SOLAR ENERGY AND BUILDING PHYSICS LABORATORY
LABORATOIRE D'ENERGIE SOLAIRE ET DE PHYSIQUE DU BÂTIMENT

Activity Report 2014

Energy Efficiency and Renewables in the Built Environment
Solar Energy and Building Physics Laboratory (LESO-PB)
Swiss Federal Institute of Technology Lausanne (EPFL)
School of Architecture, Civil and Environmental Engineering (ENAC)
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The Solar Energy and Building Physics Laboratory (LESO-PB) works at the forefront of research and technological development in renewable energy, building science and urban physics. It is part of the Civil Engineering Institute (IIC) of the School of Architecture, Civil and Environmental Engineering (ENAC) of the Swiss Federal Institute of Technology (EPFL) in Lausanne, Switzerland. Placed under the responsibility of Prof. Dr Jean-Louis Scartezzini and four group and project leaders, the laboratory counts about 40 scientists, engineers and technicians. This report presents the teaching, research and technology transfer for 2014.
RESEARCH HIGHLIGHTS

INTRODUCTION

The research activities of the Solar Energy and Building Physics Laboratory focus on the development and implementation of energy efficient and renewable energy technologies in the built environment. They are structured along the following priority axes:

- Integrated day and electric lighting
- Nanotechnology for solar energy conversion
- Urban systems simulation
- Complex urban systems
- Smart buildings / Smart cities
- Architectural integration of renewable energy

This report describes the activities of the lab in 2014.

Highlights 2014

- Official approval by the CTI Board of a proposal for a new Swiss Competence Center for Energy Research (SCCER) in the field of Future Energy Efficient Buildings and Districts (FEEB&D) and recruitment of seven new staff members for innovative research projects financed in this framework.
- Publication of four patents by the research group “Nanotechnology for Solar Energy Conversion” and major innovations in this domain, such as for example a black coating for solar thermal concentrators that considerably improves their life span.
- Involvement of researchers in the design of an energy efficient school campus in Dubai.

Further research activities are presented in the following pages.

Outreach

Promoting interdisciplinary dialog has always been an integral part of the Solar Energy and Building Physics Laboratory’s program:

- Funded by and in collaboration with Velux-Stiftung Schweiz, Prof. Scartezzini organised in 2014 a transdisciplinary workshop with 20 selected international experts to detect hotspots in daylighting and solar technology. The fundamental reflexion and dialogue that took place on 11 September 2014 in Buchillon showed up many open issues and possible directions to take in future research.
- Prof. JL Scartezzini is Board Member and Work Package leader of the Swiss Competence Center for Energy Research in the field of Future Energy Efficient Buildings and Districts (SCCER FEEB&D). In this framework, he and the LESO-PB research team collaborate closely with researchers from several Swiss research institutions to rapidly find innovating solutions that will help Switzerland reach its ambitious “Energy Turnaround”.
- At the end of 2014, LESO-PB launched a call for papers for the international scientific conference CISBAT 2015 to take place from 9 to 11 September 2015 under the heading “Future Buildings and Districts – Sustainability from Nano to Urban Scale”. LESO-PB will host the conference for the 13th time in academic partnership with Cambridge University and MIT. CISBAT will also serve as a platform both for the Swiss Chapter of IBPSA as well as SCCER FEEB&D.
INTEGRATED DAY- AND ELECTRIC LIGHTING

Group leader: Prof. Jean-Louis Scartezzini
Senior researcher: Dr Jérôme Kämpf, Dr Bernard Paule (ESTIA SA)
PhD students: Apiparn Borisuit, Chantal Basurto, Yujie Wu

The Integrated Day and Electric Lighting research group works on advanced systems for optimal use of daylight in buildings with the aim to improve user comfort and health and reduce energy consumption.

The group has set up a sophisticated daylighting laboratory with, among other, a scanning sky simulator and an automated heliodon, which allow reproducing with very high precision all daylight conditions that exist around the world. Several anidolic (non-imaging) daylight systems have been developed and tested by the group. Furthermore, a bidirectional reflection and transmission goniophotometer based on digital imaging allows assessing the characteristics of complex fenestration systems. A photobiological laboratory completes the equipment.

Simulated daylighting distribution in an office room through a Laser Cut Panel (LCP) at noon, 3PM and 5PM on Spring equinox.

Published work relates to

- Circadian rhythms and impact of light in humans, visual comfort
- Daylighting computer design and analysis tools
- Integrated day- and electric lighting systems
- Bidirectional reflection and transmission goniophotometer
- Anidolic daylighting systems
- Experimental and ergonomical daylighting test modules
- High dynamic range vision sensors

2014 Activities

The PhD thesis of Chantal Basurto was successfully defended in 2014. It explores the potentiality of Complex Fenestration Systems (CFS) to improve the interior daylight distribution in buildings located at low latitudes while maintaining a satisfactory visual and thermal comfort for the occupants. The daylighting performance of two office buildings located in the central-north of México (Zacatecas 22° 783’ N., 102° 583’ W, Altitude: 2543m) was monitored for that purpose from 2011 to 2013. Illuminance and luminance were measured on critical periods (summer and winter solstices as well as spring equinox), in order to characterize the existing daylighting situation. The performance of several CFS (Laser Cut Panel, 3M Prismatic film, Light Louver™, Lumitop™) was assessed using computer simulations for clear sky conditions. Three main indicators were considered: i) the interior daylight distribution, ii) discomfort glare probabilities and iii) overheating risks. The impact of the CFS in the rooms were simulated using RADIANCE and Energy Plus together with BTDF data (Bidirectional Transmission Distribution Function) monitored using a bidirectional goniophotometer. The CFS contributed in an optimal way to the indoor lighting environment in each building without compromising the thermal and visual comfort of the occupants.
Current Projects

SCCER FEEB&D Self-Sufficient Lighting Systems – Efficient Integrated Day- and Electric Lighting Modelling

**Funding:** Swiss Commission for Technology and Innovation (CTI)

**Duration:** 2014-2016

The integration of advanced daylighting systems with high efficacy light sources (LEDs), energy efficient luminaries (based on non-imaging optics) and advanced controllers for HVAC and lighting systems (based on high dynamic range vision sensors) should allow reaching energy self-sufficiency for lighting systems. This task will develop advanced simulation tools for daylighting systems. It will include compression methods for simulating complex fenestration systems for which transmission properties are characterized using a Bidirectional Transmission Density Function (BTDF data) from a novel bidirectional goniophotometer. These improvements to simulation software can foster their dissemination among practitioners (lighting industry, energy consultants and architects).

