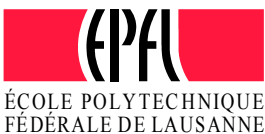


SOLAR ENERGY AND BUILDING PHYSICS LABORATORY

LABORATOIRE D'ENERGIE SOLAIRE ET DE PHYSIQUE
DU BÂTIMENT



Activity Report 2017



Energy Efficiency & 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)
Civil Engineering Institute (IIC)

EPFL – ENAC – LESO-PB
Bâtiment LE
Station 18
CH-1015 Lausanne
Switzerland
Phone: +41 21 693 45 45
Fax: +41 21 693 2722
Email: leso-pb@epfl.ch

<http://leso.epfl.ch>

EPFL Solar Energy and Building Physics Laboratory (LESO-PB)

ACTIVITY REPORT 2017

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, architects and technicians. This report presents the 2017 teaching, research and technology transfer activities of the lab.

LIST OF CONTENTS

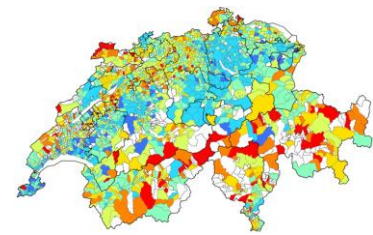
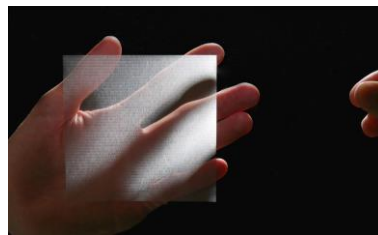
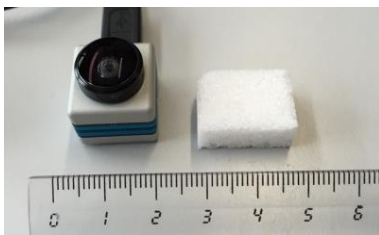
RESEARCH OVERVIEW	2
INTRODUCTION.....	2
INTEGRATED DAYLIGHTING AND ELECTRIC LIGHTING	3
NANOTECHNOLOGY FOR SOLAR ENERGY CONVERSION.....	5
URBAN SYSTEMS SIMULATION	7
COMPLEX URBAN SYSTEMS.....	9
SMART BUILDINGS.....	11
BUILDING INTEGRATION OF RENEWABLE ENERGIES	13
EDUCATION AND TEACHING	15
2017 COURSES AND STUDENT FIGURES	15
Bachelor/Master Programmes	15
Additional Teaching	15
ADVISING.....	15
PhD	15
Master Theses	16
Semester projects	16
Apprentices and Trainees.....	17
Visiting scholars, interns and grant holders	17
PUBLICATIONS 2017	18
REFEREED SCIENTIFIC JOURNALS.....	18
CONFERENCE PAPERS	20
CONFERENCE PROCEEDINGS	21
REVIEWS.....	21
PHD THESES	21
REPORTS	21
OUTREACH	22
INVITED PRESENTATIONS	22
EVENTS ORGANISED.....	23
REPRESENTATION	23
EPFL INTERNAL COMMITTEES.....	23
EXTERNAL COMMITTEES & APPOINTMENTS.....	23

RESEARCH OVERVIEW

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. This report describes the activities of the lab in 2017, 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
- Building integration of renewable energy



Research highlights in 2017 - Shaping a more sustainable future

- Major advances have been made in the field of thermochromic materials. The results were reported in Applied Physics and in Scientific Reports, among other, and an international patent was published. (Schüler, Krammer)
- A novel High Dynamic Range Vision Sensor has made integrated electric lighting and shading control systems much more sensitive to human needs with respect to visual comfort. For this research as well, an international patent was published. (Motamed et al.)
- Links have been established between human outdoor comfort and building energy efficiency simulation, in an effort to improve the design of entire neighbourhoods with an eye on global warming. (Mauree, Cocco et al.)
- Solar and wind mapping methods have advanced significantly. Here as well, the aim is to foster renewable energies considering large areas. (Mohajeri, Assouline)
- At the same time, work has progressed on distributed urban energy systems, essential for high efficiency use of a combination of renewable energy sources. (Perera)

Events and media

- The CISBAT 2017 International Conference on "Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale" organised by our lab in September attracted 265 participants from 30 countries. 192 papers were published in Elsevier's open access Energy Procedia. Academic partners were Cambridge University, MIT, the Swiss chapter of the International Building Performance Simulation Association IBPSA and the Swiss Competence Center for Energy Research "Future Energy Efficient Buildings & Districts" (SCCER FEEB&D).
- At the SCCER FEEB&D "Science meets Industry" event organised in the framework of CISBAT 2017, researchers and industry executives discussed the paths to take towards a more sustainable and energy efficient built environment, presenting both expectations and potentials on industry side and the rapid advances made by research.
- The nanogroup was very present in the media when the World's largest coloured solar glass envelope was installed on the iconic building of Copenhagen International School with technology developed at LESO-PB. The same technology was chosen for the new façade of the Swedish Research Institute later in the year. The availability of efficient solar cladding in diverse colours opens up great possibilities for renewable energy integration in large scale architecture.

INTEGRATED DAYLIGHTING AND ELECTRIC LIGHTING

Group leader: Prof. Jean-Louis Scartezzini

Senior scientist : Prof. Jérôme Kämpf (HEIA-FR)

PhD students: Yujie Wu, Marta Benedetti



The embedded photometric device assessing work-plane illuminance based on sky monitoring.

The Integrated Daylighting 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 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 and advanced monitoring devices are under development.

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 ergonomic daylighting test modules
- High-resolution mapping of the sky and ground vault

2017 Activities

2017 was mostly dedicated to R&D in the framework of Module “Building Human Interaction” of the Swiss Competence Center for Energy Research “Future Energy Efficient Buildings and Districts”. In an effort to improve the accuracy of real-time on-board lighting simulation, an embedded device for high resolution mapping of the sky and ground vault has been developed and fine-tuned within a test module.

A new paper was furthermore published in Alzheimer Research based on studies on the effect of light on humans, performed at our lab by Mirjam Muench et al.

Research results in the field of day and electric lighting are fully integrated in smart building control systems (see separate topic).

Current Projects

SCCER FEED&D Phase II, Task 1.2.2 Automated “Eyesight” Venetian Blinds

Funding: Commission for Technology and Innovation (CTI)

Duration: 2017- 2020

External Venetian Blinds (EVB) are prevalently used to manage daylight and solar radiation in dwellings and office buildings. Automation of the blinds can enhance occupants’ visual comfort and achieve energy savings regarding electric lighting as well as cooling/heating load. In this task, an integrated ‘open-loop’ automated EVB system is developed by implementing a digital camera in the outer part of a window frame, pointing toward the sky vault. Issues of traditional ‘close-loop’ systems such as installing separate indoor sensors in the working space will be avoided by that way. Based on image processing and lighting computations, glare risks and luminance distribution (horizontally and vertically) in the room are evaluated in order to satisfy occupants’ visual comfort. Both algorithms will be implemented in an ultra-fast microprocessor for real-time calculation in the system embedded in the window frame.

NEST SolAce | REcomfort - Perception based Human Comfort and Multi-Functional Solar Facade

Funding: ETH Board

Duration: 2017-2020

Even in old-established branches like the heating, ventilating and air conditioning industry there are blank areas: one of these spots is the capture of solar energy and daylight by the building envelope. These topics are investigated by EPFL Researchers and their industrial partners in the SolAce | REcomfort unit: multifunctional facade technologies are implemented to achieve an Energy-Plus and Low Carbon combined working/living space.

