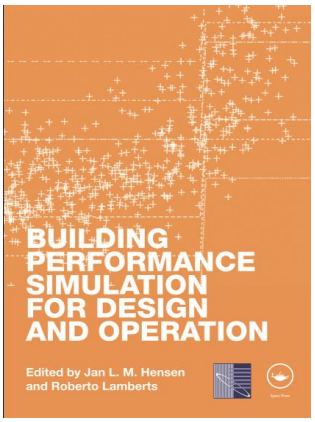
Building Performance Simulation for Design and Operation



Jan L.M. Hensen and **Roberto Lamberts**

Effective building performance simulation can reduce the environmental impact of the built environment, improve indoor quality and productivity, and facilitate future innovation and technological progress in construction. It draws on many disciplines, including physics, mathematics, material science, biophysics and human behavioural, environmental and computational sciences. The discipline itself is continuously evolving and maturing, and improvements in model robustness and fidelity are constantly being made. This has sparked a new agenda focusing on the effectiveness of simulation in building life-cycle processes.

Building Performance Simulation for Design and Operation begins with an introduction to the concepts of performance indicators and targets, followed by a discussion on the role of building simulation in performance-based building design and operation. This sets the ground for in-depth discussion of performance prediction for energy demand, indoor environmental quality (including thermal, visual, indoor air quality and moisture phenomena), HVAC and renewable system performance, urban level modelling, building operational optimization and automation.

Produced in cooperation with the International Building Performance Simulation Association (IBPSA), and featuring contributions from fourteen internationally recognised experts in this field, this book provides a unique and comprehensive overview of building performance simulation for the complete building life-cycle from conception to demolition. It is primarily intended for advanced students in building services engineering, and in architectural, environmental or mechanical engineering; and will be useful for building and systems designers and operators.

Selected Table of Contents

1. The Role of Simulation in Performance Based Building 2. Weather Data for Building Performance Simulation 3. People in Building Performance Simulation 4. Thermal Load and Energy Performance Prediction 5. Ventilation Performance Prediction 6. Indoor Thermal Quality Performance Prediction 7. Room Acoustics Performance Prediction 8. Daylight Performance Predictions 9. Moisture Phenomena in Whole Building Performance Prediction 10. HVAC Systems Performance Prediction 11. Micro-cogeneration System Performance Prediction 12. Building Simulation for Practical Operational Optimization 13. Building Simulation in Building Automation Systems 14. Integrated Resource Flow Modelling of the Urban Built Environment 15. Building Simulation for Policy Support 16. A View on Future Building System Modelling and Simulation

January 2011 |536pp | Hb: 978-0-415-47414-6 | £65.00

About the Authors

Jan L. M. Hensen *(Ph.D. & M.S., Eindhoven University of Technology) has his background in building physics and mechanical engineering. His professional interest is performance-based design in the interdisciplinary area of building physics, indoor environment and building systems. His teaching and research focuses on the development and application of computational building performance modelling and simulation for high performance.*

Roberto Lamberts *is a Professor in Construction at the Department of Civil Engineering of the Federal University of Santa Catarina, Brazil. He is also currently a board member of the IBPSA, Vice-President of the Brazilian Session and Counsellor of the Brazilian Council for Sustainable Buildings.*

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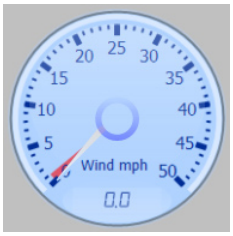


Climate.OneBuilding.Org update: new weather data sets for Turkey and Argentina now available

Dru Crawley and Linda Lawrie

Climate.OneBuilding.Org, a web resource with free weather data in EPW format at **http://climate.onebuilding.org**, continues to grow its impressive range of data. The following new weather data sets for Turkey and Argentina are now available:

- **TurTMY 81 locations**
  Turkey Climate Data Set Prepared by Dr.Saban PUSAT; in some stations relative humidity was not previously available. For these, a monthly mean relative humidity data table has now been added. Saban Pusat, Ýsmail Ekmekçi, Mustafa Tahir Akkoyunlu, Generation of typical meteorological year for different climates of Turkey, Renewable Energy, Volume 75, March 2015, Pages 144-151, ISSN 0960-1481, http://dx.doi.org/10.1016/j.renene.2014.09.039.
- **ArgTMY 15 locations**
  Generation of typical meteorological years for Argentine Littoral Region, Facundo Bre and Victor Fachinotti, Energy and Buildings, Volume 129, 1 October 2016, Pages 432–444, Argentine Data Set - Bre/Fachinotti - CIMEC/CONICET - Basic data measured by CIM/SMN (1994-2014).

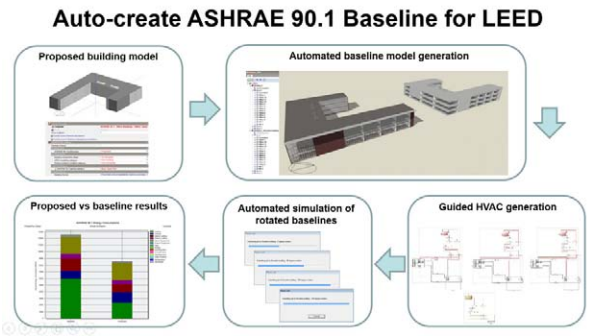
Amongst many others, Climate.OneBuilding.Org's features include:

- Annual and **monthly** design conditions from Chapter 14, *2013 ASHRAE Handbook-Fundamentals*
- Annual **design conditions calculated from source weather data** in absence of ASHRAE design conditions.
- **Hourly precipitation** in a separate file for direct use in simulations (where source data includes precipitation)
- **DAYSIM/Radiance wea format files** included in zip files for weather.
- **EPW data and extended statistics, DAYSIM/Radiance wea format files, and ESP-r ascii format files (clm) included in location zip files.**
- **Extensive quality checking** to identify and correct data errors and out of normal range values where appropriate. All changes - alternate design condition locations and corrections to data - are documented on the web site for each data set.
- Frequent updates as new weather data sets and design conditions are released. ■

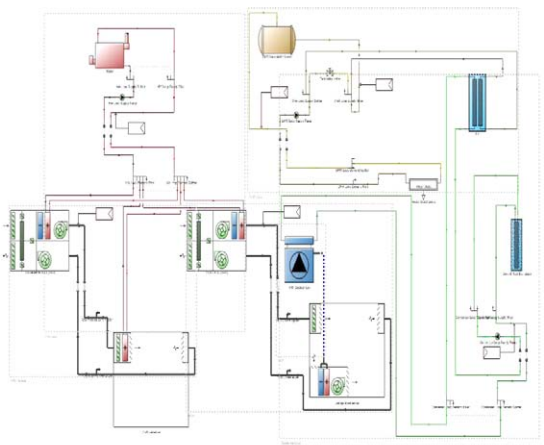
DesignBuilder update

DesignBuilder provides a suite of fully-integrated advanced modelling tools in a GUI to open-source simulation engines, including EnergyPlus and Radiance, focused on modelling productivity. It significantly simplifies and speeds up the modelling process, and provides users with the flexibility to create an early-stage model then quickly and easily develop that model as the design matures. DesignBuilder have announced a number of new features and improvements in their recent release:

- The fully-automated ASHRAE 90.1 Appendix G PRM baseline building generation tool - perhaps the most mportant enhancement in the new release. The baseline building can be easily auto-created from the proposed building, and the simulation of the four baseline orientations is also automated to generate comparative results. The flexibility of the modeller means the proposed building is easily changed as the project evolves, and the updated baseline building can be quickly re-generated.



- Powerful new HVAC additions, most notably the EnergyPlus fluid-to-fluid heat exchanger component. The heat exchanger adds significant flexibility, enabling energy to be transferred between loops and systems. The DesignBuilder screenshot shows one example, with the heat exchanger being used to recover excess heat from a VRF condenser to pre-heat domestic/service hot water.



- The EnergyPlus Energy Management System (EMS), adding a whole new modelling dimension with the ability to customise simulations. The EMS allows the functionality of many control objects to be tailored. The possibilities are almost infinite, but examples include overriding the default control linkage between an economiser and heat recovery or providing more precise control over simulated behaviour for systems, such as enabling the user to link earth tubes to HVAC air inlets.

  DesignBuilder makes using the EMS much simpler and includes some important extensions to the standard EnergyPlus EMS and Erl system allowing EMS programs to be reused and shared. DesignBuilder also provides easy-to-use dialogs to load fully-formed actuator, sensor, and variable output statements, and to read building, zone or surface settings from the model to populate data within the script.

The full list of new features and improvements is too large to list here. There will be a

webinar highlighting the latest DesignBuilder developments in early November, but full details of these and many more new features and improvements are available now at **www.designbuilder.co.uk**.

Finally, congratulations go to Team DeeBees, who won the "Best Energy Performance" prize in the recent ASHRAE energy modelling competition. The team used DesignBuilder to create their low-energy design with a focus on health and wellbeing. ■

A Data and Computing Platform for City and District Scale Building Energy Efficiency

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Lawrence Berkeley National Laboratory
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ABSTRACT

Buildings in cities consume 30 to 70% of the cities' total primary energy. Retrofitting the existing building stock to improve energy efficiency and reduce energy use is a key strategy for cities to reduce greenhouse gas emissions and mitigate climate change. Planning and evaluating retrofit strategies for buildings requires a deep understanding of the physical characteristics, operating patterns, and energy use of the building stock. This is a challenge for city managers as data and tools are limited and disparate. This paper introduces a web-based data and computing platform, City Building Energy Saver (CityBES), which focuses on energy modeling and analysis of a city's building stock to support district or city-scale efficiency programs. CityBES uses an international open data standard, CityGML, to represent and exchange 3D city models. CityBES employs EnergyPlus to simulate building energy use and savings from energy efficient retrofits. CityBES provides a suite of features for urban planners, city energy managers, building owners, utilities, energy consultants and researchers.

1 INTRODUCTION

Urbanization is one of the great challenges of this century, with linkages to climate change and the need to develop sustainable use of energy and other natural resources. Urban energy models aim to explore opportunities to address these issues by combining the data generated in cities with new energy simulation tools. Urban computational tools combine urban sensing, data management, and data analytics, to evaluate city-scale energy and environmental systems. Urban computing is an interdisciplinary field where computer science meets city-related fields, like transportation, civil engineering, energy supply and demand analysis, environmental science, economics, ecology, and sociology in the context of urban spaces [1].

