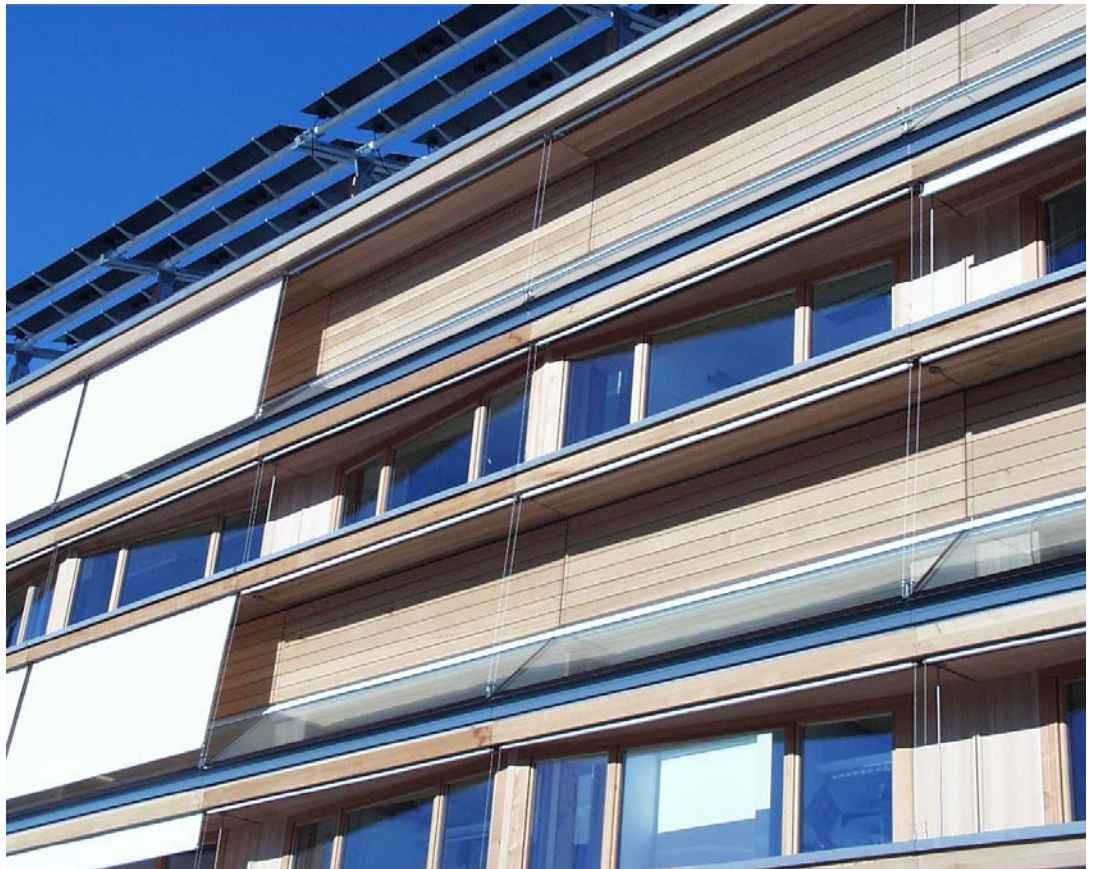


SOLAR ENERGY AND BUILDING PHYSICS LABORATORY

LABORATOIRE D'ENERGIE SOLAIRE ET DE PHYSIQUE
DU BÂTIMENT



Activity Report 2013



ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Innovations for Renewable Energy Use 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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EPFL Solar Energy and Building Physics Laboratory (LESO-PB)

ACTIVITY REPORT 2013

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 2013.

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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. Due to the staff development in 2013-14, the following new research axes have been defined:

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

This report describes the activities of the lab as structured until 2013.