Recent PhD theses in this domain

- Integrated Daylighting and Artificial Lighting Control based on High Dynamic Range Vision Sensors, *Ali Motamed, EPFL PhD Thesis #8277, 2017*
- Lighting Environment in Buildings - Nonvisual Light Perception and Inter-Individual Differences, *Lenka Maierova, PhD Thesis Czech Technical University in Prague, Faculty of Civil Engineering 2015, based on studies performed in the framework of a SCIEX Scholarship at our Lab from 2011-2013*
- On advanced daylighting simulations and integrated performance assessment of complex fenestration systems for sunny climates, *Chantal Basurto, EPFL PhD Thesis #6425, 2014*
- 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*

Selected 2017 publications

- Scartezzini J.L. (editor & author) et al. SCIENCE/AAS Supplement “Changing Perspectives on Daylight: Science, Technology, and Culture”, Daylight Academy, 2017
- Basurto C., Kämpf J. H., Scartezzini J.-L., Multi-criteria analysis for the integrated performance assessment of complex fenestration systems, in *Building Research And Information*, vol. 45, num. 8, p.926-942, 2017
- Wu Y., Kaempf J. H., Scartezzini J.-L., Characterization of a quasi-real-time lighting computing system based on HDR imaging, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.649-654
- Muench M., Schmieder M., Bieler K., Goldbach R., Fuhrmann T., Zumstein N., Vonmoos P., Scartezzini J.-L., Wirz-Justice A., Cajochen C., Bright Light Delights: Effects of Daily Light Exposure on Emotions, Rest-activity Cycles, Sleep and Melatonin Secretion in Severely Demented Patients, in *Current Alzheimer Research*, vol. 14, num. 10, p.1063-1075, 2017

Patents

- Sky monitoring system, Deutsches Patent-und Markenamt, P17020-DE, Wu Yujie, Kämpf Jérôme Henri, Scartezzini, Jean-Louis

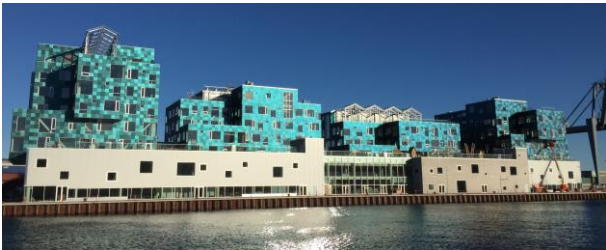
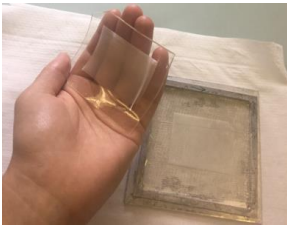
NANOTECHNOLOGY FOR SOLAR ENERGY CONVERSION

Group leader: Dr Andreas Schüler

Postdoctoral fellow: Dr André Kostro,

PhD students: Olivia Bouvard, Jing Gong, Anna Krammer, Djamel Mansour (FhG-ISE, Freiburg, Germany)

Research assistants: Luc Burnier, Alexandre Diévar, Jérémy Charmillot



Due to their fascinating optical and electronic 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 nano-crystals 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 facades, 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. It has submitted and been granted several patents.

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
- Structured transparent low emissivity coatings with high microwave transmission

2017 Activities

Highlights of this year include:

- Major advances were made with respect to phase change properties in the field of thermochromic materials and microelectronics. The results were reported in Applied Physics and in Scientific Reports, among other, and a European patent was published.
- A PCT application was filed on a High Performance Solar Cooker and an grant was obtained for its further development. The development was a joint effort with the Urban systems group.
- The group advanced in the development of dry lithiation for all-solid-state electrochromic windows, which should considerably expand their lifetime and quality.
- The microwave transparent insulation glazing developed in a project with AGC-Vim and BLS was commissioned for 29 trains and other major train companies expressed their interest.
- The flagship Copenhagen International School building as well as several other iconic buildings were covered with colored solar pv cladding based on patented developments by this group.

Current Projects

Target 95 - Thermochromic coatings for overheating protection of solar thermal collectors - novel type of doping

Funding: Swiss Federal Office of Energy (SFOE)

Duration: 2015-2018

Overheating and stagnation of solar thermal collectors lead to water evaporation, glycol degradation and stresses as well as degradation of collector component materials. In this project, thermochromic coatings that exhibit a change in optical properties at critical temperatures are further developed. The effect of doping on the transition temperature is studied. Multi-layered coatings for maximised performance are developed, applications explored, and promising fields for market introduction identified.

Reduzierung des Heizenergiebedarfs von Bahnfahrzeugen durch verbesserte Wärmedämmung der Fahrzeughülle

Funding: Swiss Federal Office of Energy (SFOE)

Duration: 2017-2019

To reduce electricity consumption in rail transport, a large project with multiple partners including LESO-PB investigates all relevant aspects of vehicle envelopes. Based on Phase I of this project, which included the development of insulation glazing transparent to microwaves used in mobile networks (Windowave), a prototype train wagon is installed, monitored and compared to a reference train.

SCCER FEEB&D Phase II, Task 1.1.2 Glazing with dynamic solar heat gains

Funding: Commission for Technology and Innovation (CTI)

Duration: 2017-2020

Novel glazing with dynamic solar heat gains is developed applying two approaches: the development of light-redirecting microstructures that allow a clear view while providing seasonal thermal control and visual comfort and the development of nanostructured electrochromic materials with enhanced switching speed and durability.

High-performance solar cooker (Project in collaboration with Urban Systems group)

Funding: ENAC Enable-InnoSeed Program

Duration: 2017-18

In this project, a new, high-efficiency solar cooker is developed with the aim of market introduction. Its novelty resides in the combination of high thermal performance glazing with low-emissivity coating, high window-to-wall surface ratio, vacuum insulation and a foldable high reflectivity concentration system.

Selected 2017 publications

- Krammer A., Magrez A., Vitale W. A., Mocny P., Jeanneret P., Guibert E., Whitlow H. J., Ionescu A. M., Schueler A., Elevated transition temperature in Ge doped VO₂ thin films, in Journal Of Applied Physics, vol. 122, num. 4, p.045304, 2017
- Bouvard O., Lanini M., Burnier L., Witte R., Cuttat B., Salvadè A., Schueler A., Structured transparent low emissivity coatings with high microwave transmission, in Applied Physics a Materials Science and Processing, vol. 123, num. 66, 2017
- Burnier L., Lanini M., Bouvard O., Scanferla D., Varathan A., Genoud C., Marguerit A., Cuttat B., Dury N., Witte R., Salvade A., Schueler A., Energy saving glazing with a wide band-pass FSS allowing mobile communication: up-scaling and characterisation, in IET Microwaves Antennas & Propagation, vol. 11, num. 10, p.1449-1455, 2017
- Vitale W. A., Casu E. A., Biswas A., Rosca T., Alper C., Krammer A., Luong G. V., Zhao Q.-T., Mantl S., Schüler A., Ionescu A. M., A Steep-Slope Transistor Combining Phase-Change and Band-to-Band-Tunneling to Achieve a sub-Unity Body Factor, in Scientific Reports, vol. 7, num. 1, 2017
- Oliva N., Casu E. A., Yan C., Krammer A., Rosca T., Magrez A., Stolichnov I., Schueler A., Martin O.J. F., Ionescu A. M., Van der Waals MoS₂/VO₂ heterostructure junction with tunable rectifier behavior and efficient photoresponse, in Scientific Reports, vol. 7, num. 1, p.2923-2929, 2017

Patents

- WO2017134589 A1: Coating for optical and electronic applications
- EP2882921: Glazing with embedded microstructures for daylighting and seasonal thermal control
- WO 2014045141 A2: Laminated glazing with coloured reflection and high solar transmittance suitable for solar energy systems
- WO 2014045144 A1: Interference filter with angular independent orange colour of reflection and high solar transmittance, suitable for roof-integration of solar energy systems

URBAN SYSTEMS SIMULATION

Group leader: Dr Dasaraden Mauree

PhD students: Silvia Coccolo, Amarasinghage T. Dasun Perera

Guest scientist: Prof. Emanuele Naboni

Senior scientists: Prof. Vahid Nik (Lund/Chalmers University), Prof. Jérôme Kämpf (HEIA-FR)



Annual net electricity consumption for the district of Jonction, Geneva

The group focuses on better understanding urban systems through their physical processes, to improve their environmental sustainability.

Urban systems, generally consisting of several building blocks, are analysed either by simulation or by measurement to account for the numerous interactions happening between the elementary building objects and their environment. These interactions can be radiative (with the exchange of shortwave and longwave), conductive and convective (through the exchange of heat) but can also relate to the impact of built surfaces on the air flow and trapping of heat in urban areas. The group also works on the integration of decentralized energy systems in urban areas by looking at the energy flows.

Due to the complexity of urban areas, simplified simulation tools are developed and used to maintain a balance between accuracy and computational time. The different monitoring campaigns provide useful data to validate and improve the models.