IEA-SHC Task 50 Advanced lighting solutions for retrofitting buildings

**Funding:** Swiss Federal Office of Energy (SFOE)

**Duration:** 2013-2015

Lighting accounts for approx. 19% of the global electricity demand. Energy efficient lighting techniques including daylighting, electric lighting and control can contribute to significant reduction of the electricity consumption. IEA SHC Task 50 will be focused on non-residential buildings dealing with advanced lighting solutions for building retrofits.

MICRO3D – Innovative fenestration system combining seasonal thermal dynamics, daylighting, glare protection and transparency – Manufacturing of embedded 3D microstructures

**Funding:** Swiss Federal Office of Energy (SFOE)

**Duration:** 2013-2015

The innovative glazing system proposed in this project will combine several functions. Solar gains will be used during wintertime to reduce the heating demand; sunrays will be blocked during summertime to mitigate the cooling load and avoid glare. A judicious use of daylighting will reduce furthermore the electricity demand for lighting and improve the well-being of occupants.

Postdoctoral Fellowship in Daylighting & Perception

**Funding:** VELUX Foundation (Switzerland)

**Duration:** 2013-2015

This project aimed to strengthen the education and research activities in the fields of building science and chronobiology and initiated innovating activities in relation to psycho-physiological aspects of daylight with an emphasis on human response factors, such as the perception of three-dimensional spaces and luminous environment.

PhD theses published in this domain at LESO-PB

- The impact of light including non-image forming effects on visual comfort, Apiparn Borisuit, EPFL PhD thesis #6007, 2013
- Energetic, visual and non-visual aspects of office lighting, Friedrich Linhart, EPFL PhD Thesis #4587, 2010
- Bayesian optimisation of visual comfort, David Lindelof, EPFL PhD Thesis #3918, 2007
- Innovative bidirectional video-goniophotometer for advanced fenestration systems, Marilyne Andersen, EPFL PhD Thesis #2941, 2004

Awards in this domain

- Marilyne Andersen, EPFL PhD Thesis #2941 (2004), Chorafas Award 2005
NANOTECHNOLOGY FOR SOLAR ENERGY CONVERSION

Group leader: Dr Andreas Schüler
Postdoctoral researcher: Dr André Kostro, Marina Gonzalez Lazo
PhD students: Olivia Bouvard, Jing Gong; Visiting scholars: Anna Krammer, Sara Vanzo

Due to their fascinating optical and electronical properties, nanometric scaled structures play an important role in solar energy conversion. The research group "Nanotechnology for Solar Energy Conversions" develops and characterizes novel nanostructured materials for solar energy applications. The nanocomposite coatings consist typically of dielectrics, semiconductors or metal nanocrystals embedded in a dielectric matrix. Applications include antireflection coatings on solar collector glazing, coloured coatings with high solar transmittance for novel glazing of solar thermal façades, photoluminescent quantum dot solar concentrators for photo-voltaic energy conversion and optical selective absorber coatings for thermal solar collectors and thermoelectric power generation.

The research group carries out fundamental research on novel nanocomposite materials and thin film materials and promotes the introduction of novel solar technologies through upscaling of the corresponding innovative manufacturing processes.

Published work relates to

- Coloured thermal collectors and PV modules for solar facades and solar roofing
- Nanostructured low refractive index materials on solar collector glazing
- Quantum dot solar concentrators for building integrated photovoltaics
- Durable selective absorber coatings for solar thermal collectors and electricity generation by concentrated solar power (CSP)
- Thermochromic films for smart solar energy applications
- Optical Microstructures for advanced architectural glazing

2014 Activities

Promotion of patent applications in the fields of highly durable selective solar absorber coatings, colored solar glazing for photovoltaic modules/solar thermal collectors, novel microstructured glazing for daylighting.

Research highlights include:

- Deposition of electrochromic coatings for smart windows
- Detailed study on reduction of thermal loads by microstructured glazing
- Novel doping of thermochromic thin films for matching the transition temperature to the needs of overheating protection of solar thermal collectors
- Energy efficiency in public transport: novel coatings for better train windows
- Angular dependent optical and thermal properties of advanced architectural glazing: characterization of translucent photovoltaic modules based on dye-sensitized solar cells
Current Projects

Thermochromic coatings for overheating protection of solar thermal collectors – Temperature matching and triggering

**Funding:** Swiss Federal Office of Energy (SFOE)
**Duration:** 2012-2014

Overheating and the resulting stagnation of solar thermal collectors is a common problem even in central European latitudes. During stagnation high temperatures lead to water evaporation, glycol degradation, and stresses in the collector with increasing vapor pressure. A protection of solar thermal systems without any mechanical device (e.g. for shading or for pressure release) might be provided by thermochromic coatings which exhibit a change in optical properties at a critical temperature $T_c$. This project aims at adapting the transition temperature and improving the range of optical switching as well in thermal emittance as in solar absorptance of the system. The proposed approach is based on suitable doping of the coatings, advanced multilayer design, and a novel way of triggering the optical transition.

Energy efficiency of public transportation

**Funding:** SwissElectric Research (SER), Swiss Federal Office of Energy (SFOE), Federal Office of Transport (FOT)
**Duration:** 2012-2015

Recent studies have shown that the energy used for heating and cooling of trains and trolleybuses can be in the same order of magnitude than the energy used for traction. The project aims at understanding the reasons for these tremendous energy losses, and at making suggestions for improvement. Several trains are equipped with data acquisition systems for a detailed monitoring of the various consumers on board, as well as with sensors for characterizing the outdoor and indoor climatic conditions. Thermal models of the trains and trolleybuses allow quantifying the potential impact of measures for improving their energy efficiency. Within this project, the focus will be placed on improvement of the envelope of trains and trolleybuses.

SCCER FEEB&D Dynamic Glazing & Multi-Functional Building Envelopes

**Funding:** Swiss Commission of Technology and Innovation CTI
**Duration:** 2014-2016

Novel windows with dynamic solar gains will contribute to an optimal management of the energy and light fluxes in buildings. So far, the effective g-value of most windows installed today cannot be switched, shows only a relatively weak angular dependence and thus exhibits only very small variations between summer and winter. If the g-value could be varied, overheating in summer could be reduced while maintaining large solar gains in winter. This can be achieved following two main approaches, by novel glazing with angle-selective energetic transmission or by a novel generation of switchable “smart” windows. The variation of the g-value can be combined with improved daylighting and glare protection while maintaining a clear view.

