Dr Ralph Evins MEng EngD CEng MCIBSE

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Assistant Professor
Energy Systems and Sustainable Cities group
Department of Civil Engineering
University of Victoria
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Education

Engineering Doctorate, University of Bristol, UK

November 2008 – November 2012

Multi-objective optimisation as an aid to design space exploration for low-carbon buildings.
Exploring the use of holistic optimisation of low-carbon buildings as an aid to design space exploration for architects and engineers. Developed novel methods and frameworks for applying multi-objective optimisation algorithms to low-carbon building design problems.

Bachelors & Masters in Civil and Environmental Engineering, Imperial College London, UK

October 2003 – June 2007

International Baccalaureate, St Clare's International College, Oxford, UK

September 2001 – July 2003

Employment

Energy Systems and Sustainable Cities group, University of Victoria, Canada
Tenure-track Assistant Professor *January 2017 -*
Group leader of the Energy Systems and Sustainable Cities research group in the Department of Civil Engineering. Affiliated professor with the Integrated Energy Systems Centre. Teaching a 2nd year core course on building science and a 4th year elective on building simulation (see *Teaching*). Research into modular simulation and optimisation methods (see *Research projects*). Principal supervision of masters and PhD students (see *Student supervision*). Ongoing consultancy role for Empa.

Urban Energy Systems Laboratory, Empa, Switzerland
Chair of Building Physics, Department of Architecture, ETH Zürich, Switzerland

Scientist (Empa) / **Lecturer** (ETH Zürich) *September 2014 – June 2016*
Group Leader & Deputy Head of Laboratory (Empa): *November 2015 – June 2016*
Roles and responsibilities spanning the positions at Empa and ETH Zürich included conducting, managing and leading independent research into advanced energy systems modelling at the building and urban scales, with a strong focus on simulation and optimisation. Daily supervision of four PhD students, one post-doctoral researcher and various masters students (see *Student supervision*). Coordination five inter-institution and international projects (see *Research projects*). Group and laboratory management, including recruitment, strategy and finances. Teaching on the Masters in Building Integrated Systems (see *Teaching*). Computational simulation platform development, including design, infrastructure and collaboration facilitation.

Post-doctoral Researcher / Fellow, Empa & ETH, Switzerland *December 2012 – August 2014*
Marie-Curie EU post-doctoral fellowship related to urban optimisation, for which I secured funding. Focus on tool development, including co-simulation platform (linking simulators), emulators and meta-models (linking CFD and energy use).

Research into building and urban energy use, including energy systems (design and operational optimisation), renewables (PV performance) and urban wind flow (impact of heat transfer).

Research Engineer, Buro Happold Ltd, London, UK *November 2008 – November 2012*
Application of doctoral research to commercial projects, including development of bespoke software tools and computational links between energy simulation programs. Diverse sustainable design and energy simulation work, including district energy schemes, thermal design and building regulations compliance, sustainability assessments, and CFD for ventilation and air supply design. Extensive design team co-ordination with architects and clients.

Student placement, Buro Happold, London, UK *August 2007 – May 2008*
Research project on the use of Large Eddy Simulation CFD solvers for urban wind flow analysis.

Prizes

- Shortlisted for the Outstanding Young Contributor award of the International Building Performance Simulation Association, 2015.
- Supervisor of the winning team of the Student Modelling Competition of the International Building Performance Simulation Association, 2015.
- Best paper award, Building Simulation and Optimisation Conference, 2014 (Emulating site-specific wind flow information for use in building energy simulations).
- 2nd prize ($5,000) in the Marblar sustainable homes competition for the aerogel skylight with integrated LEDs for highly-insulated constant illumination. Also highly commended for two other finalist ideas.
- Best paper award, University of Bristol IDC conference, 2012 (A case study exploring regulated energy use in domestic buildings using design-of-experiments and multi-objective optimisation).
- Best paper award, University of Bristol IDC conference, 2011 (Multi-objective design optimisation: getting more for less).

Invited talks

- **Organiser and chair**: Computational Optimisation of Low-Energy Buildings workshop, ETH Zürich, 6 – 7 March 2014. 32 attendees from 11 institutions in 7 countries.
- **Keynote:** Urban energy simulation platform development. SCCER project conference. January 2015.
- **Invited talks:** Urban energy and microclimate: a research overview. Buro Happold Ltd & XCO_2 Ltd, June 2014. Modelling and Simulation workshop, University of Bristol, August 2012.
- **Lecture**: VBA programming for engineers. 80 participants. Buro Happold, September 2011.
- **Organiser and speaker**: Optimisation workshop, University of Bristol, September 2010.
- **Doctoral project presentations**: Building optimisation (London, Bath, Leeds, Glasgow); Building physics technical forum; Product Strategy Group (senior board).