Published work relates to

- Building energy demand in urban settings
- Distributed energy systems
- Urban building effects on local microclimate
- Multi-scale modelling of urban energy fluxes
- Urban heat island effect, including urban microclimatology
- Outdoor environmental comfort
- Simulation of energy and matter resource flows in urban systems

2017 Activities

The Urban Systems Simulation group was involved in multiple projects and initiatives, in particular within the framework of the Swiss Competence Center for Energy Research - Future Energy Efficient Buildings and Districts (SCCER-FEEB&D). Its two main focal points were urban microclimate and distributed energy systems. Related investigations focused on:

- Interactions of urban buildings and local weather patterns
- Turbulences in an urban setup – measurements by means of MOTUS 27m mast on EPFL campus
- Urban energy demand and outdoor comfort, with future projections related to global warming
- Design optimization of grid integrated hybrid energy hubs
- Collaboration with industrial partners for tech transfer from research projects (Griesser and Lösinger Marazzi)

Furthermore, work was done on the development of a high efficiency solar cooker in collaboration with the nano-solar group.

Current Projects

SCCER FEED&D Phase II, Task 2.3.1 Analysis and assessment of RDES cases

Funding: Commission for Technology and Innovation (CTI)

Duration: 2017- 2020

The group is directly involved in the development of new modelling tools and transfer of findings into practice with the assessment of demonstrators and applications in typical project cases. The aim is to foster a wide-spread dissemination of findings concerning design and operation into other projects and real site applications. In existing districts and communities, integrated energy infrastructure installation possibilities are limited and require specific and combined solutions. In the future, it is expected that multi-energy grid (MEG) and energy hub (EH) shall help facilitate the effective operation and integration of such RDES. The purpose of these tasks is to analyse and assess the RDES cases with a quantitative illustration of the energy and emission reduction potentials using RDES solutions with MEG/EH and compare with conventional or alternative approaches

MOTUS

Funding: ENAC Equipment call

Duration: 2016-2019

A 27m mast with instruments at a regular interval (4m) along the vertical axis to obtain a high-resolution profile of meteorological parameters was installed in 2016. The installation was completed with 6 additional anemometers on the LESO-PB south façade to improve the understanding of turbulent processes and the automated control of blinds. Extension for its funding was obtained until December 2019.

Selected 2017 publications

- Mauree D., Blond N., Kohler M., Clappier A., On the Coherence in the Boundary Layer: Development of a Canopy Interface Model, in *Frontiers in Earth Science*, 2017
- Perera A. T. D., Nik V. M., Mauree D., Scartezzini J.-L., Electrical hubs: An effective way to integrate non- dispatchable renewable energy sources with minimum impact to the grid, in *Applied Energy*, 2017
- Perera A. T. D., Nik V. M., Mauree D., Scartezzini J.-L., An integrated approach to design site specific distributed electrical hubs combining optimization, multi-criterion assessment and decision making, in *Energy*, vol. 134, p.103-120, 2017
- Mauree D., Coccolo S., Kaempf J., Scartezzini J.-L., Multi- scale modelling to evaluate building energy consumption at the neighbourhood scale, in *PLoS ONE*, vol. 12, num. 9, p.e 0183437, 2017

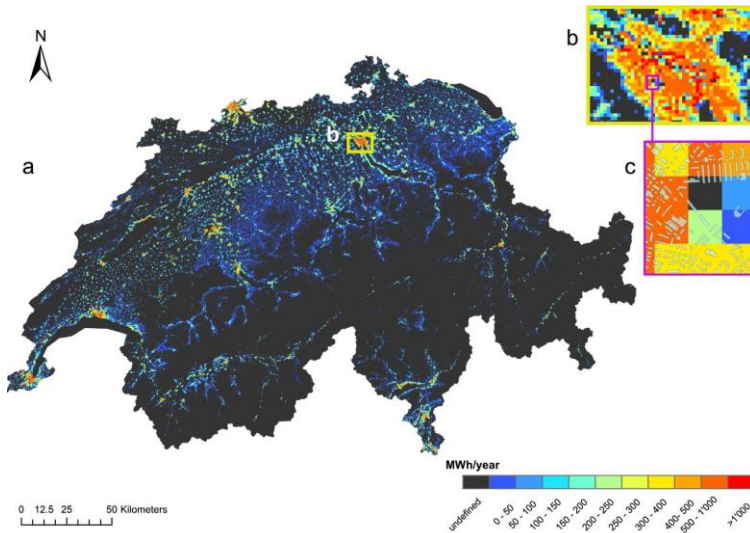
Recent PhD Theses in this field

- Coccolo Silvia, Bioclimatic Design of Sustainable Campuses using Advanced Optimisation Methods, Thèse EPFL, n° 7756, 2017
- Perez Diane, A Framework to Model and Simulate the Disaggregated Energy Flows Supplying Buildings in Urban Areas, n° 6102, 2014
- Kämpf, Jérôme, On the modelling and optimisation of urban energy fluxes, n° 4548, 2009
- Rasheed, Adil, Multiscale modelling of urban climate, n° 4531, 2009

COMPLEX URBAN SYSTEMS

Project leader: Dr Nahid Mohajeri

PhD students: Dan Assouline, Alina Walch



Yearly technical potential for rooftop PV electricity production

In order to model the dynamics of the built areas and understand their sustainable development as well as their interactions with infrastructure networks and urban ecosystems we need a comprehensive theoretical understanding of cities as complex systems. The aim of this research is to use complex system theories and methods to reduce the negative environmental impact of 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. The focus is hence on (1) Urban metabolism, (2) Energy-Efficient Urban Forms, (3) Size, Scaling Relations and Urban Metabolism, (4) Urban Data and Renewable Energy Potentials.

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

2017 Activities

Research has advanced in the project “Energy performance at regional and national level”, a collaboration between EPFL-LESO-PB, ETHZ, Empa, Geneva University and HSLU within the Swiss Competence Center for Energy Research “Future Energy Efficient Buildings and Districts”. The LESO-PB focus in 2017 was on

- The complexity of roof-shape and solar energy potential. A multidisciplinary approach for classification of different roof shapes was further developed, analysing their solar potential and assessing them based on different characteristics to find out how well they receive solar energy. The method has been extended to provide the rooftop PV technical potential for each pixel of a grid covering the entire country.
- Street canyon and accessibility of solar energy potential. GIS tools and CitySim were used to investigate how street configuration controls solar potential, particularly with regard to street surface and facades.
- A web-service for large scale geo-building energy databases was further developed in collaboration with University of Geneva. This platform will help mapping the renewable energy potential of urban sites in the whole of Switzerland.
- Kick-off of the Hyenergy project (Hybrid Renewable Energy Potential for the Built Environment using Big Data: Forecasting and Uncertainty Estimation funded by Swiss National Science Foundation - NRP 75). Two PhD students were employed for this project in collaboration with UNIL.

Furthermore, several semester projects investigated the relation between Energy consumption and Urban Form and the Energy Hub concept for two villages in Switzerland.

Current Projects

SCCER FEEB&D Phase II, Task 3.2.1 Current potential of renewable energy sources

Funding: Commission for Technology and Innovation (CTI)

Duration: 2017-2020

We develop a novel methodology combining Geographic Information Systems (GIS) and a Machine Learning (ML) algorithm, Random Forests, to estimate the technical potential for rooftop PV solar energy at the scale of a country. The study focuses on Switzerland and provides the rooftop PV technical potential for each pixel of a grid covering the entire country. The methodology is generalizable to any region for which similar data is available and useful to assess the rooftop PV capacity of a region. Prediction Intervals are also provided for the different estimated variables to measure the uncertainty of estimations. The results show that Switzerland has a large potential for rooftop PV installations, i.e. for roofs orientated at $\pm 90^\circ$ from due south, the total estimated potential PV electricity production is about 16.29 TWh/year, which corresponds to 25.3% of the total electricity demand in 2017.

HYENERGY - Hybrid renewable energy potential for the built environment using big data

Funding: Swiss National Science Foundation – National Research Program 75 “Big data”

Duration: 2017-2020

The objective of this project is to develop a method for forecasting the spatio-temporal potential of a combination of renewable energy resources for built areas. A data-driven approach and machine learning algorithms are used to (i) estimate the hybrid renewable energy potential in the built environment, in order to mitigate the effects of variability in individual energy resources and improve the reliability of power generation, (ii) develop machine learning algorithms for spatio-temporal environmental data processing and analysis as well as for LiDAR point cloud urban dataset classification, (iii) apply developed algorithms based on Extreme Learning Machine (ELM) to the built environment for predicting energy generation and potential energy savings of hybrid renewable resources, (iv) analyse the forecasting models according to the projected climate scenarios for 2035 and 2050, (v) estimate uncertainty and validate models using measurement data from weather stations and energy providers, (vi) propose Building Renewable Energy Database (BRED), geo-visualisation tools and renewable energy mapping to support evidence-based decision-making processes.