With buildings responsible for about one-third of global energy consumption and a quarter of CO2 emissions, there is a huge, untapped opportunity to create and transform cities to more sustainable environments through improving building energy efficiency [2]. More efficient buildings can generate economic benefits, reduce environmental impacts and improve people's quality of life. More than two-thirds of people in the U.S. live in urban areas. These areas face growing challenges to accelerate building retrofit activities and expand operational efficiency to reduce energy use and greenhouse gas emissions and to meet sustainability goals. Urban energy analysis is a complex, multi-scale, multi-sector challenge. Cities need to be able to evaluate their current energy use and explore how to compare, rank, contrast, and estimate strategies to reduce energy use and environmental impacts. Cities need to evaluate building retrofit opportunities for their local stock considering energy usage, vintage, size, type, ownership, and socioeconomic capabilities of each neighborhood. Advanced shared energy infrastructure, such as district heating and cooling systems, can provide huge

increases in energy efficiency by combining diverse loads where the integrated energy consumption of a group of buildings can be less than the simple sum of individual buildings.

Cities need quantitative decision analysis tools that combine measured data, physics- and data-driven models to support both new and retrofits building systems. Designing and operating such systems requires dynamic computer simulation and optimization to account for the complexities of energy systems, such as different types of building systems, operating patterns, uncertainty and variability of weather, user behavior. Recent efforts to develop these tools have integrated these computation models with geographical information system (GIS) to obtain input data for hundreds to thousands of buildings, and to visualize results in a form that is accessible to urban planners and designers.

Several urban energy simulation tools have been developed [3], [4], including the Urban Building Energy Models (UBEM) [4], [5], CitySim [6] and the Urban Modeling Interface (UMI) [7]. UBEM estimates citywide hourly energy demand from energy simulations of individual buildings in a city, supporting city policy makers to evaluate strategies on urban building energy efficiency. UMI is a Rhino-based design environment for architects and urban planners interested in modeling the environmental performance of neighborhoods and cities with respect to operational and embodied energy use, walkability and daylighting potential. UMI creates EnergyPlus models using simplified zoning and HVAC systems. Rhino is a commercial 3D computer graphics and computer-aided design (CAD) application software. CitySim provides decision support for urban planners to minimize energy and emissions by simulating the energy demand of buildings. CitySim uses its own XML schema to represent building information and a reduced order energy models assuming simplified zoning and HVAC systems. However, these tools are isolated, limited to specific applications, and not using open standards, which are key to share and exchange information across a wide array of urban modeling tools.

This paper introduces City Building Energy Saver (CityBES), describing the data structures, workflow automation, integration with existing urban data models, energy models, and calibration techniques. As an energy modeling and analysis urban computing platform, CityBES can provide insights to inform city stakeholders on the opportunities for new energy technologies and retrofit policies. For example, CityBES can help identify the technologies and strategies need to retrofit city buildings to save 30% to 50% of total energy. CityBES can also be used to evaluate the impact of climate change (long term warming and extreme heat waves) on building performance and occupant health, and strategies to mitigate such impact. The tool can be used to evaluate the impact of urban heat islands on building performance and strategies to mitigate such effects. One can also evaluate the feasibility of new advanced district heating and cooling (DHC) systems that target 50% energy savings through EnergyPlus' co-simulation with DHC models in Modelica. CityBES will in future be able to evaluate the potential of on-site renewable energy generation (PV or solar thermal) in buildings.

The paper discusses open 3D city data models, and describes the CityBES software architecture, modeling and analysis capabilities. Potential use cases, challenges and the future development of CityBES are discussed as well.

2 Open 3D Data Model for Cities

CityGML [8] emerges as an international open standard of the Open Geospatial Consortium (OGC) to represent and exchange 3D city models. CityGML is an XML-based open data model providing an application schema for the Geography Markup Language (GML), which provides a standardized geometry model. CityGML includes modules to represent bridges, buildings, city furniture, land use, transportation, tunnels, vegetation, water bodies, etc. **Figure 1** (next page) shows some examples of CityGML objects. The CityGML provides virtual 3D city models for advanced analysis and visualization in a variety of application domains such as urban planning,

indoor/outdoor pedestrian navigation, environmental simulations, cultural heritage, or facility management [9]. The CityGML version 1.0 was released in 2008, and an extended version 2.0 was adopted in March 2012.

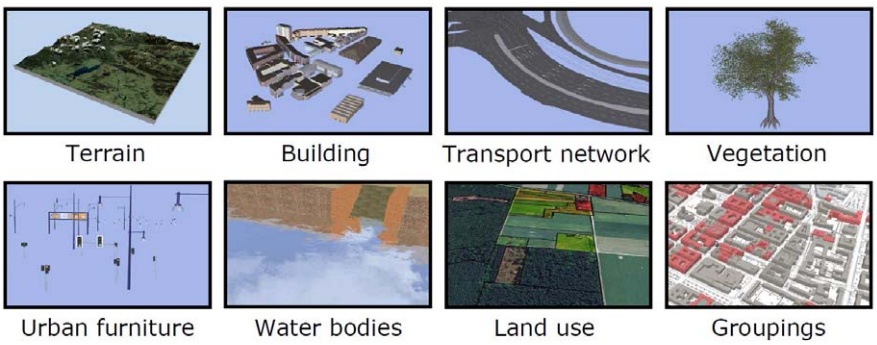

Figure 1: Examples of CityGML objects (source [10])

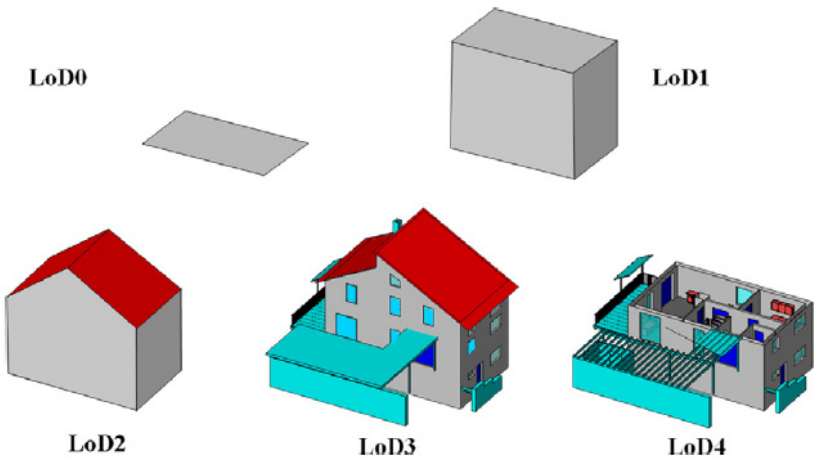

Figure 2: Five levels of details (LODs) to represent buildings in CityGML

CityGML provides a common definition of the basic entities, attributes, and relations of a 3D city model, allowing the reuse of the data in different applications. City officers are often required to provide city data in different formats for different applications, which is unnecessary redundant work. To make the city data reusable, more and more cities are creating their 3D city models using CityGML by consolidating the data from different sources. For example, Berlin 3D Portal provides CityGML data in LOD 2 for their entire 550,000 buildings in Berlin [11].

CityGML is mapped to a database as the data structure of CityBES, which is used for data management. CityGML (**Figure 2**) has five levels of details (LOD) to represent the city, landscape and infrastructure for building energy modeling and urban micro-climate simulations. CityGML allows user-defined objects and attributes to extend the data model for domain specific data elements. The Energy Application Domain Extension (ADE), which is under development, is used in CityBES to represent and exchange other essential data needed for building energy models, e.g., constructions and materials, operation schedules, and energy systems for lighting, plug-loads, and heating, ventilation, and air conditioning (HVAC).

3. CityBES

3.1 CityBES Overview

CityBES is a web-based platform to simulate energy performance of a city's building stock, from a small group of buildings in an urban district to all buildings in a city. CityBES builds upon the LBNL Commercial Building Energy Saver Toolkit [12], which provides retrofit analysis of individual commercial buildings of small and medium offices and retails. CityBES will add other commercial buildings types (e.g., large offices, hotels, hospitals) as well as residential buildings (single family and multi-family). In addition, district heating and cooling systems will be added as retrofit options. CityBES also adds new Energy Conservation Measures (ECMs) for new commercial and residential building types. To handle simulation of many buildings simultaneously, CityBES implements a parallel computing architecture to utilize high-performance computing (HPC) clusters.

CityBES uses CityGML as the data schema to represent the urban building stock. It provides 3D visualization as displayed in **Figure 3**, which shows color coded simulated energy performance of buildings in New York City.

CityBES is a handy and comprehensive tool to help city managers and stakeholders evaluate options to reduce energy use by quantifying and prioritizing building retrofit solutions at a large scale. The tool is capable of modeling 10,000 or more buildings and identifying deep energy savings of 30% to 50%. This concept is intended to exceed the capabilities of the current practice of evaluating retrofits of single buildings one at a time and with limited energy savings of 10% to 20%. CityBES also enables evaluation of interactions (such as simultaneous heating and cooling or opportunities for energy storage) between buildings in district-scale energy systems.