PhD theses published in this domain at LESO-PB

- Microstructured glazing for daylighting, glare protection, seasonal thermal control and clear view, André Kostro, EPFL PhD Thesis #6465, 2015
- Développement et optimisation de revêtements nanostructurés pour capteurs solaires thermiques et modules photovoltaïques, Martin Joly, EPFL PhD Thesis #5541, 2012

Awards in this field

The principal mission of the group is to better understand how to improve the environmental sustainability of urban systems through the simulation of physical processes. Urban systems, generally large groups of buildings, are simulated together to account for the numerous interactions happening between the elementary building objects. These interactions can be radiative (with the exchange of shortwave and longwave contributions), conductive and convective (through the exchange of heat) but also through an exchange of matter (gas, hot or cold liquid) or electricity. Due to the extensive nature of the simulation objects, simplified modelling is used wherever possible to maintain a balance between accuracy and computing time. A reasonable simulation time gives rise to enhance the urban performance by the use of optimization algorithms (such as Evolutionary Algorithms).

Published work relates to

- Simulation of energy and matter resource flows in urban systems
- Urban heat island effect, including urban microclimatology
- Outdoor environmental comfort
- Stochastic modelling of human activities
- Sustainable urban design

2014 Activities

The research team was set-up on September 1st 2014 and replaces the former group named “Computer Modelling of Complex Systems”. A participation to the Swiss Competence Center for Energy Research (SCCER) in Future Energy Efficient Buildings and Districts (FEEB&D) was initiated through activities within the WP3 “Urban Decentralized Energy Systems” more precisely relating to the Module 3.2: Modelling and Simulation. Last year saw also the completion of the MEU project “Innovative Planning and Management Instruments of Urban Energy Systems” initiated by the EPFL Energy Centre and supported by four Swiss municipalities.
Current Projects

SCCER FEEB&D Urban Decentralized Energy Systems - Modelling and Simulation
Funding: Commission for Technology and Innovation (CTI)
Duration: 2014-2016
The goal of decentralized energy systems with respect to the Energy Strategy 2050 is to achieve an effective use of local renewables and waste heat resources as well as efficient energy management including supply, distribution, storage, and consumption within districts of various sizes. The aim of considering a district instead of individual buildings is to increase the overall efficiency performance by achieving synergies between the differing behaviours of individual buildings and to reduce the overall investment costs. In this way a district can either have a net zero energy balance, or provide services to the wider region or to other decentralised energy systems (DES), respectively. The general goal of the studied module is on the one hand to develop DES and on the other hand to assess the advantages and disadvantages of DES compared to existing supply systems and central generation strategies through simulations. The holistic integration of such DES into the overall Swiss energy system is expected to reduce the total final energy demand and CO₂ emissions for Switzerland in accordance to 2035 and 2050 objectives.

IDEAS4cities – Integration of Decentralized Energy Adaptive Systems for cities
Funding: Competence Center Energy and Mobility (CCEM)
Duration: 2013-2016
This project is centred on introducing the concepts of the urban energy hub, a facility that manages the energy flows within a city quarter or community, and the urban microgrid, a small-scale urban energy system integrating electrical and thermal local generation, loads and storage having the possibility to locally interact with these devices to achieve optimal control functionalities. The integration of energy hubs and microgrids in urban energy systems would lead to new system configuration where the pros and cons of the different energy carriers are better utilized as compared with today’s urban energy system.

UMEM - Sustainable cities and urban energy systems of the future: Urban Multiscale Energy Modelling
Funding: Competence Center Energy and Mobility (CCEM)
Duration: 2012-2015
In this project the focus is on finding sustainable solutions for achieving energy targets on city quarter level, rather than at building scale. The urban energy retrofit scenarios profit from the enlarged economical potential of energy efficiency, energy production and energy storage by a cluster of buildings which are interconnected in a city neighbourhood and profiting from the urban energy infrastructure. The new urban energy retrofit scenarios have to take into account the impact of the urban heat island effect and the changing urban microclimate (e.g. heat waves) due to climatic change. The new concepts have to guarantee sustainable living conditions, comfort and health for their inhabitants in the urban and building environment. The developed urban energy simulation framework will help collectivities, urban planners and stakeholders to evaluate the environmental impact of cities in a changing climate and to provide a basis for testing new urban energy retrofit scenarios.

PhD theses published in this domain at LESO-PB
- A framework to model and simulate the disaggregated energy flows supplying buildings in urban areas, Diane Perez, EPFL thesis #6102, 2014
- Probabilistic Bottom-Up Modelling of Occupancy and Activities to Predict Electricity Demand in Residential Buildings, Urs Wilke, EPFL thesis #5673, 2013
- On the unification of behavioural modelling, human comfort and energy simulation in buildings, Frédéric Haldi, EPFL thesis #4587, 2010
- On the modelling and optimisation of urban energy fluxes, Jérôme Kämpf, EPFL thesis #4548, 2009
- Multiscale modelling of urban climate, Adil Rasheed, EPFL thesis #4531, 2009
In order to model the dynamics of built environment and understand their sustainable development, as well as their interactions with infrastructure networks and urban ecosystem we need a comprehensive theoretical understanding of cities as complex systems. One principal aim of this research is to use the complex system theories and methods from physics and engineering in order to reduce the negative environmental impact of the cities through the following approaches: (1) developing energy-efficient urban forms, (2) modelling and identifying renewable energy resources from regional to city scale, (2) improving our understanding of urban metabolism, (3) improving the environmental impacts of urban infrastructure networks and mobility patterns through data-driven approaches and real-time data (4) assessing and minimising the ecological footprints of cities.

Published work relates to

- Statistical modelling of the built environment
- Physics of urban form
- GIS (Geographic Information Systems) and spatial data analysis
- Transportation networks
- Sustainable urban planning

The Complex Urban Systems Group has been expanded to the following 4 main research themes: (1) Urban metabolism, (2) Energy-Efficient Urban Forms, (3) Size, Scaling Relations and Urban Metabolism, (4) Urban Data and Renewable Energy Potentials.