Integrating urban form and sociotechnical potentials of decentralised energy supply for sustainable urban development

Funding: SNSV – Advanced Postdoc Mobility fellowship Dr Nahid Mohajeri (host institute University of Oxford)

Duration: 2017-2019

Decentralising the urban energy supply, particularly through the use of PVs, requires a comprehensive assessment of their sociotechnical and techno-economic co-evolution. The project aims not only (a) to improve and refine our knowledge of the resource and technical PV potential for Switzerland with application to other areas (e.g., UK), but also (b) to analyse how solar energy technologies and associated social acceptance and affordability evolve together, and (c) how their co-evolution may affect sustainable urban development and energy policies. More specifically, the project aims at exploring (i) the effects of physical urban forms, particularly urban density and the shapes of rooftops, at national scale on the efficiency of energy production through PVs, and to connect urban forms to (ii) different sociotechnical aspects of decentralised electricity production and (iii) to the associated socio-economic parameters (costs, acceptance, affordability, etc.), as well as (iv) to the saving CO₂ emissions and energy policies of the local energy production.

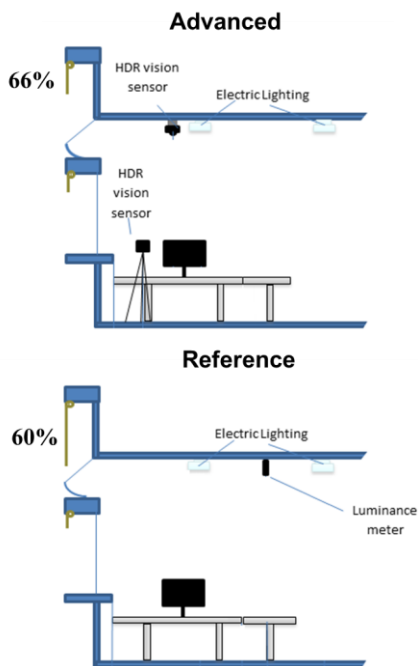
Selected 2017 publications

- Assouline D., Mohajeri N., Scartezzini J.-L., Quantifying rooftop photovoltaic solar energy potential: A machine learning approach, in *Solar Energy*, vol. 141, p. 278-296, 2017
- Mohajeri N., Assouline D., Gudmundsson A., Scartezzini J.-L., Effects of city size on the large-scale decentralised solar energy potential, *Energy Procedia*. CISBAT 2017, p. 697-702, 2017
- Assouline, D., Mohajeri, N., Scartezzini, J.L., 2017, Rooftop geometric features classification using random forests for large scale PV deployment. Remote Sensing conference, Warsaw, Poland, 2017
- Le Guen, M., Mosca, L., Perera, A.T.D., Coccolo, S., Mohajeri, N., Scartezzini, J.L. 2017. Achieving energy sustainability in future neighbourhoods through building refurbishment and energy hub concept: a case study in Hemberg-Switzerland, *Energy Procedia*, CISBAT 2017, Lausanne, Switzerland, 2017
- Kuehner, A., Mdeihli, N., Coccola, S., Perera, A.T.D., Mohajeri, N., Scartezzini, J.L., Extending building integrated photovoltaics (BiPV) using distributed energy hubs. A case study in Cartigny, Switzerland. *Energy Procedia*, CISBAT 2017, Lausanne, Switzerland, 2017

SMART BUILDINGS / SMART CITIES

Group leader: Prof. Jean-Louis Scartezzini

PhD students: Ali Motamed, Marta Benedetti



Average shading opening fraction comparison between reference and advanced office

Smart 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 smart controllers are evaluated in the LESO building, which represents a powerful tool for this 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).

2017 Activities

HDR vision sensors were integrated in a sun shading and electric lighting control platform to measure two photometric variables in a workspace: (i) the Daylight Glare Probability experienced by the user and (ii) the workplane horizontal illuminance. The system was successfully tested against a reference system in the LESO test building as well as in a testbed at Fraunhofer Institute for Solar Energy Systems. Furthermore, the platform was used to assess several energy efficient control approaches. The HDR vision sensors are in the process of further improvement in collaboration with CSEM and Analog Device Inc. (recent buyer of SNAPsensor) to provide similar integrated lighting controllers in daily life in collaboration with industrial partners.

Furthermore, a new project was launched to integrate the non-image-forming effect of light in venetian blind and electric lighting control. A prototype will be integrated in the NEST Test building at EMPA in Dübendorf.

Current Projects in Smart Buildings

SCCER FEEB&D Phase II, Task 1.2.1 - High Dynamic Range (HDR) Vision Sensing Technology

Funding: Commission for Technology and Innovation (CTI)

Duration: Phase II 2017-2020

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 should allow reaching energy self-sufficiency for lighting systems. In Phase I of this project, a high dynamic range (HDR) vision sensor was configured for use in a sun shading and electric lighting control platform, and its suitability for luminance measurements in a working environment as well as for glare risks assessment based on the Daylight Glare Probability was validated. In Phase II, sensing devices will be further refined and adapted to the needs of the lighting and shading industry. The controllers will undergo field testing in diverse testbeds.

NEST SolAce | REcomfort - Perception based Human Comfort and Multi-Functional Solar Facade

Funding: ETH Board

Duration: 2017-2020

Even in old-established branches like the heating, ventilating and air conditioning industry there are blank areas: one of these spots is the capture of solar energy and daylight by the building envelope. These topics are investigated by EPFL Researchers and their industrial partners in the SolAce | REcomfort unit: multifunctional facade technologies are implemented to achieve an Energy-Plus and Low Carbon combined working/living space.

Selected 2017 publications

- Motamed A., Deschamps L., Scartezzini J.-L., On-site monitoring and subjective comfort assessment of a sun shadings and electric lighting controller based on novel High Dynamic Range vision sensors, in *Energy and Buildings*, vol. 149, p.58-72, 2017
- Benedetti M., Motamed A., Deschamps L., Scartezzini J.-L., On the integration of Non-Image-Forming effects of light on venetian blinds and electric lighting control, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.1039-1044

Recent PhD theses in this domain

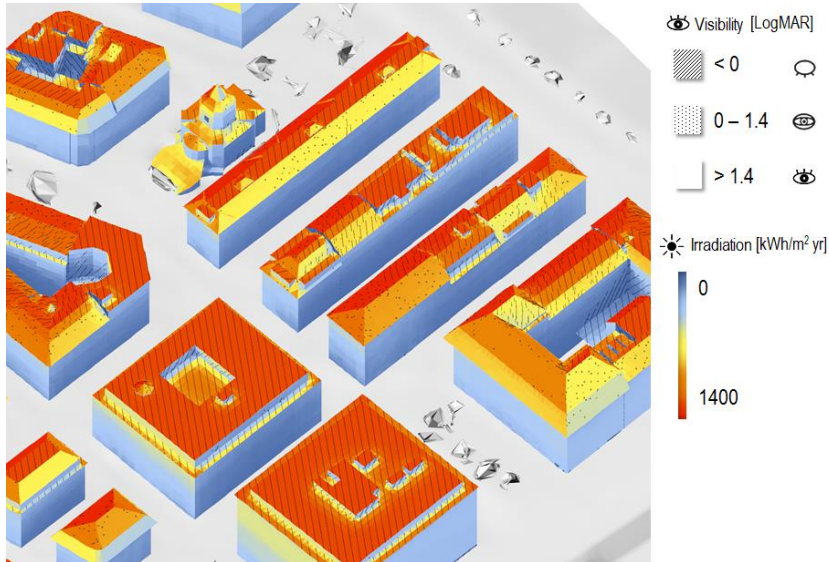
- Integrated Daylighting and Artificial Lighting Control based on High Dynamic Range Vision Sensors, *Ali Motamed, EPFL PhD Thesis #8277, 2017*
- Novel models towards predictive control of advanced building systems and occupant comfort in buildings, *Nikos Zarkadis, EPFL PhD Thesis #6440, 2015*
- Probabilistic Bottom-Up Modelling of Occupancy and Activities to Predict Electricity Demand in Residential Buildings, *Urs Wilke, EPFL PhD Thesis #5673, 2013*
- On the adaptation of building controls to the envelope and the occupants, *David Daum, EPFL PhD Thesis #4935, 2010*
- Towards a unified model of occupants' behaviour and comfort for building energy simulation, *Frédéric Haldi, EPFL PhD Thesis #4935, 2010*
- Bayesian optimisation of visual comfort, *David Lindeloef, EPFL PhD Thesis #3918, 2007*
- Simulating occupant presence and behaviour in buildings, *Jessen Page, EPFL PhD Thesis #3900, 2007*

Patents

- WO2017216623 (A2) Motamed A., Deschamps L., Scartezzini J.-L., Lighting control system, 2017

BUILDING INTEGRATION OF RENEWABLE ENERGIES

Project leader: Dr Maria Cristina Munari Probst
 Senior adviser: MSc. Christian Roecker (Cap77 sàrl)
 PhD student: Pietro Florio



Visibility and irradiation map.