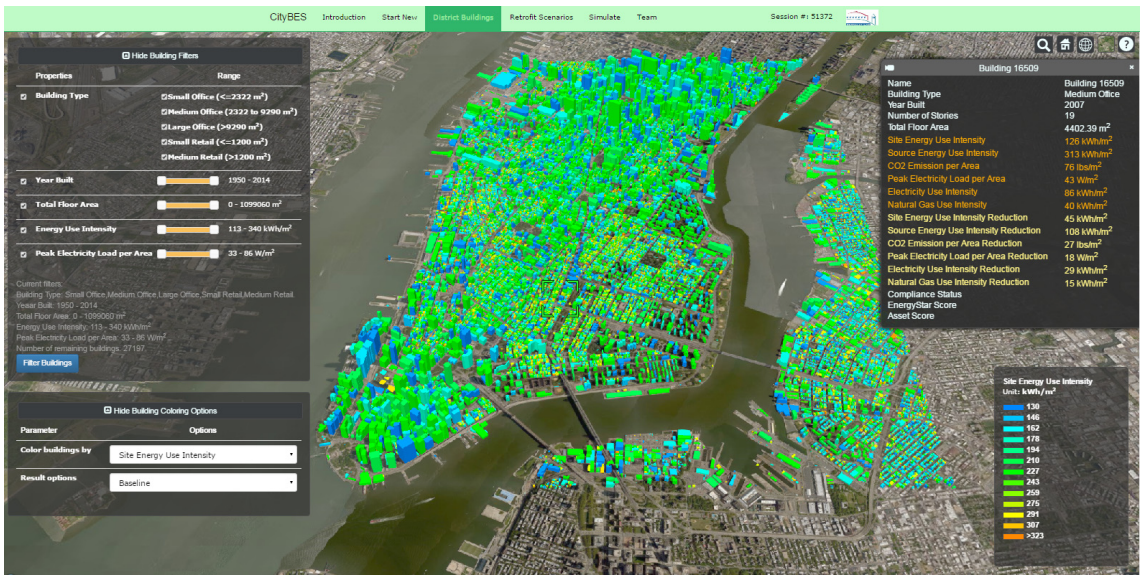

Figure 3: CityBES: Buildings in Manhattan New York (for illustrative only, using mockup building data)

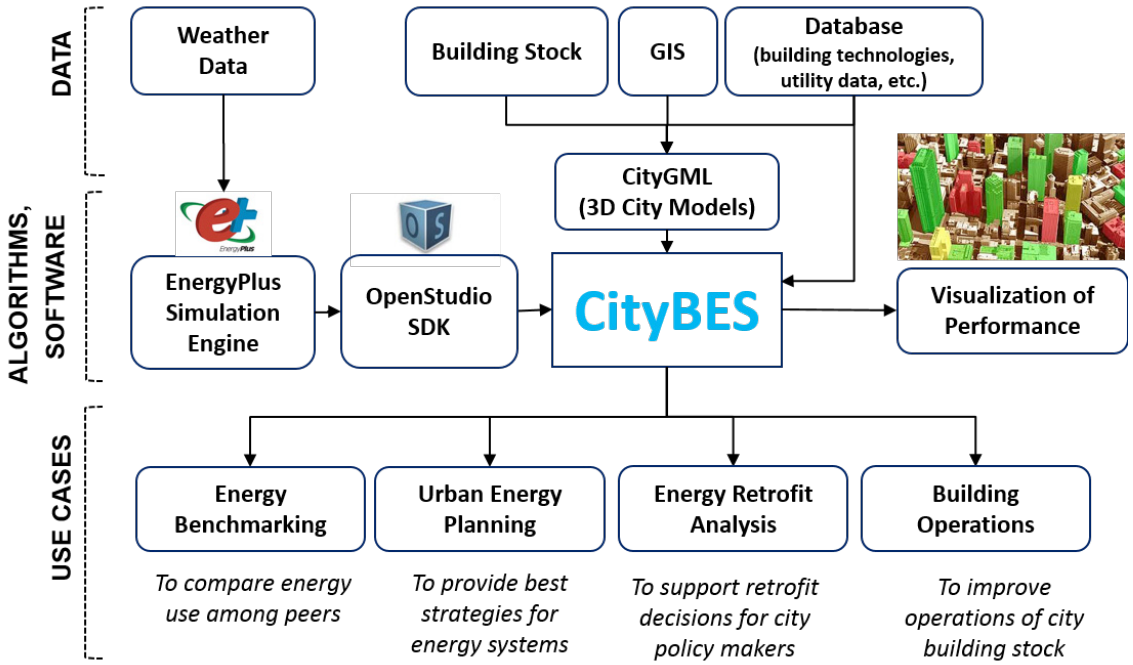

Figure 4: Software Architecture of CityBES

3.2 Software Architecture

Figure 4 shows the three layers of the software architecture of CityBES: the Data layer, the Algorithms and Software layer, and the Use Cases layer. The Data layer includes the weather data, and the 3D city model represented in CityGML compiled from building stock, GIS and other database. The Software layer includes EnergyPlus, OpenStudio [13] and CityBES. The Use Cases layer provides examples of potential applications, including energy benchmarking, urban energy planning, energy retrofit analysis, building operation improvement, as well as performance visualization.

3.3 Energy Modeling Approach

CityBES enables energy modeling through the OpenStudio software development kit (SDK) and the EnergyPlus simulation engine. EnergyPlus is the U.S. Department of Energy (DOE)'s flagship simulation program for modeling dynamic energy and environmental performance of buildings. It conducts detailed heat and mass balance calculations for each room in a building, and can estimate sub-hourly (from 1 to 60 minutes) energy use of building systems, including lighting, plug-loads, process-loads (e.g., elevators), HVAC and service water heating. EnergyPlus has been widely used by engineers, architects, and researchers to support the design of new buildings and the retrofit of existing buildings to increase efficiency and reduce energy use and carbon emissions. EnergyPlus is also used to support building energy codes and standards development, as well as support utility incentive programs and state and federal energy policies.

OpenStudio is an SDK for interfacing with EnergyPlus input and output files as well as managing simulations. The OpenStudio SDK provides an object-oriented interface to the building energy model. The OpenStudio SDK can be used to rapidly create full building energy models based on limited available data; it can also be used to alter existing building energy models.

3.4 Datasets and Integration

CityBES leverages existing data from several different sources that are compiled into a central database. The database includes a CityGML file representing 3D city model that provides the majority of the data for building energy model. Other essential data in the database are weather, building characteristics, and ECMs. CityBES uses typical meteorological year weather data in EnergyPlus simulations [14], and allows user-defined weather data measured at local stations. Building characteristic data will be extracted from various city data sources, including assessors' records, GIS data, public building energy use disclosure, and energy benchmarking ordinance. CityBES also has prototype buildings that meet minimal requirements of ASHRAE 90.1 [15] and California Title 24 [16] standards at various vintages, providing default efficiency levels for buildings built at various vintages and climates. For retrofit analysis, economic data such as energy costs, investment costs, discount rate and payback years are used.

CityBES integrates more than 75 ECMs from various sources, including the Database for Energy Efficiency Resources (DEER) [17], the Advanced Energy Retrofit Guide for offices and retails [18]–[20], and RSMeans (rsmeans.com). The ECM database includes detailed descriptions of the technical specifications, modeling methods and investment costs for each ECM. In general, typical and emerging building technologies of the building envelope, HVAC, indoor lighting, plug-loads, service water heating, outdoor lighting, and building operation and maintenance were specified. The measures and modeling of those building systems are systematically applied to the CityBES framework through EnergyPlus simulation for the city building stock retrofit analysis. Table 1 shows a sample list of ECMs that can be applied during energy retrofit analysis.

CityBES provides a rich dataset as the result of the urban scale energy simulation. CityBES generates the energy consumption of the current building stock as a baseline of the city's building energy performance. Annual, monthly, and hourly energy usage data are available to characterize current energy use. Energy end uses data are available to help identify energy saving potentials for different building systems. Taking the energy usage data as the baseline, CityBES offers a wide array of analysis suited for city's energy efficiency program, including energy benchmarking, energy savings, greenhouse gas reductions, operation improvements, and energy costs reductions.

Table 1: Energy Conservation Measures (A Sample List) Used in CityBES

Category	Component	Name	Description
Lighting	Interior Lighting Equipment Retrofit	Replace existing lighting with LED upgrade (6.5 W/m2)	Replace existing lighting to LEDs with 6.5 W/m2. LEDs consume less power and last longer than fluorescent lamps. A retrofit kit is recommended for converting ballasts. Replacement may improve lighting quality.
Plug Loads	Equipment Control	Use Plug Load Controller (30% efficient from Baseline)	Connect plug loads to a smart plug strip with some or all of the following functions: Occupancy sensing, load sensing, timers, remote control.
Envelope - Exterior Wall	Exterior Wall	Apply Wall Insulation (R21)	Apply blown-fiberglass insulation (R21) to wall cavity to maintain thermal comfort. Insulation provides resistance to heat flow, taking less energy to heat/cool the space.
Envelope - Roof	Roof	Reroof and Roof with Insulation	Demolish existing roof, install insulation (R24.83) and reroof to reduced unwanted heat gain/loss. This measure is most applicable to older roofs.
Envelope - Window	Window	Replace fixed-window to U-factor (0.25) and SHGC (0.18)	Replace existing window glass and frame with high-performance windows by changing U-factor and SHGC of window material.

Service Hot Water	Storage Tank	Efficiency Upgrade of the Gas Storage Water Heater	Replace existing service hot water heater with more efficient gas storage unit, better insulation, heat traps and more efficient burners to increase efficiency of (0.93).
HVAC - Cooling	Cooling System	Packaged Rooftop VAV Unit Efficiency Upgrade (SEER 14)	Replace RTU with higher-efficiency unit with reheat, SEER 14. Cooling only; include standard controls, and economizer.
HVAC - Economizer	Ventilation	Add Economizer	Install economizer for existing HVAC system (includes temperature sensors, damper motors, motor controls, and dampers).
Envelope - Infiltration	Infiltration	Add Air Sealing to Seal Leaks	Air sealing can reduce cold drafts and help improve thermal comfort in buildings. Air sealing is a weatherization strategy, which will change air exchange rate and IAQ.

4 CityBES MAIN FEATURES

CityBES implements a suite of analytics, modeling, simulation and visualization features to support its use for district and city-scale building energy efficiency analysis by urban planners, city energy managers, as well as energy consultants and researchers for city projects.

4.1 Filtering the building stock

Depending on the use case and analysis, the city building stock may need to be filtered to a subset of buildings by building type, year built, total floor area, energy use intensity (EUI), and peak electricity load per area. Figure 5 shows the design of the building stock filters, with an example to select sites built between 1950 to 1980, medium and large office buildings, with higher energy use intensities.