2014 Activities

The Swiss Competence Center for Energy Research (SCCER) Future Energy Efficient Buildings and Districts (FEEB&D) was initiated in June 2014. Within the Work package 3 “Urban Decentralised Energy Systems” the following task was started in October in 2014: “Data Mining: Geo-Dependent Energy Supply in Relation to Urban Form”, a new collaboration between EPFL-LESO, ETHZ, Empa, Geneva University and HSLU.
Current Projects

SCCER FEEB&D Urban Decentralized Energy Systems - Geo-dependent energy supply in relation to urban form

Funding: Swiss Commission for Technology and Innovation (CTI)
Duration: 2014-2016

Decentralized systems will require novel types of geo-spatial databases, new methods of urban pattern analysis, and new technology and modelling approaches. The aim is to develop geo-dependent energy-related tools, based on Geographic Information Systems (GIS), together with remote sensing and geo-statistics, as well as machine learning so as to identify the potential renewable energy resources (wind, solar, biomass, geothermal heat, and waste heat) and to model their spatio-temporal distributions from large to neighbourhood scale across Switzerland.
SMART BUILDINGS – SMART CITIES

Group leader: Prof. Jean-Louis Scartezzini
Postdoctoral researcher: Dr Vahid Nik
Senior adviser: Dr Nicolas Morel

Bio-mimetic control of building services (heating, cooling, ventilation, blinds, electric lighting) can simultaneously optimize energy use and indoor comfort (thermal, visual, air quality) through the use of advanced computer methodologies such as artificial neural networks, genetic algorithms, fuzzy logic, or advanced optimization algorithms. Our laboratory investigates control algorithms allowing at the same time:

- an optimal response to changing conditions (weather, building occupancy, lighting levels, thermal characteristics)
- a progressive adaptation to (possibly changing) building characteristics and to user preferences.

Research projects normally include two steps:

- development of innovative control algorithms and evaluation with computer simulation tools
- testing under real situations and evaluation of energy and comfort performances as well as acceptance by users.

Most bio-mimetic controllers are evaluated in the LESO building, which represents a powerful tool for our group.

Published work relates to

- Self-adaptive integrated building control systems
- Blind and electric lighting control algorithms
- Advanced control of electrochromic glazing
- Genetic algorithms for adaptation to user preferences
- Fuzzy logic for implementing building physics expert knowledge into the control algorithms
- Artificial neural networks for adaptive models and various control systems (for instance thermal model of the building or weather evolution).

2014 Activities

The activities were focused on the project Green-Mod supported by the Hasler Foundation; it aims elaborating of an information system able to optimize energy consumption in buildings while preserving human comfort. The main innovation of the project is the use of state-based stochastic modelling applied to temporal signals acquired from heterogeneous sources, such as distributed sensors as well as user wishes and preferences.
Current Projects in Biomimetic Building Control

SCCER FEEB&D Self-Sufficient Lighting Systems – High Dynamic Range Vision Controller

**Funding:** Swiss Commission for Technology and Innovation (CTI)

**Duration:** 2014-2016

The integration of advanced daylighting systems with high efficacy light sources (LEDs), energy efficient luminaries (based on non-imaging optics) and advanced controllers for HVAC and lighting systems (based on high dynamic range vision sensors) should allow reaching energy self-sufficiency for lighting systems. The main objective is to implement a high dynamic range vision sensor within daylighting and users presence responsive building controllers. The novel device will be set-up in an office room benefitting from integrated day- and electric lighting systems; its energy performance and users acceptance will be monitored “on-site” in a working environment. A technology transfer to the market and the real world will be set-up with industrial partners.

Green-Mod: Toward Reliable Stochastic Data-Driven Models Applied to the Energy Savings in Buildings

**Funding:** Hasler Foundation

**Duration:** 2012-2015

The Green-Mod project aims to produce a Building Information Management System (BIMS) able to minimize the energy demand in buildings while preserving human comfort. The main innovation of this BIMS for HVAC, sunshadings and electric lighting will be the use of state-based stochastic modelling applied to temporal signals acquired from heterogeneous sources.

PhD theses published in this domain at LESO-PB


Awards in this domain

- Antoine Guillemin, EPFL PhD Thesis #2778 (2003), Chorafas Award 2004
Many building surfaces are ideally suited for the use of solar energy, but high costs, technical and aesthetic considerations have long kept building owners and architects from using even a small part of this potential. The group "Renewables Integration into the Built Environment" addresses the key issue of optimal architectural integration of photovoltaic and thermal solar systems at the building and urban scales. The activities are structured around the three main axes of research hereafter.

Published work relates to

- Development of new and comprehensive urban and building strategies, to maximise solar energy use while ensuring an appropriate architectural quality to the local contexts. (LESO-QSV, Cross-mapping solar irradiation maps with criticity maps)
- Development of new adapted solar products, conceived for building integration
- Development and diffusion of architects’ and solar product manufacturers’ knowledge on solar integration issues / available solar technologies / integration criteria

2014 Activities

One key activity of the group was the implementation at urban scale of the criteria defining the quality of architectural integration established previously. This included the further development of the LESO-QSV method for communities, to help assess the acceptability of solar installations in the urban context.

The elaboration of a new software tool (LESO-QSV GRID) has been initiated to facilitate the implementation of the method by its intended users. An important activity consisted in the lead of the working group on "Processes, methods and tools" within the IEA SHC Task 51 “Solar Energy in Urban Planning”. In this context, the development of an innovative approach consisting in combining information of solar potential with urban sensitivity and system visibility has been proposed and initiated (cross-mapping).

A major contribution was delivered in the preparation of the future EPFL participation to the SOLAR DECATHLON competition (project structure, organisation and lead of summer workshop, site visits). Preparatory work has been conducted to ascertain the relevance and feasibility of a new PhD Thesis on urban criticity concept.
Current Projects

IEA SHC Task 51 Solar Energy in Urban Planning
Funding: Swiss Federal Office of Energy (SFOE)
Duration 2013 – 2016
The main objective of Task 51 is to provide support to urban planners, authorities and architects to propose urban areas and eventually whole cities with architecturally integrated solar energy solutions (active and passive), contributing to cities with a large fraction of renewable energy supply. This includes the objective to develop processes, methods and tools capable of assisting cities in developing long term urban energy strategies.

LESO QSV method
Funding: Swiss Federal Office of Energy (SFOE)
Duration 2011-2016
The goal of the project is to propose a method to help improving the architectural quality of the active solar installation projects. The method offers a way to assess the quality of a proposed integration, and helps define required quality levels, function of site sensitivity and system visibility. Extension of the concept of criticity into urban planning, in combination with irradiation mapping, was additionally included in the method.