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. Our projects address the key issue of optimal architectural integration of photovoltaic and thermal solar systems at the building and urban scales.

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 criticality maps)
- Development of new adapted solar products, conceived for building integration
- Development and promotion of architects' and solar product manufacturers' knowledge on solar integration issues / available solar technologies / integration criteria

2017 Activities

The IEA SHC Task 51 "Solar Energy in Urban Planning" was concluded with the publication of documents summarising the results to the attention of practitioners, in particular a report on the State-of-the-Art of Education on Solar Energy in Urban Planning as well as a collection of international case studies on the prospective of solar energy in Urban Planning. The LESO-QSV method developed in the context of this task to help the solar integration decision process with urban scale criteria defining the quality of architectural integration was promoted and implemented in collaboration with city councils from Switzerland and Sweden.

Much effort has furthermore been spent on the transfer of knowledge gained from recent research and development to students both at EPFL and at Venice IUAV University as well as to energy delegates of several Swiss cantons.

In collaboration with other EPFL labs, HEIA-FR and industry partners, LESO-PB has also been very active in the design of an R&D building unit in the NEST experimental building currently under construction at EMPA. Called SolAce | REcomfort, it will feature and test multi-functional facade technologies with the aim of achieving an Energy-Plus and Low Carbon combined working/living space.

Current Projects

IEA SHC Task 51 Solar Energy in Urban Planning

Funding: Swiss Federal Office of Energy (SFOE)

Duration: 2013 – 2017

The main objective of Task 51 was 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 included the objective to develop processes, methods and tools capable of assisting cities in developing long term urban energy strategies. LESO-PB acted as subtask leader.

LESO QSV Method

Funding: Swiss Federal Office of Energy (SFOE) / EPFL ENAC INNOSEED

Duration: 2011-2017

The goal of the project was to propose a method to help improving the architectural quality of active solar installation projects. The developed 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. The concept of criticality was introduced in urban planning, in combination with irradiation mapping. 2017 was primarily dedicated to knowledge transfer. A PhD focusing on visibility assessment and cross-mapping is currently under finalization.

NEST SolAce | REcomfort

Perception based Human Comfort and Multi-Functional Solar Facade

Funding: ETH Board

Duration: 2016-2020

Even in old-established branches like the heating, ventilating and air conditioning industry there are blank areas: one of these spots is the capture of solar energy and daylight by the building envelope. These topics are investigated by EPFL Researchers and their industrial partners in the SolAce|REcomfort building unit of the test building NEST set up at EMPA in Dübendorf: multi-functional facade technologies are implemented to achieve an Energy-Plus and Low Carbon combined working/living space.

Selected publications in 2017

- Florio P., Munari Probst M. C., Schueler A., Scartezzini J.-L., Visual prominence vs architectural sensitivity of solar applications in existing urban areas: an experience with web-shared photos, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale, p.955-960
- Delmas, A. et al., State-of-the-Art of Education on Solar Energy in Urban Planning, IEA SHC Task 51 Report, 2017
- Bruun Jorgensen O. et al., Illustrative Prospective of Solar Energy in Urban Planning: Collection of International Case Studies, IEA SHC Task 51 Report, 2017

EDUCATION AND TEACHING

2017 COURSES AND STUDENT FIGURES

Bachelor/Master Programmes

Course title	Lecturer	Students	Student numbers
Building Physics I	Prof. J.-L. Scartezzini	AR BA1	241
Building Physics II	Dr A. Schueler	AR BA2	241
Building Physics III	Dr A. Kostro	AR BA3	184
Building Physics IV	Dr A. Kostro	AR BA4	150
Building Physics V	Prof. J.-L. Scartezzini	AR BA5	104
Building Physics VI	Prof. J.-L. Scartezzini	AR BA6	122
Quartiers, infrastructures et aménagement durable	Prof. J.-L. Scartezzini, Prof. A.-G. Dumont, Prof. A. Buttler, Prof. P. Tosolini, Dr Ch. Ludwig, MSc D. Hofstetter, Dr N. Mohajeri, S. Cocco, Dr M. Pfister	AR/GC / ENAC BA6 (ENAC Learning Units)	21
Architecture & énergie solaire	Dr. M.-C. Munari Probst; C. Roecker	AR/GC / ENAC BA6 (ENAC Learning Units)	18
Master projects	Prof. J.-L. Scartezzini et al.	AR-MA, MT-MA	160

Additional Teaching

Name, role	Institution
Dr D. Mauree, Lecturer	MAN "Mise à niveau" Mathématiques 2A, 2B
Dr M.C. Munari Probst, Guest professor	University IUAV of Venice, Italy

ADVISING

PhD

Name	Title	Advisers	End
Walch, Alina	A data-driven methodology for the estimation of hybrid renewable energy potentials for the built environment in Switzerland	Prof. J.-L. Scartezzini; Dr N. Mohajeri (Oxford University)	2021
Mansour, Djamel FhG-ISE	Solartrain – Analysis of PV modules parameters and their correlation to degradation models	Prof. J.-L. Scartezzini; Dr A. Schueler; Dr H. Wirth (FhG ISE)	2021
Benedetti, Marta	Integration of Non-Image-Forming effects of light in venetian blinds and electric lighting control	Prof. J.-L. Scartezzini; Dr M. Münch (La Charité)	2020
Bosch Padros, Martí	Modelling of urban energy consumption versus urban forms and density through the analysis of data, specially crowd-sourced data	Prof. J. Chenal; Dr N. Mohajeri (candidacy exam referee)	2020
Gong, Jing	Novel glazing with strong seasonal dynamics	Prof. J.-L. Scartezzini; Dr A. Schueler	2019
Krammer, Anna	Thermochromic films for smart solar energy applications	Prof. J.-L. Scartezzini; Dr A. Schueler	2019
Wu, Yujie	Self-sufficient lighting systems	Prof. J.-L. Scartezzini	2019
Perera, A.T.D.	Modelling and assessment of urban energy systems	Prof. J.-L. Scartezzini; Dr V. Nik (Lund University)	2018
Assouline, Dan	Geo-dependent energy supply in relation to urban form	Prof. J.-L. Scartezzini; Dr N. Mohajeri	2018

Advising [cont'd]

Bouvard, Olivia	Novel materials for switchable windows	Prof. J.-L. Scartezzini Dr A. Schueler	2018
Florio, Pietro	Architectural integration criticality and visibility evaluation of solar energy applications in urban sites	Prof. J.-L. Scartezzini Dr M.C. Munari Probst	2018
TorabiMoghadam, Sara (Politecnico di Torino)	Integrated GIS-based urban energy modelling with multi-criteria analysis	Dr D. Mauree	2018
Coccolo, Silvia	Bioclimatic Design of Sustainable Campuses using Advanced Optimisation Methods	Prof. J.-L. Scartezzini Prof. J. Kämpf (HEIA-FR)	2017
Motamed, Ali	Integrated Daylighting and Artificial Lighting Control based on High Dynamic Range Vision Sensors	Prof. J.-L. Scartezzini	2017
Vieira Dias, Maíra (University of Campinas, Brazil)	Lighting in Industrial Environment and its Influence on Employee's Visual Field	Prof. P. S. Scarazzato (Univ. Campinas) Prof. J.-L. Scartezzini	2017
Oberrauch, Felix	Hydropower Design under Uncertainties	Prof. Anton Schleiss; Prof. Matthias Finger; Prof. J.-L. Scartezzini (Jury)	2017