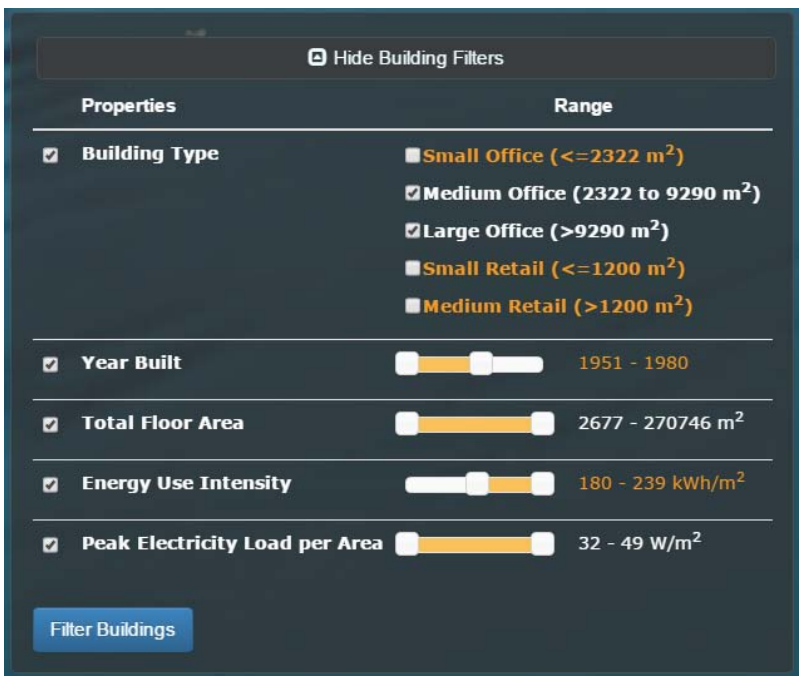

Figure 5: Building stock filters

4.2 Energy Benchmarking

The data needed for common energy use benchmarking include building characteristics (e.g. type/use, vintage, location and floor area), and 12 months of energy usage data. Following the data input, the Energy Star Portfolio Manager [21] and Building Performance Database (BPD) [22] application program interfaces (APIs) are provided to perform a benchmarking analysis.

The U.S. Environmental Protection Agency's Energy Star program developed an energy performance rating system, using a scale of 1 to 100, to provide a means for benchmarking the energy efficiency of an individual building to evaluate its energy performance. For assessing the Energy Star score, a minimum score of 75 is required for Energy Star certification [23]. CityBES obtains Energy Star scores for each selected buildings with monthly utility data through the Energy Star Portfolio Manager APIs; visualizes the scores by color-coding the 3D building shapes; and further filters the building stock by the score. For example, city managers may be interested to know buildings with Energy Star score lower than a certain value, say 50.

BPD, with more than 872,000 buildings (as of July 16, 2016), is the U.S. largest dataset of information about the energy-related characteristics of commercial and residential buildings. It combines, cleanses and anonymizes data collected by Federal, State and local governments, utilities, energy efficiency programs, building owners and private companies, and makes it available to the public. CityBES can compare the EUI distribution of the selected buildings with the peer buildings in BPD, to benchmark the building energy performance in the district scale.

4.3 Building Energy Use Data Analytics

CityBES provides operational improvement recommendations from the result of the smart meter interval data analysis using an algorithm developed by Mathieu et al. [24].

CityBES analyzes weekly 24-hour daily electric load to identify higher energy consumption during non-operating hours relative to normal operating hours. This trend may indicate that the HVAC system and other electrical equipment are operating despite occupant absence during the nighttime or weekends. CityBES shows the weekly 24-hour electric load profiles, which provide electricity use patterns during operating and non-operating hours. **Figure 6** shows an example of the analytic result: average weekly operating and non-operating hours, and their average electric load densities. CityBES also provides a sensitivity analysis of the whole building electricity use as a function of outdoor air temperature during four periods of the day (early morning, morning, afternoon, and night), which can infer energy use patterns, and building tightness and ventilation rates.

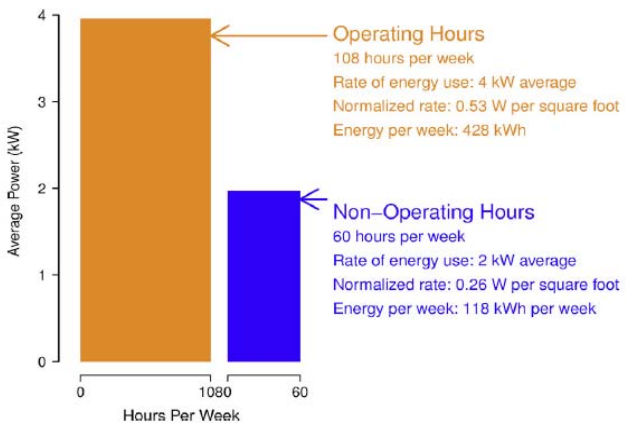

Figure 6: The weekly operating and non-operating hours, and their average power demand and energy use

4.4 Building Stock Energy Retrofit

Energy retrofit analysis is the primary use case provided by CityBES. First, building stock can be filtered based on criteria of interest (EUI, vintage, building types). Secondly, a suite of ECMs (individual and packages) can be selected from the database. Thirdly economic data such as energy costs and discount rate can be specified. CityBES runs a series of energy simulations to evaluate the selected ECMs and provides results such as energy savings, energy costs reduction, and simple payback. Retrofit measures cover most building systems and components (lighting, building envelope, equipment (i.e. plug loads), heating, ventilation, and air conditioning (HVAC), or service hot water systems) as well as operation and maintenance strategies. Some specific examples of ECMs include installing daylighting sensors for interior lighting control, replacing wall and ceiling, or roof insulation, upgrading an HVAC rooftop unit with a high-efficiency unit, adding an economizer, or upgrading to light-emitting diode (LED) lights. Hong et al. [25] identified a package of measures resulting in an estimated 20% improvement in the whole building electricity consumption. Li et al. [26] showed three most commonly installed energy-efficient technologies in high-performance buildings are daylighting, high-efficiency HVAC systems, and improved building envelope.

For a group of buildings, CityBES will also evaluate district heating and cooling (DHC) systems as a retrofit option. DHC systems have potential of reusing thermal energy between buildings (e.g., waste heat from data centers can be used to heat buildings nearby), and reducing the capacity of central plant equipment (chillers and boilers) by taking advantage of the diversity of loads of different buildings.

4.5 Automated Model Calibration

There are always concerns regarding potential discrepancies between the actual and simulated energy use in buildings. CityBES adopts an automated model calibration [27] using monthly utility data to fine tune the baseline model before retrofit analysis to estimate energy savings of ECMs.

The automated model calibration uses logic linking parameter tuning with bias pattern recognition to overcome some of the disadvantages associated with traditional calibration processes. The pattern-based process contains four key steps: (1) running the original pre-calibrated energy model to obtain monthly simulated electricity and gas use; (2) establishing a pattern bias, either universal or seasonal bias, by comparing load shape patterns of simulated and actual monthly energy use; (3) using programmed logic to select which parameter to tune first based on bias pattern, weather and input parameter interactions; and (4) automatically tuning the calibration parameters and checking the progress using pattern-fit criteria.

The pattern-based calibration approach is fully automatic without any need of manual intervention. The approach employs pre-defined rules, determined by characteristics of bias patterns, to adjust the model parameters. This method is different from the traditional optimization-based automatic calibration approach which searches a parameter space according to a specific optimization algorithm to minimize the difference between the simulated and measured energy use of the building [28].

4.6 Visualization

The CityBES main screen (Figure 4) shows a 3D view of the city building stock. Users can apply filters (in a floating window) to select a subset of the building stock. When a specific building is highlighted, a list of characteristics (building name, type, vintage, and total floor area) and its energy use and potential retrofit saving data are displayed in a floating window. CityBES can visualize a suite of performance metrics of buildings by color-coding the 3D view of the buildings.

Performance metrics that can be visualized include: site or primary energy use (absolute amount or per floor area), greenhouse gas emissions, whole building peak electric demand, Energy Star score, retrofit energy savings (absolute amount and percentage), weekly operating hours, energy use breakdown into end uses (lighting, plug-loads, cooling, heating, and process loads), and code and compliance status.

5. DISCUSSION

CityBES can serve as a data and computing urban platform to help city policymakers and their consultants to evaluate district and city-scale energy efficiency issues and opportunities in buildings. CityBES is targeted for analysis of city building stocks using CityGML which provides four levels of details to represent city buildings, and allows energy simulation with different fidelities of modeling options. The data model using CityGML can help exchange data between the building energy model and other urban environmental analysis models. The integration of city building stock data in CityBES will enable integration with other tools such as the U.S. Department of Energy's Building Energy Asset Score [29] and the Building Performance Database. In future, CityBES will also support other analysis such as urban energy planning and design, carbon emissions tracking system, and local laws and code compliance.

CityBES will be a valuable platform assisting users to answer important questions about technology deployment and policy such as:

1. Which types of buildings have the greatest potential for energy savings and cost-effective retrofits? This is part of a crucial effort of CityBES to show a city-wide building energy map with actual energy consumption, and estimate of energy potential savings from retrofit as well as operational improvements, for every building in the city.
2. Which energy efficiency technologies can help achieve the greatest energy savings?
3. Where in the city are there districts with the right mix of load density and diversity to support district energy systems, or local energy storage to reduce energy use?
4. How much energy savings can be expected if all buildings in a city use a specific retrofit, such as single pane to double pane windows, or fluorescent to LED lights?
5. If all buildings in a city upgrade to meet the current building energy code, how much energy savings and peak electricity demand reduction can be achieved?
6. What is the impact of climate change on energy use in the building stock and in occupant comfort in the next 30 or 50 years?
7. What is the impact of extreme heat waves on building energy demand and occupants' health?
8. If solar PV is installed on all available roof spaces of all buildings in a city, how much electricity can be generated? How does this meet the city's renewable energy goal? What is the cost of such a PV deployment plan?

To develop a city-scale platform like CityBES, there are five technical challenges. The first challenge is to collect data and create the 3D city models with CityGML which need to draw data sources from various public datasets in many city departments. The second challenge is to get the energy use data of the buildings which is usually subject to data privacy and security concerns. The third is to model all types of retrofit measures using EnergyPlus and the ECM database. Fourth, the computing power required to run tens of thousands or more building energy simulations for retrofit analysis on demand is a challenge. Last but not least, we need to enhance EnergyPlus to consider inter-building effect in the urban environment, e.g. radiant heat exchange between exterior surfaces of buildings, and integration with urban microclimate simulation to consider the urban heat island effect as well as local climate conditions. More features will be added in CityBES including urban energy planning to evaluate technologies and strategies (e.g. DHC systems and community scale renewable systems) to design and optimize net-zero energy or carbon neutral communities.