Task 41 DA2 Manual update and multi-translations
Funding: Swiss Federal Office of Energy (SFOE)
Duration 2014-2015
One of the main results of SHC Task 41-Solar Energy in Architecture- is the manual for Architects “Solar Energy Systems in Architecture – integration criteria and guidelines”. Unfortunately this manual is available in English only, which limits its use in Switzerland. Therefore this project proposes a major update and the translation and publication in French and Italian, with a later option for German.

Recent publications in this domain


PhD theses published in this domain at LESO-PB

## EDUCATION AND TEACHING

### COURSES AND STUDENT FIGURES 2013/2014

#### Bachelor/Master Programmes

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<th>Course title</th>
<th>Lecturer</th>
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<tr>
<td>Building Physics I</td>
<td>Prof. J.-L. Scartezzini</td>
<td>AR BA1</td>
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<td>Building Physics II</td>
<td>Dr A. Schueler</td>
<td>AR BA2</td>
<td>295</td>
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<td>Prof. J.-L. Scartezzini</td>
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<td>Prof. J.-L. Scartezzini</td>
<td>AR BA6</td>
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<td>Quartiers, infrastructures et aménagement durable</td>
<td>Prof. J.-L. Scartezzini, Prof. A.-G. Dumont, Prof. R. Schlaepfer, Dr P. Tosolini, Dr. Ch. Ludwig, MSc D. Hofstetter, Dr N. Mohajeri,</td>
<td>AR/GC/SIE BA (ENAC Learning Units)</td>
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<td>Architecture &amp; Energie solaire: SOLAR DECATHLON 2016</td>
<td>MSc C. Roecker, Dr M.C. Munari Probst, Dr P. Tosolini</td>
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<td>Diagnostic en ENAC, démarche et outils de mesure</td>
<td>Dr M. Bensimon, MSc O. Burdet, MSc. M. Deront, M. Kradolfer, Dr N. Morel</td>
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#### Outside Teaching

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<td>Dr M.C. Munari Probst, lecturer course &quot;Energie et Développement durable dans l'environnement bâti&quot;</td>
<td>HES-SO MAS</td>
<td>2014-2015</td>
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<td>Dr M.C. Munari Probst, lecturer course &quot;Développement durable&quot;</td>
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<td>2014-2015</td>
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## ADVISING

### PhD 2014

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<tr>
<td>Modelling and assessment of urban energy systems</td>
<td>A.T.D. Perera</td>
<td>Prof. J.-L. Scartezzini Dr V. Nik (Lund Univ.)</td>
<td>2018</td>
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<td>Geo-dependent energy supply in relation to urban form</td>
<td>D. Assouline</td>
<td>Prof. J.-L. Scartezzini Dr N. Mohajeri</td>
<td>2018</td>
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<td>Novel materials for switchable windows</td>
<td>O. Bouvard</td>
<td>Prof. J.-L. Scartezzini Dr A. Schueler</td>
<td>2018</td>
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<td>Integrated Daylighting and Artificial Lighting Control based on High Dynamic Range Vision Sensors</td>
<td>A. Motamed</td>
<td>Prof. J.-L. Scartezzini</td>
<td>2018</td>
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<td>Architectural integration criticality and visibility evaluation of solar energy applications in urban sites</td>
<td>P. Florio</td>
<td>Prof. J.-L. Scartezzini Dr M.C. Munari Probst</td>
<td>2018</td>
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<td>Bioclimatic Design of Sustainable Campuses using Advanced Optimisation Methods</td>
<td>S. Coccolo</td>
<td>Prof. J.-L. Scartezzini Dr J. Kämpf</td>
<td>2017</td>
<td>N/A</td>
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<tr>
<td>Urban Multiscale Energy Modelling</td>
<td>G. Upadhyay</td>
<td>Prof. J.-L. Scartezzini Dr J. Kämpf</td>
<td>2016</td>
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<td>Building integrated PV – visual assessment with saliency map method</td>
<td>R. Xu</td>
<td>Prof. J.-L. Scartezzini Prof. S. Wittkopf (NUS/HSLU Luzern)</td>
<td>2016</td>
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<tr>
<td>Novel models towards predictive control of advanced building systems and occupant comfort in buildings</td>
<td>N. Zarkadis</td>
<td>Prof. J.-L. Scartezzini Dr N. Morel</td>
<td>2015</td>
<td>6440</td>
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<tr>
<td>Microstructured glazing for daylighting, glare protection, seasonal thermal control and clear view</td>
<td>A. Kostro</td>
<td>Prof. J.-L. Scartezzini Dr A. Schueler</td>
<td>2015</td>
<td>6465</td>
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<tr>
<td>On advanced daylighting simulations and integrated performance assessment of complex fenestration systems for sunny climates</td>
<td>C. Basurto Davila</td>
<td>Prof. J.-L. Scartezzini Dr J. Kämpf</td>
<td>2014</td>
<td>6425</td>
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<tr>
<td>A framework to model and simulate the disaggregated energy flows supplying buildings in urban areas</td>
<td>D. Perez</td>
<td>Prof. J.-L. Scartezzini Dr J. Kämpf</td>
<td>2014</td>
<td>6102</td>
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</table>

### PhD External Committees

<table>
<thead>
<tr>
<th>Involvement</th>
<th>Name</th>
<th>University</th>
<th>Adviser</th>
<th>Completion Year</th>
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<tbody>
<tr>
<td>PhD thesis committee</td>
<td>Viitanen, Janne</td>
<td>Aalto University</td>
<td>Prof. J.-L. Scartezzini</td>
<td>2014</td>
</tr>
<tr>
<td>Co-supervisors</td>
<td>Gou, Shaoqin</td>
<td>Tongji University, China</td>
<td>Prof. J.-L. Scartezzini Dr V. Nik</td>
<td>2015</td>
</tr>
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### Master Theses 2014