Master Theses

Student/Institution	Title	Section	LESO-PB Supervisor
Fantini, Niels Ange; Gil, Cédric G.	"The open Church". Réaffectation des églises de la Gruyère	AR-PM	Ortelli Luca (dir. pédagogique); Bakker Marco (prof.); Scartezzini Jean-Louis (maître EPFL); Dufieux Philippe (expert)
Haghpourast, Zisti; Noori, Noona	L'esprit hybride, dans le nouvel écoquartier lausannois	AR-PM	Fröhlich Martin (dir. pédagogique); Scartezzini Jean-Louis (prof.); Borges Tiago (maître EPFL); Naboni Emanuele (expert)
Henriques Lopes, Micael; Vauthey, Antoine	Surélévation et densification en bois du quartier de Sévelin (VD)	AR-PM	Rey Emmanuel (dir. pédagogique); Scartezzini Jean-Louis (prof.); Dind Aleksis (maître EPFL); Bonnet Pierre (expert)
Keller, Odile	Coexistences. Transformation d'une ferme protégée à Bière (VD)	AR-PM	Ortelli Luca (dir. pédagogique); Scartezzini Jean-Louis (prof.); Hatt Fred (maître EPFL); Gueissaz Philippe (expert)
Lehot, Camille Catherine	Smart Adaptive Control of Blinds, Electric Lighting and Heating System integrating novel High Dynamic Range (HDR) Vision Sensor	MT- PME	Billard, Aude (LASA); Scartezzini, Jean-Louis

Semester projects

Student/Institution	Title	Section	Supervisors
Chiappinelli, Julien Philippe	Interlayers for microstructure replication for innovative glazing with seasonal-dependant solar gains	MT-MA3	Schueler, Andreas; Gong, Jing
Delannoy, Louis Marc Bruno	Project in energy management and sustainability I: European Climatic Projections (MES)	EME- MA1	Scartezzini, Jean-Louis; Coccolo, Silvia; Perera A.T.D.
Gómez Quintanilla, Miguel	Project in energy management and sustainability I: Swiss historical and future climatic conditions and their impact on the thermal behavior of buildings	EME- MA1	Scartezzini, Jean-Louis; Coccolo, Silvia; Perera A.T.D.

Semester projects [cont'd]

Kühner, Antoine Laurent	Project in energy management and sustainability II: Energy hub concept	EME- MA2	Mohajeri, Nahid ; Coccolo, Silvia ; Perera A.T.D.
Lagier, Maxime	Research project in materials III: Optimization of Cu- Co-Mn black selective coating for solar collectors	MX-MA3	Muralt, Paul (SCI-PM); Schueler, Andreas; Krammer, Anna
Le Guen, Morgane	Project in energy management and sustainability II: Solar Energy and Building Physics	EME- MA2	Mohajeri, Nahid; Coccolo, Silvia; Perera, A.T.D.
Manquat, Gautier Fabien Anthelme	Assessment of decentralized urban energy systems models	PH-PMH	Yazyev, Oleg (C3MP) ; Mauree, Dasaraden
Masquelier, Eloïse	Research project in materials I: Determination of thermal emittance of smart solar absorber coating based on temperature dependent FTIR measurements	MX-MA1	Schueler, Andreas; Muralt, Paul (SCI-STI- PM); Krammer, Anna
Mdeihli, Nour	Project in energy management and sustainability II: LESO	EME- MA2	Mohajeri, Nahid; Coccolo, Silvia; Perera, A.T.D.
Meyer, Frank	Study of the shrinkage of a micro-structure in hyper- branched acrylate polymer under accelerated aging tests for a novel glassing system	MX-MA3	Muralt, Paul (SCI-STI- PM); Schueler, Andreas; Gong, Jing
Pereira, Joshua; Mosca, Lucas	Project in energy management and sustainability II: Achieving energy sustainability in future neighborhoods through building refurbishment and energy hub concept: a case study in Hemberg, Switzerland	EME- MA2	Binder, Claudia R. (HERUS); Mohajeri, Nahid; Coccolo, Silvia; Perera A.T.D.
Petri, Delphine	Development of nickel oxide deposited by magnetron sputtering for electrochromics devices	MX-MA3	Muralt, Paul (SCI-STI- PM); Schueler, Andreas; Bouvard, Olivia
Puri, Salil	Project in energy management and sustainability I: European Climatic Projections	EME- MA1	Scartezzini, Jean-Louis; Coccolo, Silvia; Perera A.T.D.
Siraganyan, Karni	Modélisation des systèmes énergétiques à l'échelle d'un quartier	SIE-PMH	Scartezzini, Jean-Louis ; Mauree Dasaraden
Vaucher-Joset, Joanne Hélène	Characterization of solid electrolytes for application in smart windows	MX-MA3	Muralt, Paul (SCI-STI-PM) Schueler, Andreas; Bouvard, Olivia

Apprentices and Trainees

Student/Visitor	Domain	Programme/Institution
Di Giacomo, Théo	IT Intern	ETML
Divià, Michael	IT Apprentice	EPSIC
Loup, Matthias	IT Intern	HEIA FR
Marquez, Jonathan	IT Intern	ETML
Santa Cruz Paz, Alejandro	IT Apprentice	EPSIC
Stoll Alexandre	IT Apprentice	EPSIC

Visiting scholars, interns and grant holders

Student/Visitor	Domain	Programme/Institution
Prof. Naboni, Emanuele	Guest scientist	Royal Danish Academy of Fine Arts, Denmark
Vieira Dias, Maíra	Visiting scholar	University of Campinas, Brazil

PUBLICATIONS 2017

REFEREED SCIENTIFIC JOURNALS

Oliva N., Casu E. A., Yan C., Krammer A., Rosca T., Magrez A., Stolichnov I., Schueler A., Martin O. J. F., Ionescu A. M., **Van der Waals MoS₂/VO₂ heterostructure junction with tunable rectifier behavior and efficient photoresponse**, in *Scientific Reports*, vol. 7, num. 1, p.2923-2929, 2017

Bittel M. H., Perera A. T. D., Mauree D., Scartezzini J.-L., **Locating multi energy systems for a neighborhood in Geneva using K-means clustering**, CISBAT 2017 - Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia Special Issue CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.169-174, 2017

Basurto C., Kampf J. H., Scartezzini J.-L., **Multi-criteria analysis for the integrated performance assessment of complex fenestration systems**, in *Building Research And Information*, vol. 45, num. 8, p.926-942, 2017

Siraganyan K., Mauree D., Perera A. T. D., Scartezzini J.-L., **Evaluating the need for energy storage to enhance autonomy of neighborhoods**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.253-258, 2017

Perera A. T. D., Wickramasinghe P. U., Nik V. M., Scartezzini J.-L., **Optimum design of distributed energy hubs using hybrid surrogate models (HSM)**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.187-192, 2017

Naboni E., Meloni M., Cocco S., Kaempf J. H., Scartezzini J.-L., **An overview of simulation tools for predicting the mean radiant temperature in an outdoor space**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.1111-1116, 2017

Mohajeri N., Assouline D., Gudmundsson A., Scartezzini J.-L., **Effects of city size on the large-scale decentralised solar energy potential**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.697-702, 2017

Kuehner A. L., Mdeihli N., Cocco S., Perera A. T. D., Mohajeri N., Scartezzini J.-L., **Extending building integrated photovoltaics (BiPV) using distributed energy hubs. A case study in Cartigny, Switzerland**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.487-492, 2017

Cocco S., Mauree D., Naboni E., Kaempf J. H., Scartezzini J.-L., **On the impact of the wind speed on the outdoor human comfort: a sensitivity analysis**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.481-486, 2017

Nik V. M., Cocco S., Kämpf J., Scartezzini J.-L., **Investigating the importance of future climate typology on estimating the energy performance of buildings in the EPFL campus**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.1087-1092, 2017

Mauree D., Lee D. S.-H., Naboni E., Cocco S., Scartezzini J.-L., **Localized meteorological variables influence at the early design stage**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.325-330, 2017