6. CONCLUSIONS AND FUTURE WORK

CityBES will be a publically available web-based data and computing platform providing a suite of analytic and modeling features to improve energy efficiency and reduce carbon emissions in city buildings. CityBES uses the international standard CityGML to represent the 3D building stock in cities, and uses EnergyPlus for detailed building energy simulation to evaluate energy savings potential of a wide array of building technologies. CityBES can visualize various performance metrics of buildings by color-coding the 3D view of buildings in cities. CityBES targets audience of urban planners, energy consultants, city and utility energy program managers, and urban systems researchers. Further research is needed to understand the usability of the tool and evaluate the availability of such data to populate the analysis. Further research is also needed to obtain feedback from city stakeholder groups to organize the data outputs to provide actionable information and salient feedback for urban energy planning.

ACKNOWLEDGMENTS

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In Pursuit of Building Energy Performance

Dharini S K., M.Tech Building Energy Performance program, CEPT University, India

1.0 SYNOPSIS

Reliable building energy simulation results require an understanding of inputs for envelope, lighting, HVAC systems and equipment and occupant operations along with a clarity for how they interact with each other and with the climate. Determining which default inputs to override requires years of experience or equivalent education specially designed for building performance. The Master of Technology in Building Energy Performance (M.Tech BEP) at Centre for Environmental Planning and Technology (CEPT) University is a graduate program that delivers just that.

1.1 Building Performance Simulation for Smarter Investments

Buildings with low energy use are a social and economic imperative for India and other tropical regions that are experiencing an economic growth coupled with a rising awareness of environmental concerns. Building codes, regulations, green building rating systems, and a demand by owners for buildings that are efficient and comfortable have created a need in the building industry for professionals who understand energy systems, propose and evaluate innovative solutions.

Building Performance Simulations is a growing area that improves the performance of buildings through simulations that assess the energy and comfort parameters to provide solutions for better performance. Building designers and owners debate about the necessity of simulations. "Why do we need to simulate a building when it is obvious that certain technologies or measures reduce energy consumption?" Simulations help assess the actual value of such technologies and measures, and help to put their value in the context of all possible measures with a broad comparative analsis. As we move towards more aggressive energy efficiency solutions, simulations provide a way to understand the interactions between measures and optimize investment in technologies. In other words, they help decide design alternatives that yield the best benefits.

Too often we see energy modelers who treat simulation inputs as abstract quantities. At CEPT we give students a robust exposure to the building systems, components and system interaction through physical measurement and experimentation. This makes the energy simulation, its inputs and its algorithms more real for the students

- Prasad Vaidya

Professor and Area Chair, Building Energy Performance, CEPT University

1.2 Master of Technology in Building Energy Performance at CEPT

CEPT University launched the M.Tech BEP as a two-year program in July 2015. The program focuses on tropical climate as the context to prepare professionals who will tackle challenges in economies that are expected to grow in the next two decades. Students learn state of the art tools to conduct simulation and assess building energy performance during building design and operation. The hands-on learning in the coursework is strengthened by a world-class research facility, at CARBSE (Centre for Advanced Research in Building Science and Energy). It houses an array of testing and metering equipment for measuring thermal and luminous effects in buildings. CEPT University has led the way

in India with internationally recognized research, practical experience in energy efficiency implementation, and net zero energy buildings (NZEB). The NZEB in CEPT acts as a living laboratory and was designed largely by the faculty of this programme.

2.0 CURRICULUM AND PEDAGOGICAL STYLE

During each of the first 3 semesters, the students take one 12-credit Lab course, and one 3-credit Seminar Course. Each Lab course is an immersion into a building system area of

1. Passive comfort
2. HVAC
3. Lighting and daylighting

The Lab courses use 3 types of modules for learning: ***Concepts and Practices*** learned through lectures, discussions and problem-solving; ***Measurement and Experimentation*** using real buildings, systems and tools; and ***Simulations*** for virtual experimentation. The students learn concepts, practices, conduct physical measurements and experimentation in the first half of each semester. Simulations are used in the second half of the semester after the students have gained a deep understanding of the concepts and have an exposure to the systems and quantities. Over the curriculum, students learn to use software like DesignBuilder, eQuest, Climate Consultant, Data Viewer, DiaLux, and Radiance

The seminar courses handle topics that help the students connect the dots and require less immersion. These include an understanding of the relationship between building energy use and the environment, methods and techniques for communicating building energy efficiency information, and integrating renewable energy technologies. In the fourth semester, students pursue a research or capstone project thesis.

Simulations for building performance have provided a new dimension for building design and energy analysis. It gives a better insight about the whole building performance. Simulations help every stakeholder to have a better understanding of the building and hence it is easier to develop strategies and make the correct choice to reduce overall energy consumption

Jaydeep Bhadra, Student, M.Tech BEP, CEPT University

Beyond the pedagogical approach of the three lab modules, the teaching methodology used also relies on proven *beyond classroom* techniques:

a. ***Readings*** are assigned to give students an idea of what they can expect in class, and to expose them to available resources. Class slides that are used by the instructors are shared with the students for their reference.
b. ***Assignments*** are often in groups that extend out of the problems introduced in class, requiring collaboration and planning of work, and help develop analytical and writing skills.
c. ***Presentation*** of the assignments prepares the students for a professional life full of discussions and debates. They also learn effective communication.

d. ***Comments*** are given on the assignment by the faculty so that the students can revise their submissions and resubmit with even better clarity of concepts and methodology.

3.0 COURSE CONTENT

3.1 Passive Comfort Lab

The lab combines concepts and practices, systems and strategies, simulation techniques, physical measurement and data comprehension. It includes the basics of building physics, thermal comfort, ventilation needs, climate response, and passive comfort strategies.

Figure 1 Students with their solar cookers- first semester mid –semester project

a. Concepts and Practices modules deal with:

- Understanding climate, conducting climate analysis, and sun-shading.
- Understanding energy, heat and mass transfer, psychometric processes and evaluating thermal comfort.
- Learning about building envelope components, materials, and construction details.
- Calculating heating and cooling loads and the impact of orientation, form, envelope components and ventilation needs.
- Understanding passive (cooling and heating) comfort design techniques including theory (thermal mass, shading, ventilation, radiation, evaporation, and earth contact); examples through case studies, site visits and literature; rules of thumb and manual calculations; architectural implications of passive design.
- Approaches to optimizing costs - construction costs and life cycle costs.

b. Simulation modules deal with:

- Principles and concepts of simulation, its uses, and types of tools.
- Simulating loads and observing annual and peak variations.
- Disaggregation of internal and external loads in a building.
- Use of design day and annual simulations.
- Simulating passive design strategies.
- Learning to simulate a baseline building and conduct parametric analysis.

c. Measurement and Experimentation modules deal with:

- Learning to assemble, and operate a weather station and analyze actual meteorological data.
- Using handheld and long-term monitoring devices for measuring air and surface temperature, humidity, air-speed and conducting heat and mass transfer calculations in real situations.
- Conducting a thermal comfort survey, studying PMV, PPD and measuring instantaneous environmental conditions.
- Measuring the performance of solar cooker, designing, and building improvements to the solar cooker to improve efficiency using predictive calculations and field-testing.

Figure 2 Instruments used by the students for M&E

d. Sample Assignment

In one of the simulation exercises using Design Builder, the students analyzed a building in 2 cities with different climates – Ahmedabad and Bangalore. They varied the orientation, window area, shading devices, and observed summer and winter performance with a number of thermal comfort metrics. They simulated envelope measures prescribed in the energy code, and compared the performance with business-as-usual construction.

3.2 HVAC Lab

This lab includes basic thermodynamics of HVAC systems, ventilation requirements, introduction to systems and components, load calculations, and efficiency strategies.

a. Concepts and Practices modules deal with:

- Indoor air quality, particulates, pollution, ventilation needs, and acoustics.
- Basics of electricity and power, safety issues, standards, transformers and metering.
- In-depth look at thermodynamics, refrigeration cycle, flow, pressure, fan curves, fan power, filtration load curves, and energy demand.

- Understanding HVAC system types, design considerations, components and operation along with delivery systems. Introduction to pressure drop, supply and return modes, duct sizing, calculation of leakage, thermal loss.
- In-depth exploration of a common HVAC system and introduction to low energy cooling systems and mixed mode buildings.
- Introduction to HVAC controls, heat recovery, demand control, drives, and building management systems.
- Field trips and a 2-day exposure at an industry expo to review market availability of systems and components.
- Introduction to HVAC system selection based on physical design constraints, economics, usage patterns, ventilation needs and acoustics.

b. Simulation Modules deal with:

- Studying the impact of thermal zoning on HVAC energy use and sizing.
- Simulating central, distributed, and low energy systems.
- Using simulations to observe the seasonal, daily, and hourly variations in system performance.
- Learning to simulate HVAC system measures including efficiency improvements, controls and heat recovery.
- Learning to estimate load reduction and capacity downsizing.

In the past, architects and engineers have largely used energy modeling for demonstrating building energy code compliance. While it is still common in current practice to simulate the performance of a single design solution, the real power of simulations lie in finding technically, aesthetically and economically optimum solutions

-Rajan Rawal, Executive Director, CARBSE, CEPT University

Figure 5 Students studying the HRV

Figure 6 Installation of the HRV in class

c. Measurement and Experimentation Modules deal with

- Measuring air quality and particulates, CO2 concentrations and calculating infiltration rates.
- Installing a heat recovery ventilator (HRV) monitoring its operation for temperature, flow and power, and assessing its coefficient of performance.
- Site visits to see HVAC system installations.
- Analyzing data from BMS systems to understand operational aspects of HVAC systems, seasonal and diurnal variation, and calculating coefficient of performance.

d. Sample assignment

The students used eQuest for simulating a four-storied school building with different HVAC systems like Packaged Single Units and Packaged multi-zone units. They strategized the thermal zoning and assigned systems to the zones. They studied the impact of various changes on energy consumption, hours when the systems could not meet the loads . They simulated Energy Conservation Measures (ECMs) including economizer controls, night-flush ventilation; evaporative sprays, preconditioning of outside air, and increasing the efficiencies of the system components.