Publications

Peer-reviewed journal papers

1. Morvaj B, Evins R, Carmeliet J. (2017). Decarbonizing the electricity grid: the impact on urban energy systems, distribution grids and district heating potential. Applied Energy. 191: 125–140.
2. Morvaj B, Evins R, Carmeliet J. (2016). Optimising urban energy systems: simultaneous system sizing, operation and district heating network layout. Energy. 116: 619-636.

3. Evins R. (2016). A bi-level design and operation optimization process applied to an energy centre. Journal of Building Performance Simulation. 9(3): 255-271.
4. Morvaj B, Knezovic K, Evins R, Marinelli M. (2016). Integrating multi-domain distributed energy systems with electric vehicle PQ flexibility: optimal design and operation scheduling for sustainable low-voltage distribution grids. Sustainable Energy, Grids and Networks.
5. Morvaj B, Evins R, Carmeliet J. (2016). Optimization framework for distributed energy systems with integrated electrical grid constraints. Applied Energy. 171: 296-313.
6. Evins R, Orehounig K, Dorer V. (2016). Variability between domestic buildings: the impact on energy use. Journal of Building Performance Simulation. 9(2): 162-175.
7. Evins R. (2015). Multi-level optimization of building design, energy system sizing and operation. Energy. 90, Part 2: 1775-1789.
8. Allegrini J, Orehounig K, Mavromatidis G, Ruesch F, Dorer V, Evins R. (2015). A review of modelling approaches and tools for the simulation of district-scale energy systems. Renewable and Sustainable Energy Reviews. 52: 1391-1404.
9. Orehounig K, Evins R, Dorer V. (2015). Integration of decentralized energy systems in neighbourhoods using the energy hub approach. Applied Energy. 154: 277-289.
10. Evins R, Orehounig K, Dorer V, Carmeliet J. (2014). New formulations of the 'energy hub' model to address operational constraints. Energy. 73: 387-398.
11. Orehounig K, Mavromatidis G, Evins R, Dorer V, Carmeliet J. (2014). Towards an energy sustainable community: An energy system analysis for a village in Switzerland. Energy and Buildings. 84: 277-286.
12. Evins R, Dorer V, Carmeliet J. (2014). Simulating external longwave radiation exchange for buildings. Energy and Buildings. 75: 472-482.
13. Evins R. (2013). A review of computational optimisation methods applied to sustainable building design. Renewable and Sustainable Energy Reviews. 22: 230-245.
14. Evins R, Joyce S, Pointer P, Sharma S, Vaidyanathan R, Williams C. (2012). Multi-objective design optimisation: getting more for less. Proceedings of the ICE - Civil Engineering. 165(5): 5-10.
15. Evins R, Pointer P, Vaidyanathan R, Burgess S. (2012). A case study exploring regulated energy use in domestic buildings using design-of-experiments and multi-objective optimisation. Building and Environment. 54: 126-136.

Peer-reviewed conference papers

1. Wortmann, T., Waibel, C., Nannicini, G., Evins, R., Schroepfer, T. & Carmeliet, J. (2017). Are Genetic Algorithms Really the Best Choice for Building Energy Optimization? Symposium on Simulation for Architecture & Urban Design (SimAUD).
2. Evins, R. (2017). On holistic urban energy modelling and optimization. Symposium on Simulation for Architecture & Urban Design (SimAUD).
3. Waibel C, Evins R, Carmeliet J. (2016). Using interpolation to generate hourly annual solar potential profiles for complex geometries. Building Simulation & Optimisation.
4. Morvaj B, Evins R, Carmeliet J. (2016). Impact of electrical storage and grid upgrade on the optimal design and operation of a microgrid. IEEE Power & Energy Society General Meeting.
5. Waibel C, Evins R, Carmeliet J. (2016). Holistic optimization of urban morphology and district energy systems. Sustainable Built Environment.
6. Morvaj B, Evins R, Carmeliet J. (2015). The impact of low energy buildings on the optimal design of distributed energy system and networks. Building Simulation.