Perera A .T .D ., Mauree D., Scartezzini J.-L., **The energy hub concept applied to a case study of mixed residential and administrative buildings in Switzerland**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.181-186, 2017

Le Guen M., Mosca L., Perera A .T .D ., Coccolo S., Mohajeri N., Scartezzini J.-L., **Achieving energy sustainability in future neighborhoods through building refurbishment and energy hub concept: a case study in Hemberg- Switzerland**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.265-270, 2017

Wu Y., Kaempf J. H., Scartezzini J.-L., **Characterization of a quasi-real-time lighting computing system based on HDR imaging**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.649-654, 2017

Vieira Dias M., Motamed A., Scarazzato P. S., Scartezzini J.- L., **Toward proper evaluation of light dose in indoor office environment by frontal lux meter**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.835-840, 2017

Benedetti M., Motamed A., Deschamps L., Scartezzini J.-L., **On the integration of Non-Image-Forming effects of light on venetian blinds and electric lighting control**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.1039-1044, 2017

Jolissaint N., Hanbali R., Hadorn J.-C., Schueler A., **Colored solar façades for buildings**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.175-180, 2017

Florio P., Munari Probst M. C., Schueler A., Scartezzini J.-L., **Visual prominence vs architectural sensitivity of solar applications in existing urban areas: an experience with web-shared photos**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.955-960, 2017

Mansour D., Bouvard O., Schueler A., **Development and characterization of electrochromic oxide and ion conductor deposited by reactive magnetron sputtering**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.787-792, 2017

Krammer A., Bouvard O., Schueler A., **Study of Si doped VO₂ thin films for solar thermal applications**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.745-750, 2017

Gong J., Meyer F., Leterrier Y., Kostro A., Schueler A., **Dimensional stability analysis of a UV printed polymer microstructure for a novel glazing system**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.763-768, 2017

Bouvard O., Lanini M., Burnier L., Witte R., Cuttat B., Salvadè A., Schueler A., **Mobile communication through insulating windows: a new type of low emissivity coating**, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in *Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale*, p.781-786, 2017

Muench M., Schmieder M., Bieler K., Goldbach R., Fuhrmann T., Zumstein N., Vonmoos P., Scartezzini J.-L., Wirz-Justice A., Cajochen C., **Bright Light Delights: Effects of Daily Light Exposure on Emotions, Rest-activity Cycles, Sleep and Melatonin Secretion in Severely Demented Patients**, in *Current Alzheimer Research*, vol. 14, num. 10, p.1063-1075, 2017

- Krammer A., Magrez A., Vitale W. A., Mocny P., Jeanneret P., Guibert E., Whitlow H. J., Ionescu A. M., Schueler A., **Elevated transition temperature in Ge doped VO₂ thin films**, in *Journal Of Applied Physics*, vol. 122, num. 4, p.045304, 2017
- Mauree D., Coccolo S., Kaempf J., Scartezzini J.-L., **Multi-scale modelling to evaluate building energy consumption at the neighbourhood scale**, in *PLoS ONE*, vol. 12, num. 9, p.e0183437, 2017
- Burnier L., Lanini M., Bouvard O., Scanferla D., Varathan A., Genoud C., Marguerit A., Cuttat B., Dury N., Witte R., Salvade A., Schueler A., **Energy saving glazing with a wide band-pass FSS allowing mobile communication: up-scaling and characterisation**, in *IET Microwaves Antennas & Propagation*, vol. 11, num. 10, p.1449-1455, 2017
- Perera A. T. D., Nik V. M., Mauree D., Scartezzini J.-L., **An integrated approach to design site specific distributed electrical hubs combining optimization, multi-criterion assessment and decision making**, in *Energy*, vol. 134, p.103-120, 2017
- Motamed A., Deschamps L., Scartezzini J.-L., **On-site monitoring and subjective comfort assessment of a sun shadings and electric lighting controller based on novel High Dynamic Range vision sensors**, in *Energy and Buildings*, vol. 149, p.58-72, 2017
- Vitale W. A., Casu E. A., Biswas A., Rosca T., Alper C., Krammer A., Luong G. V., Zhao Q.-T., Mantl S., Schüler A., Ionescu A. M., **A Steep-Slope Transistor Combining Phase-Change and Band-to-Band-Tunneling to Achieve a sub-Unity Body Factor**, in *Scientific Reports*, vol. 7, num. 1, 2017
- Perera A. T. D., Nik V. M., Mauree D., Scartezzini J.-L., **Electrical hubs: An effective way to integrate non-dispatchable renewable energy sources with minimum impact to the grid**, in *Applied Energy*, vol. 190, p.232-248, 2017
- Mauree D., Blond N., Kohler M., Clappier A., **On the Coherence in the Boundary Layer: Development of a Canopy Interface Model**, in *Frontiers in Earth Science*, 2017
- Bouvard O., Lanini M., Burnier L., Witte R., Cuttat B., Salvade A., Schueler A., **Structured transparent low emissivity coatings with high microwave transmission**, in *Applied Physics a Materials Science and Processing*, vol. 123, num. 66, 2017
- Assouline D., Mohajeri N., Scartezzini J.-L., **Quantifying rooftop photovoltaic solar energy potential: A machine learning approach**, in *Solar Energy*, vol. 141, p.278-296, 2017

CONFERENCE PAPERS

- Casu E.A., Vitale W.A., Tamagnone M., Lopez M. M., Oliva N., Krammer A., Schueler A., Fernandez-Bolanos M., Ionescu A.M., **Shunt capacitive switches based on VO₂ metal insulator transition for RF phase shifter applications**, *ESSDERC 2017 - 47th IEEE European Solid-State Device Research Conference (ESSDERC)*, Leuven, Belgium, 11-14 September 2017
- Coccolo S., Vanos J., Kämpf J. H., Scartezzini J.-L., **Comfort Map, a dynamic visualization of children's thermal sensation in the outdoor environment**, *21st International Congress of Biometeorology*, Durham, UK, September 3-7, 2017
- Mauree D., Deschamps L., Becquelin P., Loesch P., Scartezzini J.-L., **Measurement of the impact of buildings on meteorological variables**, *Building Simulation Applications, BSA 2017, 3rd IBPSA Italy conference*, Bozen-Bolzano, Bozen-Bolzano, Italy, 8-10 February 2017
- Mauree D., Motamed A., Deschamps L., Scartezzini J.-L., **Improving local wind estimation for the automated control of blinds**, *Building Simulation Applications BSA 2017, 3rd IBPSA Italy conference*, Bozen-Bolzano, Bolzano, Italy, 8-10 Feb. 2017
- Naboni E., Meloni M., Coccolo S., Cucchi F., Macrelli G., Kämpf J. H., Scartezzini J.-L., **The Integration of Outdoor Thermal Simulation Tools in Architectural Design**, *International Conference on Passive and Low Energy Architecture*, Edinburgh, July 3-5th, 2017

Carozza M., Mutani G., Coccolo S., Kaempf J. H., **Introducing a hybrid energy-use model at the urban scale: the case study of Turin (IT)**, 3rd Building Simulations Application Conference BSA 2017, Bolzano, Italy, February, 8th-10th 2017

Fezzioui N., Draoui B., Roulet C.-A., **Etude du comportement aéralique des maisons à ouverture zénithale**, 1st International Seminar on the Apport of the Simulation in Technological Innovation, Ghardaïa (Algeria), March., 07-08, 2017

CONFERENCE PROCEEDINGS

Scartezzini J.-L., Smith B., **Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale**, CISBAT 2017 International Conference Future Buildings & Districts – Energy Efficiency from Nano to Urban Scale, Lausanne, Switzerland, September 6-8, 2017

REVIEWS

Norton B., Scartezzini J.-L., **Closing thoughts**, in *Science/AAAS*, supplement Changing perspectives on daylight: Science, technology, and culture (Supplement), p.43-44, 2017

Aarts M.P.J., Brown S.A., Bueno B., Gjedde A., Mersch D., Münch M., Scartezzini J.-L., Volf C., Wienold J., Wirz-Justice A., Bodart M., Kaempf J., **Reinventing daylight**, in *Science/AAAS*, supplement Changing perspectives on daylight: Science, technology, and culture (Supplement), p.33-37, 2017