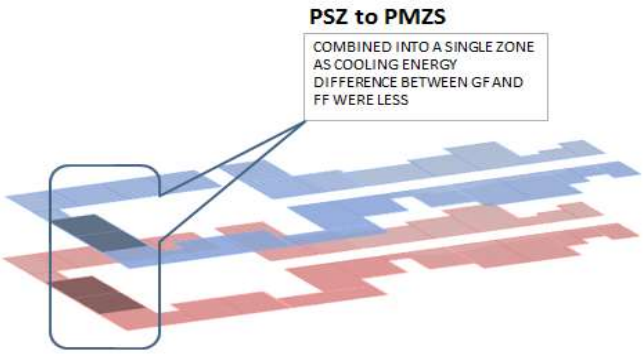


Figure 3 Study of a zoning strategy

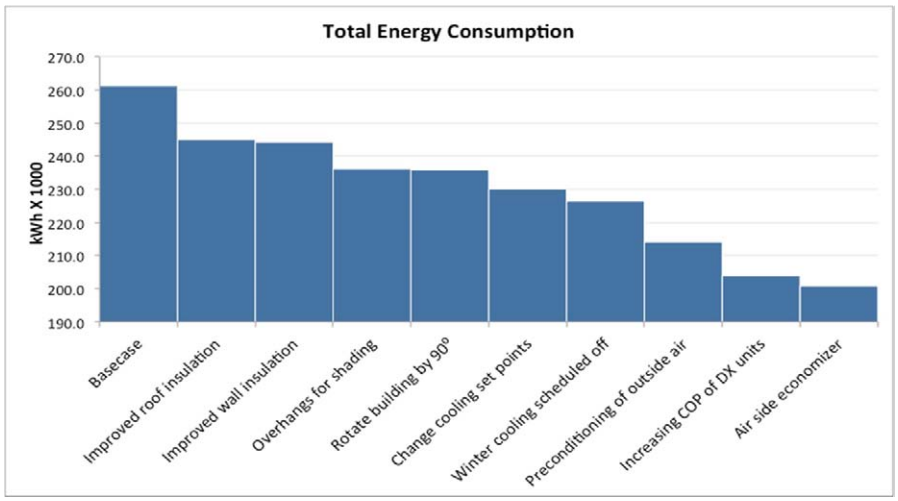


Figure 4 Impact on energy consumption with different measures – findings of one of the students

3.3 Lighting Daylighting and Integrated Design Lab

The lab covers visual needs, glare, lighting metrics and design considerations, light sources, luminaire selection, electric lighting and daylighting strategies, and lighting control systems. It combines concepts and best practices, techniques for lighting, physical measurement and data comprehension. Towards the end, this lab also integrates the learning of the three semesters to explore energy code interpretation and whole building simulation.

a. Concepts and Practices modules deal with:

In the Core/Lecture Module

- Understanding visual needs, metrics for light, and lighting basics.
- Evaluating electric light sources and luminaires, including photometrics and manual calculation methods.
- Learning the best practices of daylighting and shading design, rules of thumb and manual calculation techniques for assessing daylighting.
- Lighting control and integration of daylighting with electric lighting, including control zones, fixture layouts, control technologies and calibration.
- Learning about the methods and approaches to Whole Building Integrated Design

b. Simulation modules deal with:

- Learning to simulate daylighting and electric lighting with Dialux, Radiance and DaySim.
- Simulating electric lighting to achieve illuminance levels, uniformity and contrast ratios by selecting luminaires.
- Parametric simulations of daylighting strategies to evaluate illuminance and luminance levels.
- Parametric simulations to evaluate annual daylighting metrics like sDA and ASE.
- Whole building simulation for energy code compliant base case and measures for improving the energy performance beyond code.
- Manipulating simulation results in Excel for analysis and presentation.
- Preparing a whole building simulation report and graphic presentation of simulation results.

c. Measurement and Experimentation Module deals with:

- Measuring illuminance and luminance levels, developing a library of materials and their reflectance based on measurements.
- Evaluating lighting in a space using measurements on a grid, trending horizontal and vertical illuminance levels, and understanding the relationship between task, illuminance and contrast.
- Long-term monitoring of occupants and lighting systems to characterize lighting use and occupancy patterns to be used in simulation models.
- Measuring photometric characteristics of of luminaires.
- Evaluating daylighting strategies with physical models using an artificial sky.

Sample assignment

Using DiaLux for lighting simulations, the students studied a classroom, and an open office space. The objective was to achieve adequate illuminance on the work plane and an acceptable uniformity ratio. They are encouraged to explore interior surface reflectances, task-ambient approaches, and different luminaires for their photometric distribution, varying the number, types and layout.

3.4 Buildings Energy and Environment Seminar

In the first semester, this course provides an introduction to how buildings use energy; it covers case studies on how energy conservation has been achieved in different climates; it introduces green building rating systems; makes the connections between buildings, energy use, and environmental impacts. It builds a larger context with an overview of the energy sector, highlighting the current status of conventional resources, technologies, supply and demand and potential of renewable energy deployment. Using case studies, audits and class discussions, the course covers challenges and approaches to sustainable energy planning.

Sample assignment

Students conduct energy survey of various building types and compare the building characteristics, energy consumption patterns with published studies of national and regional averages. The students become familiar with concepts such as connected load, base load, seasonal load, end-use energy, source energy, and energy use intensity using different methods of normalization.

3.5 Communication for Energy Efficiency Business Seminar

This course focuses on the communication needed for doing and acquiring energy efficiency work in the profession. Students learn about techniques for reading early design documents and communicating the potential for low energy strategies, participating in design charrettes, preparing reports, and writing project proposals. Students evaluate numerous metrics contained in simulation reports and identify those that matter to various stakeholders.

Sample assignment

The students present themselves as energy consultants on a project and make a case to persuade a client. This exercise is done in the first class and repeated in the last class of the semester. They are expected to apply the methods and knowledge they learn over the semester in the repeat presentation.

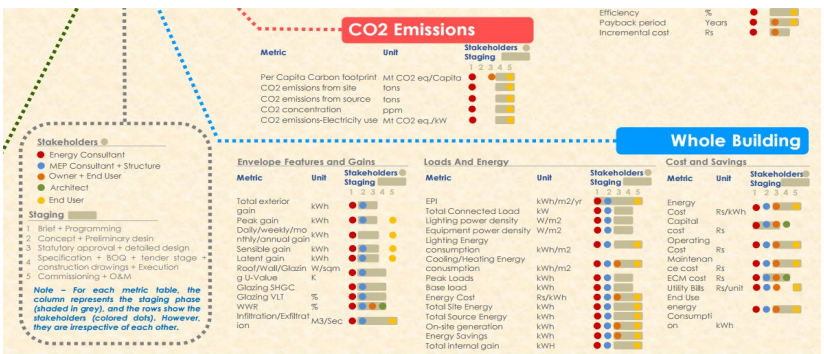


Figure 5 Students' study of energy related metrics in the Communication for Energy Efficiency Business Seminar. See the entire chart here.

3.6 Renewable Energy Systems Seminar

This seminar course covers four primary renewable energy systems: solar PV, solar thermal, biomass, and wind generation. Students learn to assess on-site generation potential, sizing and efficiency issues. They learn about building level integration, loadshapes, economics, and the issues of scaling these technologies.

Sample assignment

Students calculate the size of a Photovoltaic array, propose a layout and installation and identify pros and cons for typical residential and commercial scenarios. The exercise familiarizes them with a technology that is gaining popularity even in the lowest income groups in India.

4.0 OTHER OPPORTUNITIES AVAILABLE

4.1 Research Connections

The Center for Advanced Research in Building Science and Energy conducts research in the fields of building materials and technologies, passive design, adaptive thermal comfort and mixed mode buildings, low energy cooling technologies, and city level energy use. It works with funding from bilateral government programs as well as state and central government in India. The center is housed in a Net Zero Energy Building that is also a living laboratory for continuous and in-depth building energy efficiency research. The building design incorporates sophisticated controls and instrumentation. Students at the M.Tech BEP program benefit from the ongoing research, array of equipment, visiting researchers and scholars, internship opportunities, and an overall culture of rigorous investigation.

4.2 Design Charrettes

Mock design charrettes are arranged for the students to participate in for preparing them to work with different stakeholders in a real life project. Practicing professionals also take part in these charrettes.

4.3 BHAVANs scholarship

The Department of Science and Technology, Government of India and the Indo-US Science and Technology Forum have launched the Building Energy Efficiency Higher & Advanced Network (BHAVAN) internships that places Indian students at US universities to pursue research opportunities. One student from the M.Tech BEP is about to start her internship in the Centre for Sustainable Building Research at the University of Minnesota.

4.4 Summer and Winter Schools (SWS)

SWS at CEPT University provides opportunities for students to gain valuable learning experience that goes beyond the curriculum. These courses differ from those in the regular semesters in terms of structure, approach and content. The courses in SWS are intense and are for short durations of between one to four weeks. This brings in professionals, academicians, artists, and experts from across the country and abroad to teach. During the winter school of 2015 the M.Tech 2015 students did an immersive 6-day learning of simulation with IES-VE. In another course they redeisgned a Le Corbusier building using energy simulation reports from eQuest.

5.0 CONCLUSION

With a focus on comfort and low energy in tropical climates, the graduates of the M.Tech program can work on the problems in India and other countries in South-east Asia and the Middle-east. These students learn building performance simulation over a two-year period in an immersive curriculum for building energy systems, technologies and design approaches. They solidify their understanding with exposure to realistic situations, researchers and professionals. Their simulation learning is built upon a foundation of theory and physical experimentation. ■

IBPSA announcements

Building Simulation 2017: Call for nominations for Awards

The Board of Directors of IBPSA is seeking nominations for Awards to be presented at Building Simulation 2017, in San Francisco, USA (7-9 August 2017).

IBPSA makes three awards for outstanding work in the building performance simulation field. These awards are made on a biennial basis at each Building Simulation Conference, providing there is a qualified candidate. In order to allow the awardees time to plan to attend, it is time to consider nominations for the up-coming conference in 2017. The three categories awarded are:

IBPSA Distinguished Achievement Award

This award, formerly named the IBPSA Award for Distinguished Service to Building Simulation, recognizes an individual who has a distinguished record of contributions to the field of building performance simulation over a long period. The award consists of a certificate and $500 (US). Awarded biennially.

IBPSA Outstanding Young Contributor Award

This award recognizes an individual at the beginning of their career who has demonstrated potential for significant contributions to the field of building performance simulation. The award consists of a certificate and $500 (US). Awarded biennially.

IBPSA Innovative Application Award

This award, formerly named the IBPSA Award for Distinguished Practice, 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. The award may be given for: a unique or noteworthy use of simulation in practice; development of simulation software or supporting software that has had a significant impact on industry practice; or other contribution that has advanced building performance simulation in practice. The award consists of a certificate and $US500. Awarded biennially.