7. Waibel C, Ramallo-Gonzalez A, Evins R, Carmeliet J. (2015). Reducing the computing time of multiobjective building optimisation using self-adaptive sequential model assessment. Building Simulation.
8. Marquant J, Omu A, Evins R, Carmeliet J. (2015). Application of spatial-temporal clustering to facilitate energy system modelling. Building Simulation.
9. Waibel C, Evins R. (2015). Exploring the use of variable mapping for optimizing urban morphologies. Building Simulation.
10. Marquant J, Omu A, Orehounig K, Evins R, Carmeliet J. (2015). Density-based clustering and aggregation method to facilitate multi-scale urban energy systems modelling. International Land Use Symposium.
11. Evins R, Orehounig K, Dorer V. (2015). Integrated urban energy modelling approaches to support the Swiss Energy Strategy 2050. CISBAT.
12. Morvaj B, Evins R, Carmeliet J. (2015). Bi-level optimisation of distributed energy systems incorporating non-linear powerflow constraints. CISBAT.
13. Hohmann M, Waibel C, Evins R, Carmeliet J. (2015). Multi-objective optimization of the design and operation of an energy hub for the Empa campus. CISBAT.
14. Bollinger L, Evins R. (2015). HUES: A Holistic Urban Energy Simulation platform for effective model integration. CISBAT.
15. Marquant J, Evins R, Carmeliet J. (2015). Reducing computation time with a rolling horizon approach applied to a MILP formulation of multiple urban energy hub system. International Conference On Computational Science.
16. Bollinger L, Evins R. (2015). Facilitating model reuse and integration in an urban energy simulation platform. International Conference On Computational Science.
17. Orehounig K, Evins R, Dorer V, Carmeliet J. (2014). Assessment of renewable energy integration for a village using the energy hub concept. ISES Solar World Congress.
18. Mavromatidis G, Evins R, Orehounig K, Dorer V, Carmeliet J. (2014). Multi-objective optimization to simultaneously address energy hub layout, sizing and scheduling using a linear formulation. Engineering Optimisation.
19. Morvaj B, Evins R, Carmeliet J. (2014). Optimal selection and operation of distributed energy resources for an urban district. Engineering Optimisation.
20. Evins R, Allegrini J, Moonen P. (2014). Emulating site-specific wind flow information for use in building energy simulations. Building Simulation and Optimisation.
21. Evins R, Orehounig K. (2014). A bi-level design and operation optimisation process applied to an energy centre. Building Simulation and Optimisation.
22. Orehounig K, Mavromatidis G, Evins R, Dorer V, Carmeliet J. (2014). Predicting energy consumption of a neighborhood using building performance simulation. Building Simulation and Optimisation.
23. Evins R, Vaidyanathan R, Burgess S. (2014). Multi-material compositional pattern-producing networks for form optimisation. EvoStar Energy.
24. Dowson M, Evins R. (2013). Simulation of movable translucent aerogel shutters. Central European Symposium on Building Physics.
25. Knott D, Evins R. (2013). Using comfort criteria and parametric analysis to drive passive building design. Building Simulation.
26. Evins R, Pointer P, Burgess S. (2012). Multi-objective optimisation of a modular building for different climate types. Building Simulation and Optimisation.
27. Evins R, Knott D, Pointer P, Burgess S. (2012). Visual data exploration in sustainable building design. Building Simulation and Optimisation.

28. Evins R, Pointer P, Vaidyanathan R. (2011). Optimisation for CHP and CCHP decision-making. Building Simulation.
29. Evins R, Pointer P, Vaidyanathan R. (2011). Multi-objective optimisation of the configuration and control of a double-skin facade. Building Simulation.

Other publications

1. Evins, R. Zero opportunity: code for sustainable homes zero carbon bias, Journal of the Chartered Institute of Building Services Engineers, pp. 26-30, June 2013.

Teaching

Current

Building and Urban Energy Simulation (CIVE 480F), fourth year elective course, Civil Engineering, University of Victoria.
Building Science Fundamentals (CIVE 295), core second year course, Civil Engineering, University of Victoria.

Past

Masters in Integrated Building Systems, Department of Architecture, ETH Zürich.
- Building Systems. Course coordinator. Six 3-hour lectures (50% of the course).
- Building Simulation. Four 3-hour lectures (30% of the course).
- Building Automation and Control. Two 3-hour lectures (20% of the course).

Building Physics undergraduate course, Department of Architecture, ETH Zürich.
- Guest lecture: Examples of how energy can shape buildings (one 3-hour lecture).