Solt J., Aarts M.P.J., Andersen M., Appelt S., Bodart M., Kaempf J., Bueno B., Kuhn T.E., Coccolo S., Scartezzini J.-L., Schueler A., Szynska Matusiak B., Volf C., Wienold J., Wirz-Justice A., Fournier C., **Daylight in the Built Environment**, in *Science/AAAS*, supplement Changing perspectives on daylight: Science, technology, and culture (Supplement), p.24-32, 2017

Norton B., Balick M., Hobday R., Fournier C., Scartezzini J.L., Solt J., Braun A., **Daylight: Contexts and concepts**, in *Science/AAAS*, supplement Changing perspectives on daylight: Science, technology, and culture (Supplement), p.4-8, 2017

PHD THESES

Motamed A., **Advisor(s): Scartezzini J.-L., Integrated Daylighting and Artificial Lighting Control based on High Dynamic Range Vision Sensors**, Thèse EPFL, n° 8277, 2017

Coccolo S., **Advisor(s): Scartezzini J.-L., Kämpf J. H., Bioclimatic Design of Sustainable Campuses using Advanced Optimisation Methods**, Thèse EPFL, n° 7756, 2017

REPORTS

Delmas, A. et al., **State-of-the-Art of Education on Solar Energy in Urban Planning**, IEA SHC Task 51, 2017

Bruun Jorgensen O. et al., **Illustrative Prospective of Solar Energy in Urban Planning: Collection of International Case Studies**, IEA SHC Task 51, 2017

Krammer A., Schueler A., **Thermochromic coatings for overheating protection of solar thermal collectors - novel type of doping (TARGET95)**, 2017

OUTREACH

INVITED PRESENTATIONS

Key person	Role / Title of talk	Location/Organizer	Date
Assouline, Dan	Invited poster presentation / PV potential at both commune and pixel scale	Université de Genève	05/2017
Bouvard, Olivia	Invited talk / Vitrages innovants pour la façade du futur / Innovatives Glas für die Fassade der Zukunft	Bern University of Applied Sciences	03/2017
Mauree, Dasaraden	Invited talk / Impacts of buildings on the urban climate: modelling and experimental approaches	Smart Living Lunch, EPFL Fribourg	09/2017
Mauree, Dasaraden	Speaker / Going back to basics – Atmospheric sciences	Open Science in Practise Summer School	09/2017
Munari Probst, Maria Cristina	Powerful Architecture: Integrating Solar Technology into Buildings the Swiss Way	American Solar Energy Society, Denver, USA	10/2017
Munari Probst, Maria Cristina	Invited talk – Urban integration of solar systems	Lund University, Sweden	10/2017
Munari Probst, Maria Cristina	Presentation “LESO QSV – method for urban integration of solar systems”	Malmö City Council	09/2017
Munari Probst, Maria Cristina	Workshop on implementation of LESO QSV method in Malmö	Malmö City Council	09/2017
Scartezzini, Jean-Louis	Invited chairman for daylighting symposium “The impact of daylight on human health” and expert in the panel discussion	SLTBR Meeting 2017, Society of Light Treatment & Biological Rhythms, Berlin	06/2017
Scartezzini, Jean-Louis	Chairman Daylight Academy Annual Meeting	Daylight Academy, EPFL Lausanne	11/2017
Scartezzini, Jean-Louis	Chairman Daylight Academy General Assembly	Daylight Academy, EPFL Lausanne	11/2017
Scartezzini, Jean-Louis; Mauree, Dasaraden; Schueler, Andreas; Motamed, Ali	Hosts of EPFL Alumni Visit	LESO-PB, EPFL, Lausanne	06/2017
Schueler, Andreas	Keynote / Nouveaux vitrages solaires: de la lame de microscope à la plus grande façade photovoltaïque au monde	4 ^{ème} Conférence Zéro Carbone, Fribourg	11/2017
Schueler, Andreas	Keynote / Selective solar absorber coatings on receiver tubes for CSP : From vacuum-deposited carbon based coatings to wet-chemical derived mixed oxide coatings	8 th International Conference on Power Electronics f. Plasma Engineering	04/2017
Schueler, Andreas	Keynote / Innovative optical coatings for active and passive solar glass façades	8 th Power Electronics for Plasma Eng. Conference, Zielonka, Poland	05/2017

EVENTS ORGANISED

Title	Organiser	Date
CISBAT 2017 International Conference – Future Buildings & Districts – Energy Efficiency from Nano to Urban Scale	Scartezzini, Jean-Louis (Chair) ; Smith, Barbara (Conference Manager)	09/2017
Open Science in Practice – Summer School	Mauree, Dasaraden	09/2017
Leso Lunchtime Lecture - Aytac Kubilay - Influence of thermal and moisture storage in building materials on urban microclimate	Mohajeri, Nahid; Smith, Barbara	03/2017
Leso Lunchtime Lecture - Patrizia Lombardi - Innovation of urban districts & cities in context of energy transition	Mohajeri, Nahid; Smith, Barbara	05/2017

REPRESENTATION

EPFL INTERNAL COMMITTEES

Name	Service	Role
Scartezzini, Jean-Louis	EPFL Excellence Fellowship Committee	Committee member
Scartezzini, Jean-Louis	Architecture Section - Academic Committee	Committee member
Scartezzini, Jean-Louis	ENAC IT Strategic Committee	Committee member
Scartezzini, Jean-Louis	Smart Living Lab, Scientific committee	Committee member
Scartezzini, Jean-Louis	Solar Decathlon Academic Committee	Committee member
Scartezzini, Jean-Louis	SLL EPFL Energy and Building Faculty Position Search Committee	Committee Member
Schueler, Andreas	Architecture Section - Teaching Committee	Committee member
Schueler, Andreas	COSEC Security	Lab coordinator

EXTERNAL COMMITTEES & APPOINTMENTS

Name	Service	Role
Kostro, André	CISBAT 2017 Internat. Conference "Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale"	Scientific Committee Member
Mauree, Dasaraden	CISBAT 2017 Internat. Conference "Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale"	Scientific Committee Member
Mauree, Dasaraden	European Geosciences Union	Editor Atmospheric Sciences Blog Div.
Mauree, Dasaraden	SCCER Future Energy Efficient Buildings and Districts	Work package deputy leader
Mohajeri, Nahid	Frontiers in Built Environment: Sustainable Design and Construction Journal	Associate Editor
Mohajeri, Nahid	Frontiers in Built Environment: Urban Science	Associate Editor
Mohajeri, Nahid	CISBAT 2017 Internat. Conference "Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale"	Scientific Committee Member
Munari Probst, Maria C.	IEA Task 51 Solar Energy in Urban Planning	Group Leader
Munari Probst, Maria C.	University IUAV of Venice, Italy	Invited professor
Scartezzini, Jean-Louis	Daylight Academy	Steering Com. Member, Speaker
Scartezzini, Jean-Louis	NEST Steering Committee	Committee Member
Scartezzini, Jean-Louis	SIA Umsicht-Regards 2017 Award	Committee Member
Scartezzini, Jean-Louis	Swiss Academies of Arts & Sciences, Energy Commission	Committee Member

External committees & appointments [cont'd]

Name	Service	Role
Scartezzini, Jean-Louis	Solar Energy International Journal	Associate Editor
Scartezzini, Jean-Louis	Qatar National Research Fund (QNRF), National Priorities Research Programme (NRRP)	Expert Reviewer
Scartezzini, Jean-Louis	Int. Council for R&I in Building & Construction CIB	EPFL Representative
Scartezzini, Jean-Louis	Europ. Renew. Energy Research Centres Agency EUREC	College of Members, EPFL Repr.
Scartezzini, Jean-Louis	SCCER Future Energy Efficient Buildings and Districts	Board Member, WP Leader
Scartezzini, Jean-Louis	Fond National de la Recherche Scientifique, Brussels	Expert Reviewer
Scartezzini, Jean-Louis	CISBAT 2017 Internat. Conference "Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale"	Conference Chair
Scartezzini, Jean-Louis	Science / AAS Supplement "Changing perspectives on daylight: Science, technology, and culture"	Coordinator, editor
Schueler, Andreas	CISBAT 2017 Internat. Conference "Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale"	Scientific Committee Member

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)

EPFL – ENAC – LESO-PB
Bâtiment LE
Station 18
CH-1015 Lausanne
Switzerland
Phone: +41 21 693 4545
Fax: +41 21 693 2722
Email: leso-pb@epfl.ch



<http://leso.epfl.ch>