<table>
<thead>
<tr>
<th>Title</th>
<th>Student/Institution</th>
<th>Year</th>
<th>Programme</th>
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<tbody>
<tr>
<td>Planification des concepts énergétiques dans le cadre du développement immobilier d’un quartier durable appliqué à une entreprise totale</td>
<td>Amchikak, Marwan (EPFL)</td>
<td>2014</td>
<td>MSc Génie Civil</td>
</tr>
<tr>
<td>Les Bouquetins, une nouvelle cabane sur la haute route Chamonix-Zermatt (F, CH)</td>
<td>Hasler, Stéphanie Aline (EPFL)</td>
<td>2014</td>
<td>MSc Architecture</td>
</tr>
<tr>
<td>Les Bouquetins, une nouvelle cabane sur la haute route Chamonix-Zermatt (F, CH)</td>
<td>Pisanova, Barbora (EPFL)</td>
<td>2014</td>
<td>MSc Architecture</td>
</tr>
<tr>
<td>Diagnostic et Expertise Énergétique d’un bâtiment administratif « Minergie-ECO » construit en paille à Lausanne</td>
<td>Chaussinand, Adrien (INSA, Strasbourg/France)</td>
<td>2014</td>
<td>M. Eng. Génie Climatique</td>
</tr>
<tr>
<td>Effect of doping on VO2 thermochromic thin films deposited by magnetron sputtering</td>
<td>Krammer, Anna (INP, Grenoble /France)</td>
<td>2014</td>
<td>MSc FAME</td>
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<tr>
<td>Complex Geometry Facade Design and Daylighting Analysis</td>
<td>Shafeiminabad, Ayda (EPFL)</td>
<td>2014</td>
<td>MSc MES</td>
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<tr>
<td>Un « Energy Hub » sur le campus de l’EPFL : besoins et approvisionnement en chaleur</td>
<td>Walter, Emmanuel (EPFL)</td>
<td>2014</td>
<td>MSc MES</td>
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</table>

### Students from foreign universities, interns and grant holders

<table>
<thead>
<tr>
<th>Research</th>
<th>Student/Institution</th>
<th>Programme</th>
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<tbody>
<tr>
<td>Climate responsive strategies of traditional Chinese dwellings</td>
<td>S. Gou, Tongji University, China</td>
<td>Visiting scholar</td>
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<tr>
<td>Nanotechnology for solar energy conversion</td>
<td>R. Kukreja, IIT Bombay</td>
<td>Visiting scholar</td>
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<tr>
<td>IT</td>
<td>M. Leuret</td>
<td>Apprentice</td>
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<tr>
<td>Urban systems simulation</td>
<td>S. Seelig</td>
<td>Visiting scholar</td>
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<tr>
<td>IT</td>
<td>P. Roulin</td>
<td>Intern (Maturity)</td>
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<tr>
<td>IT</td>
<td>A. Stoll</td>
<td>Apprentice</td>
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<tr>
<td>IT</td>
<td>M. Winter</td>
<td>Apprentice</td>
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<tr>
<td>IT</td>
<td>R. Zweifel</td>
<td>Apprentice</td>
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<tr>
<td>Users probabilistic Modelling</td>
<td>U. Wilke</td>
<td>Programme BNF</td>
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### Semester Projects 2014

<table>
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<tr>
<th>Title</th>
<th>Student/Institution</th>
<th>Year</th>
<th>Programme</th>
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<tbody>
<tr>
<td>Energy use in Swiss building stock with changing climate</td>
<td>I. Dagsland Halderaker (NTNU Norway)</td>
<td>2014</td>
<td>-</td>
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<tr>
<td>Ecobilan comparatif ventilation double-flux / ventilation hybride</td>
<td>Favre, Adrien (EPFL)</td>
<td>2014</td>
<td>SIE-MA2</td>
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<tr>
<td>Built Form and Energy Efficiency (case study: Fribourg)</td>
<td>Gantet, Max Lucas (EPFL)</td>
<td>2014</td>
<td>EME-MA1</td>
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<tr>
<td>Ecobilan comparatif ventilation double-flux / ventilation hybride</td>
<td>Martinasso, Mélanie (EPFL)</td>
<td>2014</td>
<td>SIE-MA2</td>
</tr>
<tr>
<td>Energy and Urban Form</td>
<td>Minnig, Morgane (EPFL)</td>
<td>2014</td>
<td>EME-MA1</td>
</tr>
</tbody>
</table>
PUBLICATIONS 2014

REFEREED SCIENTIFIC JOURNALS


Gudmundsson, Agust; Lecoeur, Nora; Mohajeri, Nahid; Thordarson, Thorvaldur; Dike emplacement at Bardarbunga, Iceland, induces unusual stress changes, caldera deformation, and earthquakes, in Bulletin of Volcanology, vol. 76, num. 10, 2014.

Gou, Shaoqing; Li, Zhengrong; Zhao, Qin; Nik, Vahid; Scartezzini, Jean-Louis; Climate Responsive Strategies of Traditional Dwellings located in an Ancient Village in Hot Summer and Cold Winter Region of China, in Building and Environment Vol. 86, p. 151-165, 2014.

Münch, Mirjam; Plomp, Gijs; Thunell, Evelina; Kawasaki, A.; Scartezzini, J. L.; Herzog, Michael H.; Different colors of light lead to different adaptation and activation as determined by high-density EEG, in Neuralmage, Vol. 201, p. 547-554, 2014.


Mohajeri, Nahid; Poursistani, Pooneh; Poursistani, Poopak; Gudmundsson, Agust; Quantitative analysis of structural changes during rapid urban growth, in Journal of Urban Planning and Development, p.05014014-1, 05014014-10, 2014.

Kawasaki, Aki; Collomb, Sylvie; Leon, Lorette; Muench, Mirjam; Pupil responses derived from outer and inner retinal photoreception are normal in patients with hereditary optic neuropathy, in Experimental Eye Research, vol. 120, p.161-166, 2014.

Mertin, Stefan; Hody-Le Caër, Virginie; Joly, Martin; Mack, Iris; Oelhafen, Peter; Scartezzini, Jean-Louis; Schueler, Andreas; Reactively sputtered coatings on architectural glazing for coloured active solar thermal façades, in Energy and Buildings, vol. 68, p.764-770, 2014.

**CONFERENCE PROCEEDINGS**

Mohajeri, Nahid; Gudmundsson, Agust; Scartezzini, Jean Louis; Analysing and modelling the growth and efficiency of urban transportation infrastructures, *Symposium on Applied Urban Modelling - Planning Urban Infrastructure*, University of Cambridge, UK, April 1-3. 2014.