Teaching courses attended:
- Backwards course design (1 day course) October 2015.

Student supervision

Current

Masters student: The impact of BC renewable energy policy on building systems.
PhD student: Hyper-heuristic optimisation of urban energy systems.

Past

PhD student: Electrical versus thermal energy transport for sustainable districts
PhD student: Multi-scale modelling urban energy systems and networks
PhD student: Optimal operational strategies for urban energy systems
Masters project: Developing an online set-point optimizer for heat pumps
Semester project: Automated wind tunnel boundary layer generation for urban microclimates.
Semester project: Developing a controller model for heat pumps
Semester project: Combining demand response with energy hub modelling
Semester project: Energy modelling of the NEST building

Skills and expertise

- **Thermal** and **building systems simulation** (EnergyPlus, OpenStudio, IES, DesignBuilder, TRN-SYS) and **daylight and solar** analysis (Diva, Radiance).
- **Urban energy system simulation and optimisation** (AIMMS, CPlex, Pyomo).
- **3D modelling and generative design** including parametric modelling and programmatic model generation (SketchUp, Rhino, Grasshopper).
- **Optimisation algorithm development and application** (genetic algorithms, mixed integer linear programming).

- **Sustainable building design** and application of **sustainable assessment** methodologies (LEED, BREEAM).
- **Computational fluid dynamics** simulation of wind flow around buildings and ventilation within buildings (CFX, FDS, FloVent).
- **Design of building systems** (air supply and conditioning, energy storage, controls) and **renewable technologies** (PV, solar thermal, CHP, biomass).
- **Programming and scripting** (Matlab, Python, VBA, Fortran, Processing, Arduino).
- Unix-based **cluster and cloud computing** (Bash, PBS/Torque).
- **Dynamic website and app development** (HTML5, CSS, PHP, SQL, JavaScript, D3S, Drupal).

Research projects

Modular Optimization and Simulation of Energy Systems (MOSES) *May 2017 – April 2022*
Role: sole Principal Investigator.
Funding: Natural Sciences and Engineering Research Council Discovery Grant.
Total funding: CAD$130,000.
Developing a modular framework for the analysis of the many complex interacting elements in urban energy systems. Inclusion of optimisation, hyper-heuristics and model emulation.

Future Energy Efficient Buildings & Districts (FEEB&D) *June 2013 – December 2016*
Role: Task leader; module coordinator.
Funding: Swiss federal government, via the Commission for Technology and Innovation.
Total funding: 7,278,000 CHF (CAD$10,162,000).
Funding for Urban Energy Systems lab: 949,000 CHF (CAD$1,325,000).
A Switzerland-wide project intended to deliver a sustainable energy transition by 2030 as part of the Swiss Competence Centres for Energy Research. Specific focus on the holistic analysis of thermal, solar, daylight, ventilation, air flow and other aspects of the urban environment, including conceptual and detailed energy systems design and optimisation.

Synergistic Energy and Comfort through Urban Resource Effectiveness (SECURE)
April 2014 – March 2017
Role: Joint Principal Investigator; project coordinator.
Funding: Swiss Competence Centre for Energy and Mobility (2,187,000 CHF / CAD$3,053,000).
Development of a framework and tools for the holistic analysis and optimisation of urban energy, comfort and utility, including microclimate, district and building energy use, renewable energy generation and daylight availability.

Urban Optimisation, *September 2013 – August 2015*
Role: Project applicant.
Funding: CoFund fellowship, European Union (95,000 CHF / CAD$132,000).
Two-year fellowship on the holistic optimisation of energy use in urban areas, covering the interactions between building fabric, systems, renewables, district systems and urban layout.

Other positions of responsibility

- Projects Committee member, IBPSA World.
- Scientific committee member:
  - ACM BuildSys conference.
  - EvoEnergy conference.
  - Building Simulation and Optimisation conference.
- Invited reviewer:
  - Elsevier Science and Technology Books
  - US Department of Energy Office of Energy Efficiency and Renewable Energy.

- Tubitak (Scientific and Technological Research Council of Turkey).
- Energy Policy journal.
- Journal of Building Performance Simulation.
- Environmental Modelling & Software journal.
- Energy & Buildings journal.
- International Journal of Heat and Mass Transfer.
- Applied Energy journal.
- Solar Energy journal.
- International Journal of Information Technology & Decision Making.
- IET Generation, Transmission & Distribution.