Nominations

Nominations for awards MUST be made by an independent third party.

Nominations for the Distinguished Achievement Award should include a brief CV which gives the history of involvement with building performance simulation, publications etc., and a summary of the nominee's specific contribution to the field of building performance simulation – e.g. in the development/ contribution to development of building performance simulation tools or in furthering knowledge in the field of application of building performance simulation, etc. Nominations should be on institutional or corporate letterhead and scanned if necessary.

Nominations for the IBPSA Outstanding Young Contributor Award should include a brief CV which gives a summary of the individual's contributions to the field of building performance simulation, their publications etc., and an assessment of the potential for future contributions arising from the individual. Nominations should be on institutional or corporate letterhead and scanned if necessary. In addition, each nomination

should be submitted as a single pdf file.

Nominations for the Innovative Application Award should be accompanied by a summary of the individual's, group's or firm's contributions to the field of building performance simulation in practice and an assessment of the significance of these contributions.

Nominations must be submitted **by email** to the Chair of the Awards and Fellows Committee, Cheol-Soo Park, at **cheolspark@skku.ac.kr** .

The deadline for nominations is 30 November 2016. ■

Building Simulation 2017: Call for nominations for Fellows

The Board of Directors of IBPSA is seeking nominations for the 2017 Class of Fellows. The IBPSA membership grade of Fellow recognizes individuals who match the following description:

> "A member who has attained distinction in the field of building performance simulation, or in the allied arts or sciences, or in teaching of major courses in said arts and sciences, or who by way of research, simulation code development, original work, or application of building simulation on projects of a significant scope, has made substantial contribution to said arts and sciences, and has been active in the field for at least ten (10) years".

The IBPSA Board of Directors elects new Fellows on a two-year cycle, culminating with recognition at the biennial Building Simulation conferences. Nominations may be made by IBPSA members other than the nominee. The application package will include details of the nominee's qualifications, a CV, supporting letters, and other relevant materials. The details of the nominee's qualifications shall include summaries of accomplishments in one or more of the following categories: industrial leadership, research, simulation code development, application of building simulation on projects of significant scope, educational leadership, and significant technical contributions to the allied arts and sciences. The application form and instructions are available on the web at:

- **www.ibpsa.org/downloads/fellow_nomination_application.pdf**
- **www.ibpsa.org/downloads/fellow_application_instructions.pdf**

Nominations that do not follow the format requirements will not be considered.

Nominations must be submitted **by email** to the Chair of the Awards and Fellows Committee, Cheol-Soo Park, at **cheolspark@skku.ac.kr**.

The deadline for nominations is 31 October 2016. ■

Building Simulation 2017: Call for applications for student travel awards

Travel to IBPSA Conferences can be an expensive business – especially for students. In order to assist as many students as possible to participate in BS 2017 in San Francisco, USA, IBPSA will grant a number of travel awards of up to 1,000 USD to students presenting papers. The number of places is limited to a maximum of 5 grants and as a result is highly competitive.

The selection committee bases its decisions upon the following selection criteria:

- need for financial assistance, evidenced in a letter of recommendation from the student's supervisor/ advisor of studies (must be on university letterhead)
- overall quality of the paper
- relevance of contribution to the field of and/or furthering the effective application of building simulation.

To be eligible:

- the student must be enrolled in a graduate programme related to building simulation at the time of the conference; AND
- the thesis project must be directly related to building simulation.

Applications **MUST** be supported by a letter of recommendation from the student's supervisor/ advisor / director of studies.

Applications for the award must be made by 15 January, 2017 via e-mail to **cheolspark@skku.ac.kr**. The subject heading of the e-mail should be "Student Travel Award" followed by the name of the student.

The e-mail application must include the following:

- The student's name;
- The name of the programme, department, faculty, and university;
- The title of the PhD or Master's research;
- The name of the student's supervisor(s)/ advisor(s);
- The faculty recommendation letter on university letterhead in PDF format.

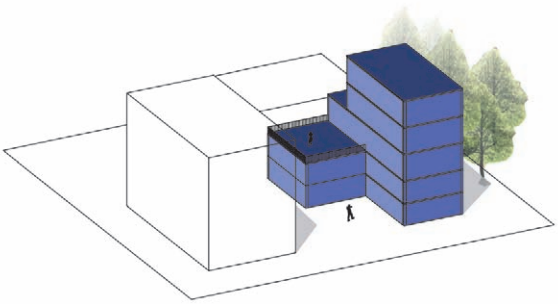
The selection committee will base its decision upon a review of the letters of support and the final manuscripts.

IBPSA would like as many nominations as possible, so please contact the chair of the Awards and Fellows Committee, Cheol-Soo Park, via **cheolspark@skku.ac.kr** to discuss a possible nomination if required.

Payment will be made either to the academic department before the conference or directly to the student at the conference. ■

Building Simulation 2017: Student modelling competition

IBPSA is organizing a student modeling competition as part of the 2017 Building Simulation conference. The aim is to facilitate wider participation in the conference and to provide a competitive forum for student members of the building simulation community. It is expected that several tutors of relevant courses in universities around the world will use this as part of their teaching material.



The BS2017 competition will be about the Design and Simulation of a Laboratory Building, and is being organized by Ben Brannon, Anna Brannon, Zahraa Saiyed, Christina Hopfe, and Gerhard Zweifel.

Further details will be announced soon on the BS 2017 website, **www.buildingsimulation2017.org,** and on **www.ibpsa.org**. ■

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-Argentina, IBPSA-Brazil and IBPSA-Chile

Forthcoming regional event

There will be a regional event of the IBPSA affiliates from Brazil, Chile and Argentina on 07 and 08 November in Buenos Aires, Argentina. This is our first joint effort to meet on this side of the world. Presentations are accepted either in Spanish, Portuguese or English although the website is in Spanish. For more information, please contact IBPSA-Argentina Representative Dr Raúl Ajmat, **rfajmat@hotmail.com** . ■

IBPSA-Australasia

CONFERENCE NEWSFLASH

The Joint AIRAH/IBPSA Building Simulation Conference will be held in Melbourne on 15-16 November 2017. A Call for Abstracts will be issued shortly and will include refereed academic and industry paper streams. Details will be announced at **www.ibpsa-australasia.org** and **www.airah.org.au**.

AGM and Seminar

IBPSA-Australasia held its AGM and Seminar at the School of Architecture, University of Sydney on 13 October 2016. Planned speakers at the seminar were:

- PC Thomas, Team Catalyst: *HVAC Design and Performance: A Modern Approach*
- Jongsoo Kim, University of Sydney: *Occupant Behaviours in Australian Residences*
- Erica Kenna, Energy Action: *Aim High: Using the NABERS Commitment Agreement to target efficient operation in new hotels, shopping centres and data centres*

The AGM was also an opportunity to seek additional Board members; new roles are being created to help support IBPSA-Australasia's burgeoning activities timetable.

First event IBPSA in New Zealand

New Zealand's first IBPSA event was recently held on 30 August 2016. Hosted by Victoria University of Wellington at the School of Architecture and Design, the evening comprised presentations from industry practitioners, research institutes, and the academic community. Topics presented were:

- *An exploration of building energy model (BEM) calibration in New Zealand*, Ethan Duff, eCubed
- *Accurate early design stage BIM modelling for material Life Cycle Assessment*, Brian Berg, BRANZ
- *Benchmarking present-day New Zealand stand-alone residential stock,* Roman Jaques, BRANZ

- *The challenges of WUFI modelling interstitial moisture in New Zealand*, Stephen McNeil, BRANZ
- *Modelling heat loss and gain in tall buildings*, Michael Donn, Victoria University of Wellington

The event was well attended, with representation from industry practitioners, the local research community and, most pleasing, undergraduate and postgraduate students. In true kiwi style, it had a casual and light-hearted atmosphere, with plenty of discussion centred on the quality assurance of building performance models compared to measured reality.

Following the formal presentations, many of the members concluded the evening over dinner, and in true simulation fashion an in-depth discussion broke out. Topics debated included New Zealanders' unique cultural values on indoor thermal comfort, the indoor climate of New Zealand houses, and how we can encourage simulation to become more widely used throughout the construction industry.

A provisional date in March 2017 has been set for the next New Zealand event, with emphasis between now and then being placed on organising some presentation themes, and promoting more industry involvement. As a membership, many expressed a willingness to see IBPSA grow here in New Zealand to include all forms of quantitative building performance assessment, not just dynamic energy simulation, and to engage with the local design and engineering communities.

IBPSA-England

BSO 2016: IBPSA-England's 3rd conference - and 10th anniversary!

IBPSA England's third conference, Building Simulation & Optimization 2016, took place in Newcastle Upon Tyne, UK from 12 to 14 September 2016. This was a regional event supported by both Newcastle and Northumbria Universities. The night of the conference dinner also coincided with IBPSA-England's 10th anniversary.

The conference built on the success of the preceding conferences in Loughborough (2012) and London (2014) and demonstrated that it could attract international participants (including US, India, Japan, and Canada). It was chaired by Dr Neveen Hamza (Newcastle University and Vice-Chair IBPSA England); Prof Chris Underwood from Northumbria University chaired the scientific committee. The conference had over 50 reviewers who double-blind reviewed the papers.

Key software and energy monitoring companies including DesignBuilder, Integrated Environmental Solutions (IESVE) and Tempcon sponsored the event, which attracted 100 delegates and 76 full paper presentations from various parts of the world.

Four conference themes highlighted advancements in simulation tools, optimization techniques and building information modelling at the building and the micro-urban scale:

- progress in simulation tools and optimization methods
- application of environmental and sustainability modelling to case studies
- new directions in building environmental modelling including BIM and visualization methods
- progress in modelling micro-urban environments.

And three keynote speakers addressed the topics:

- *Performance Driven Design: Simulation, Experiments and more* (Harsh Thapar)
- *BPS: How did we get to where we are today and what are the key challenges for the future?* (Ian Beausoleil-Morrison)
- *Designing enhanced educational environments that deliver a vastly enhanced learning experience for students of all levels* (Maria Nesdale).

Three best paper awards were nominated by the scientific committee:

- Maria Carmen Carballeira Rodriguez and Neveen Hamza: *Assessment of indoor visual environments using dementia-friendly design criteria in day care centres*
- Christoph Waibel, Ralph Evins and Jan Carmeliet: *Using Interpolation to Generate Hourly Annual Solar Potential Profiles for Complex Geometries*
- Dane George and Lukas Swan: *New profiles of occupancy driven appliance, lighting, and hot water use for residential sector energy demand modelling*.