Mohajeri, Nahid; Gudmundsson, Agust; Kämpf, Jérôme; Scartezzini, Jean-Louis; Editor(s): Tourre, Vincent ; Besuievyksy, Gonzalo ; Visualizing street orientation and solar radiation in relation to complex topography, *Workshop on Urban Data Modelling and Visualisation*, Strasbourg, France., April 6, 2014.

Upadhyay, Govinda; Kämpf, Jérôme Henri; Scartezzini, Jean-Louis; Editor(s): Tourre, Vincent ; Besuievyksy, Gonzalo ; Ground temperature modelling: The case study of Rue des Maraîchers in Geneva, *Eurographics Workshop on Urban Data Modelling and Visualisation*, Strasbourg, France., April 6, 2014.

Vitale, Wolfgang Amadeus; Paone, Antonio; Fernández-Bolaños, Montserrat; Bazigos, Antonios; Grabinski, Wladek; Schüler, Andreas; Ionescu, Adrian; Steep slope VO2 switches for wide-band (DC-40 GHz) reconfigurable electronics, *72nd Device Research Conference*, Santa Barbara, California, USA, June 22-25, 2014.


Vitale, Wolfgang Amadeus; Paone, Antonio; Moldovan, Clara Fausta; Schueler, Andreas; Ionescu, Mihai Adrian; Growth optimization of vanadium dioxide films on SiO2/Si substrates, *40th Micro and Nano Engineering, Lausanne*, Switzerland, September 22-26, 2014.

Coccolo, Silvia; Kämpf, Jérôme Henri; Vigliotti, Franco; Scartezzini, Jean-Louis; Improving outdoor comfort and energy consumption of a city district in a desert area, *The 5 th International Conference on Drylands, Deserts and Desertification Healthy Lands - Healthy People*, Blaustein Institutes for Desert Research Sede Boqer Campus of Ben-Gurion University, Israel, November 17-20, 2014.

**PHD THeses**

A framework to model and simulate the disaggregated energy flows supplying buildings in urban areas, Diane Perez, EPFL thesis #6102, 2014

OTHER PUBLICATIONS, REVIEWS, PATENTS, REPORTS

Schueler, Andreas Joly, Martin, Patent WO 2014045241 A2 Method for hardening a coating of a solar collector element, and elements produced by means of said method

Schueler, Andreas Le Caër, Virginie, Patent WO 2014045141 A2 Laminated glazing with coloured reflection and high solar transmittance suitable for solar energy systems

Schueler, Andreas Le Caër, Virginie Joly, Martin, Patent WO 2014045144 A1 Interference filter with angular independent orange colour of reflection and high solar transmittance, suitable for roof-integration of solar energy systems

Schueler, Andreas Kostro, André Gabriel, Patent WO 2014024146 A1 Glazing with embedded microstructures for daylighting and seasonal thermal control

INVITED PRESENTATIONS AND OTHER EVENTS


Coccolo S., Il progetto bioclimatico urbano e la realtà montana. Spunti e riflessioni, Invited Lecturer, Politecnico di Torino, 12th March 2013 (Italy)

Schueler, A. “Nanocomposite optical coatings for solar energy conversion”, Keynote Speaker, Basler Forschungs Forum BASF, Basel, Switzerland 26 March, 2014

Munari Probst M.C., “Intégration des systèmes solaires actifs : critères d’acceptabilité urbaine”, PV-Tagung 2014, Keynote Speaker, Lausanne, April 2014

Mohajeri N., “Quantitative methods and visualisations techniques in urban studies (Spatial data Analysis), Invited lecturer, London School of Economics and Political Science, LES Cities, 6 May 2015


Mohajeri N., “Complex built environment systems”, Invited lecturer, University College London, Faculty of the Built Environment, The Bartlett School, 9 September 2014

Mohajeri N., “Sustainable urban design”, Keynote Speaker, Cardiff University, ARCHI – Welsh School of Architecture, 22 September 2014

Schueler, A. “Neues von der Glasfront”, Keynote Speaker, EcoBau 2014, september 2014, Bern, Switzerland
Invited presentations and other events [cont’d]


Kämpf, J. H. ETHZ Chair of information Architecture, Dr. R. König, December 2014

Nik, V. NSB 2014 – 19th Nordic Symposium on Building Physics, presenter and session chair.

Nik, V. “Future challenges for buildings in Europe until 2050”, Invited Lecturer, June 2014

MEDIA

Munari Probst MC, Technologies Solaires et Architecture - une Synthèse delicate, opening article for the special issue “Construction Solaire” of the Swiss journals Tec 21, Tracé and Archi, 05/2013 (translated in French, German, Italian).

Munari Probst, M. C., "Préserver la qualité architecturale” – Interview in « Efficience 21 », Autumn 2014

LESO LUNCHTIME LECTURES AND OTHER EVENTS

<table>
<thead>
<tr>
<th>Title</th>
<th>Lecturer</th>
<th>Date</th>
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<tbody>
<tr>
<td>Impact Assessment of Climate Change on the Hygrothermal Performance of Buildings</td>
<td>Dr Vahid Nik, EPFL/LESO-PB and Lund University, Sweden</td>
<td>11.04.2014</td>
</tr>
<tr>
<td>Architectural performative design: Case studies, processes and simulation tools</td>
<td>Prof Emanuele Naboni, LEED AP</td>
<td>06.06.2014</td>
</tr>
<tr>
<td>Thermal insulation – take some breaks in summer?</td>
<td>Dr Nikolaus Nestlé, BASF SE Ludwingshafen, Germany</td>
<td>27.06.2014</td>
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<tr>
<td>La construction en paille : Une innovation dans le développement des bâtiments durables ?</td>
<td>Adrien Chaussinand, INSA Strasbourg</td>
<td>04.09.2014</td>
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<tr>
<td>Improving Urban Climate Modeling from the City to the Building Scale</td>
<td>Dr Dasaraden Mauree, EPFL/LESO-PB</td>
<td>03.10.2014</td>
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<tr>
<td>Visual assessment of BIPV with saliency map method</td>
<td>Ran Xu, Lucerne University of Applied Sciences and Arts</td>
<td>07.11.2014</td>
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<td>Design implications on future urban energy systems</td>
<td>Kristina Orehounig, ETH Zurich, EMPA</td>
<td>05.12.2014</td>
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### REPRESENTATION

#### EPFL INTERNAL

<table>
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<th>Name</th>
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<tbody>
<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>Member of EPFL Excellence Fellowship Committee</td>
<td>2012</td>
<td>-</td>
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<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>Member of SAR Academic Committee</td>
<td>2012</td>
<td>-</td>
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<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>Member of CISBAT 2015 Scientific Committee</td>
<td>2013</td>
<td>-</td>
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<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>EPFL Doctoral Programme in Energy (EDEY), Member of Doctoral Committee</td>
<td>2010</td>
<td>-</td>
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<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>Search Committee, ENAC Chair “Renewable Energy Integration in Buildings”, Member</td>
<td>2014</td>
<td>-</td>
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<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>ENAC IT Strategic Committee</td>
<td>2014</td>
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<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>Member of CISBAT 2015 Scientific Committee</td>
<td>2013</td>
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<tr>
<td>Dr J. Kämpf</td>
<td>Member of CISBAT 2015 Scientific Committee</td>
<td>2013</td>
<td>-</td>
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<tr>
<td>Dr A. Kostro</td>
<td>Member of CISBAT 2015 Scientific Committee</td>
<td>2014</td>
<td>-</td>
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<tr>
<td>Dr N. Mohajeri</td>
<td>OQA/CTI Audit MES Teacher Meeting</td>
<td>2014</td>
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<td>Dr N. Mohajeri</td>
<td>Member of CISBAT 2015 Scientific Committee</td>
<td>2014</td>
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<td>Dr N. Morel</td>
<td>Member of CISBAT 2015 Scientific Committee</td>
<td>2013</td>
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<tr>
<td>Dr M.C. Munari Probst</td>
<td>Member of CISBAT 2015 Scientific Committee</td>
<td>2013</td>
<td>-</td>
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<tr>
<td>Dr A. Schueler</td>
<td>Member of SAR Teaching Committee</td>
<td>2013</td>
<td>-</td>
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<tr>
<td>Dr A. Schueler</td>
<td>Coordinator for Security COSEC for LESO-PB</td>
<td>2011</td>
<td>-</td>
</tr>
<tr>
<td>Dr A. Schueler</td>
<td>Member of CISBAT 2015 Scientific Committee</td>
<td>2013</td>
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#### EPFL EXTERNAL

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<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>Solar Energy International Journal, Associate Editor</td>
<td>2000</td>
<td>-</td>
</tr>
<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>IPCC Working Group III – Mitigation of Climate Change, Expert Reviewer</td>
<td>2008</td>
<td>-</td>
</tr>
<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>Qatar National Research Fund (QNRF), National Priorities Research Program (NRRP), Peer Reviewer</td>
<td>2007</td>
<td>-</td>
</tr>
<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>SIA Regards 2013 – National award for sustainable and promising achievements, Swiss Society for Engineers and Architects (SIA), Zurich, Member of Jury Panel</td>
<td>2013</td>
<td>2014</td>
</tr>
<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>Swiss Competence Centre for Energy and Mobility (CCEM-CH), Research Committee Chair</td>
<td>2005</td>
<td>2014</td>
</tr>
<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>International Council for Research and Innovation in Building and Construction, EPFL Representative</td>
<td>2004</td>
<td>-</td>
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<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>European Renewable Energy Research Centres Agency (EUREC), College of Member, EPFL Representative</td>
<td>2004</td>
<td>-</td>
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<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>Canadian Foundation for Innovation (CFI), Expert Reviewer</td>
<td>2010</td>
<td>2014</td>
</tr>
<tr>
<td>Prof. J.-L. Scartezzini</td>
<td>InnoTech Award Committee, Services Industriels de Genève, 18th Nov. 2014, member</td>
<td>2014</td>
<td>-</td>
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<tr>
<td>Dr M.C. Munari Probst</td>
<td>IEA Task 51 Solar Energy and Urbanism, Subtask B co-group leader</td>
<td>2013</td>
<td>2016</td>
</tr>
<tr>
<td>Dr M.C. Munari Probst</td>
<td>Swissolar Association (Bern), Member of Architecture Group</td>
<td>2010</td>
<td>-</td>
</tr>
<tr>
<td>Dr M.C. Munari Probst</td>
<td>International Conference Eurosun 2014, Aix-Les-Bains, September 2014, Scientific committee, Presenter and session chair</td>
<td>2013</td>
<td>2014</td>
</tr>
<tr>
<td>MSc C. Roecker</td>
<td>IEA Task 51 Solar Energy and Urbanism, Subtask B co-group leader</td>
<td>2013</td>
<td>2014</td>
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<tr>
<td>MSc C. Roecker</td>
<td>Swiss PV days programming group</td>
<td>2013</td>
<td>-</td>
</tr>
<tr>
<td>Dr J. Kämpf</td>
<td>Second Eurographics Workshop on Urban Data Modelling and Visualisation (UDMV), Strasbourg, April 2014, Program committee member</td>
<td>2014</td>
<td>-</td>
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<tr>
<td>Dr J. Kämpf</td>
<td>Building Simulation and Optimisation Conference 2014 (BSO14), 23-24.6.2014, Scientific committee member</td>
<td>2014</td>
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<td>Dr J. Kämpf</td>
<td>Eurosun 2014, Reviewer</td>
<td>2014</td>
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<td>Dr N. Mohajeri</td>
<td>Environment and Planning B: Planning and Design Journal, Reviewer</td>
<td>2014</td>
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<tr>
<td>Dr N. Mohajeri</td>
<td>Urban Studies Journal, Reviewer</td>
<td>2014</td>
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<tr>
<td>Dr N. Mohajeri</td>
<td>Journal of Geographical Systems, Reviewer</td>
<td>2014</td>
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<td>Dr N. Mohajeri</td>
<td>International Journal of Geographic Information Science, Reviewer</td>
<td>2014</td>
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<tr>
<td>Dr A. Schüler</td>
<td>6th IBPC Conference – Building Physics for a Sustainable Built Environment, June 2015, Committee member</td>
<td>2014</td>
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<tr>
<td>Dr V. Nik</td>
<td>Journal of automation in Construction, Reviewer</td>
<td>2014</td>
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<td>Dr V. Nik</td>
<td>Solar Energy Journal, Reviewer</td>
<td>2014</td>
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<td>Dr V. Nik</td>
<td>Journal of Building and Environment, Reviewer</td>
<td>2014</td>
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</table>
Solar Energy and Building Physics Laboratory (LESO-PB)
Swiss Federal Institute of Technology Lausanne (EPFL)
School of Architecture, Civil and Environmental Engineering (ENAC)
Civil Engineering Institute (IIC)

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