The conference proceedings are available online at **www.ibpsa.org/?page_id=797**.

Picture left: Ian Ward (the first chair of IBPSA-England) and Loughborough's Malcolm Cook (long standing Chair of IBPSA-England and co-organizer of the first BSO conference) were awarded prizes in recognition of their long standing commitment to the organisation.

Picture right: IBPSA-England Board. From left to right: Malcolm Cook, Yeonsook Heo, Robert McLeod, Christina Hopfe, Neveen Hamza, Pieter De Wilde, Simon Rees, Dejan Mumovic, Rokia Raslan, Jon Wright, Ruchi Choudhary, Rebecca Ward.

Happy Birthday, IBPSA-England! ■

IBPSA-Nordic

Introduction

IBPSA-Nordic is a regional affiliate of IBPSA covering four countries: Denmark, Finland, Norway and Sweden. IBPSA-Nordic is linked to the IBPSA-World association but acts as an independent organisation. This affiliate could become a role model for other countries who have a small market with regard to building simulation and cannot manage the operation of being an affiliate member of IBPSA on their own. It helps if the countries that join forces have a common ground (in this case, it is the Nordic countries of Europe).

Historic background

IBPSA-Nordic was founded on 12 August 2011 with the first IBPSA-Nordic Board meeting. Later that year in December 2011 IBPSA-Nordic held its first 2-day seminar on building performance simulation and it is proud of the fact that it has run events annually since then. The events are organized by board members of IBPSA-Nordic and are held in different locations in the various Nordic countries:

- 2016: Trondheim, Norway (link to program: **http://ibpsa-nordic.org/onewebmedia/BuildSim-Nordic%202016_programme_final3.pdf**)
- 2015: Aalborg, Denmark (link to program: **http://ibpsa-nordic.org/onewebmedia/BuildSim-Nordic%202015_preliminary%20program.pdf**)
- 2014: Espoo, Finland (link to presentations: **http://ibpsa-nordic.org/events/buildsim-nordic%202014%2C%2025.-26.9/presentations.html**)
- 2013: Lund/Malmö, Sweden (link to presentations: **http://ibpsa-nordic.org/events/ibpsa-nordic%20seminar%202013/presentations-2.html**)
- 2012: Lillestrøm, Norway
- 2011: Aalborg, Denmark (link to presentations: **http://www.zeb.aau.dk/Arrangementer/Arrangement/f-lles-nordisk-phd-seminar.cid160064**)

The seminars are open to members and non-members of IBPSA-Nordic. Young researchers, such as PhD and Masters students and postdoctoral researchers, are particularly encouraged to participate.

An annual IBPSA-Nordic Simulation Award has been made at each BuildSim-Nordic seminar since 2014; the award is announced to all IBPSA-Nordic members by email and on IBPSA-Nordic's web pages. The criteria for the award are outstanding research or implementation work in the field of building simulation, and the selection of the recipient is made by the IBPSA-Nordic board. The first awardee was Dr Sunliang Cao, at that time a PhD candidate at Aalto University in Finland; the picture shows Sunliang Cao receiving his award in 2014 from Ala Hasan, president of IBPSA-Nordic 2011 – 2015.

Organizational structure

The Board is responsible for the action planning of IBPSA-Nordic and takes care of finances and the property of the association; it is composed of twelve members, three from each member country. As in most chapters of IBPSA, a Board member must be active in the field of building simulation and must be based in one of the four member countries. The Board meets twice a year to discuss and decide the affairs of the association, including the financial report.

At Board meetings, chaired by the President (Ass. Prof Jørgen Christensen, Denmark), the Board tries hard to reach decisions by consensus. This is a sensitive part of work in this IBPSA chapter since it consists of members from 4 different countries with different approaches to BPS.

The President actively participates in realising the mandate of the organisation and chairs the Board meetings. The Secretary (Dr. Matthias Haase, Norway) assists the membership and the Board in the execution of their programs of work and in the coordination and progress of the organisation's activities. The Secretary also takes care of informing all members about these activities. The Board members act as contact points in their countries. There is a list of board members at **http://ibpsa-nordic.org/people.html**.

Membership

The association has two types of members: Normal Members and Special Corporate Members.

A Normal Member can be any individual, legally operating organisation or foundation interested in building simulation. Building simulation does not have to be the sole job function in order to qualify for membership. There is no membership fee for normal members.

Between 2011 and 2016 the normal membership of IBPSA-Nordic has grown to 174 – 55 from Denmark, 45 from Finland, 39 from Norway, 29 from Sweden and 6 from outside the Nordic countries. The increase has been generated from two main sources: some people have been invited to IBPSA-Nordic events and have gone on to join the organisation; others have been directly invited by members of the Board. Recently efforts have been made to reach out to other Nordic countries such as Iceland, Lithuania, and Estonia.

A Special Corporate Member can be any legally operating organisation that works in the building and related sectors. Special Corporate Members have the right to put their organisation's logo on the IBPSA-Nordic website, with a link to the organisation's own website. They receive a free copy of the biennial technical regional meeting's papers and they pay an annual membership fee.

Membership benefits and conditions for IBPSA-Nordic members include:

- receiving announcements on upcoming events and new services
- access to an electronic copy of IBPSA's newsletters
- the right to nominate and participate in the election of IBPSA-Nordic Board members
- membership of IBPSA-World.

The IBPSA-Nordic Board has the right to refuse membership to any individual, organisation or foundation. A member can terminate his/her membership by writing to the Board or the President or by informing a General Meeting, when it will be included in the minutes of the meeting.

For information about joining IBPSA-Nordic visit **http://ibpsa-nordic.org/membership.html.**

IBPSA-Switzerland

Achim Geissler, IBPSA-CH

2016 has proven to be a difficult year for IBPSA-CH. After the loss of two board members due to affiliation (and country) change in one case and general overwork issues in the other, the drive of previous years has somewhat been lost. We did, however, become a partner institution to the newly formed association Bauen Digital Schweiz (Building Digital Switzerland) which is focused on BIM in Switzerland. The association has a very wide support base in the building sector in Switzerland and is closely linked with buildingSMART Switzerland. We will see where this leads for IBPSA-CH.

On 9 September, IBPSA-CH held an embedded session focused on building simulation at the Brenet conference held in Zürich. The session was well attended and featured four presentations.

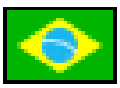
Sadly, the group forums added to the members' area a year ago did not seem to resonate with the members' needs, even though they were implemented at members' explicit wishes. Ah well! Membership count has nevertheless seen a slight increase to nearly 60 members. We hope that this number will increase again in the near future and will try to revitalize IBPSA-CH again. ■

IBPSA affiliates

See the IBPSA Central web site at http://www.ibpsa.org/?page_id=29 for details of affiliate websites and contacts. Affiliate representatives are voting members of the IBPSA Board except where marked *.

IBPSA-Argentina
contact: **Raul Ajmat**

IBPSA-Australasia
contact: **Quentin Jackson**



IBPSA-Brazil
contact: **Nathan Mendes**

IBPSA-Canada
contact: **William O'Brien**

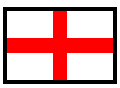
IBPSA-Chile
contact: **Danny Lobos**

IBPSA-China
contact: **Da Yan**

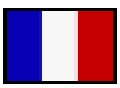
IBPSA-Czech Republic
contact: **Martin Bartak**

IBPSA-Danube
contact: **Marija Todorovic**

IBPSA-Egypt
contact: **Mohammad Fahmy**



IBPSA-England
contact: **Pieter De Wilde**



IBPSA-France
contact: **Etienne Wurtz**

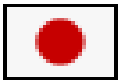
IBPSA-Germany
contact: **Christoph Nytsch-Geusen**

IBPSA-India
contact: **Jyotirmay Mathur**

IBPSA-Indonesia
contact: **Ramadhani Santoso***

IBPSA-Ireland
contact: **James O'Donnel**

IBPSA-Italy
contact: **Vincenzo Corrado**



IBPSA-Japan
contact: **Yoshiyuki Shimoda**

IBPSA-Korea
contact: **Cheol-Soo Park**

IBPSA-Mexico
contact: **Jose Luis Jaspeado-Escalona***

IBPSA-Netherlands + Flanders
contact: **Wim Plokker**

IBPSA-Nordic
contact: **Jørgen Erik Christensen**

IBPSA-Pakistan
contact: **Naghman Khan**

IBPSA-Poland
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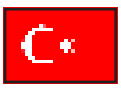

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ÉNERGÉTIQUE DES BÂTIMENTS & SIMULATION THERMIQUE

Ouvrage coordonné par Bruno Peuportier

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Préface de Ian Beausoleil-Morrison, professeur à l'université d'Ottawa
Introduction d'Ubert Pénicaud

Œuvrant tous à la **conception ou la réhabilitation énergétique des bâtiments**, domaine de plus en plus important où les objectifs environnementaux d'une part et la réglementation de l'autre encouragent à l'amélioration des performances, les auteurs exposent dans ce livre de référence quels sont les différents modèles d'outils de **simulation énergétique**. Ce sont notamment la **thermique**, l'**aéraulique**, l'**éclairage** et les transferts de masse, l'**enveloppe** et les équipements sur le **cycle de vie des bâtiments**. Une **description des outils les plus employés en France** ainsi que plusieurs études sur la **validation des modèles** complètent cet ensemble.

On y trouvera de nombreux **conseils** portant sur les données disponibles d'un bâtiment, le climat, les scénarios d'usage et l'exploitation des résultats; les aspects d'incertitudes et d'optimisation sont eux aussi étudiés. La **conception de bâtiments neufs** et les **réhabilitations** font l'objet d'exemples particuliers. Enfin, les auteurs tracent des perspectives pour progresser vers la **garantie de performance énergétique**.

1. Modèles et principales hypothèses : modélisation thermique du bâtiment, éclairage, aéraulique, transferts de masse, systèmes thermiques et électriques, ENR, cycle de vie
2. Validation des modèles : bancs d'essais, comparaisons inter-logiciels, validation expérimentale
3. Mise en œuvre de la simulation : adéquation aux objectifs de l'étude, données d'entrée, utilisation de la simulation et exploitation des résultats (incertitudes, optimisation)
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