Highlights 2013

- **CISBAT 2013 International Conference "CleanTech for Smart Cities and Buildings - From Nano to Urban Scale"** - Designed as a platform for interdisciplinary dialog and presentations of innovative research and development in the field of sustainability in the built environment, the conference covered a wide range of subjects from solar nanotechnologies to the simulation of buildings and urban areas. LESO-PB hosted the conference for the 12th time in academic partnership with Cambridge University, MIT and the Swiss Chapter of IBPSA, and backed by a strong international scientific committee. The conference registered a record number of participants and submissions and received excellent feedback.
- **Four patents pre-submitted in 2012 were filed in 2013** by the group "Nanotechnology for Solar Energy Conversion" in the framework of collaboration with different industrial partners (SwissINSO SA, BASF Switzerland AG, Solar Control SA, Zettl GmbH).
- **Release of CitySim**, a decision support software tool for urban energy planners and stakeholders to minimize the net use of non-renewable energy sources as well as the associated emissions of greenhouse gases. The software comprises CitySim Designer, a Graphical User Interface (GUI) set-up to facilitate the 3D geometrical and thermo-physical description of buildings as well as the visualization of simulation results. It also includes CitySim Solver, an Integrated Solver (IS) for simulating the energy demand and supply of buildings for space conditioning. Great interest has been shown for this tool both by the academic world and by city planners.

Further research activities are presented in the following pages.

2013 AWARDS AND HONOURS

Name	Award, distinction	Year
Dr M. Joly, Dr A. Schuler and al.	Solar Energy Journal Best Paper Award 2012-2013	2013
Dr M. Münch	Election at the Scientific Board Member in the Society for Light Treatment and Biological Rhythms	2013

DAYLIGHTING AND PERCEPTION

Group leader: Prof. Jean-Louis Scartezzini

Research associate: Dr Mirjam Münch

Postdoctoral researcher: Dr Jérôme Kämpf

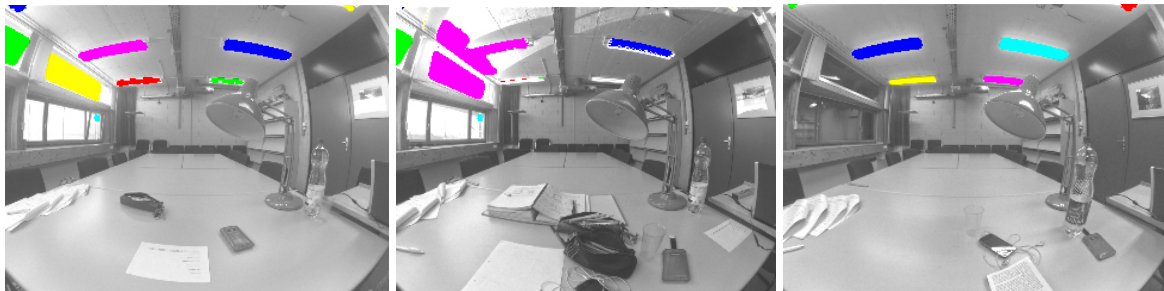
PhD students: Apiparn Borisuit, Chantal Basurto

Guest PhD student: Lenka Maierova, Czeck University Prague

The daylighting and perception 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.

Research on the impact of natural and artificial light on circadian rhythms in humans (chronobiology) is combined with technological advances in a multidisciplinary approach.



Lighting conditions at different times of the day. The coloured areas indicate potential glare sources.

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
- Scanning sky simulator and automated heliodon
- Experimental and ergonomical daylighting test modules

2013 Activities

A project with patients suffering from ophthalmological diseases was completed in 2013 in collaboration with Privat Docent MER Dr. A. Kawasaki of Hôpital Ophtalmique Jules Gonin, Lausanne. A study on regulatory health functions of light in demented patients was also completed in 2013. A PhD thesis was successfully presented on the Impact of Light including Non-Image Forming Effects on Visual Comfort (Dr A. Borisuit) after completion of studies carried out on human subjects in the photobiological test rooms of the LESO Solar Experimental Building as well as in the Photobiological Laboratory (PHOBIO). Last year has also seen the conclusion of the main phase of the Post-Doctoral Fellowship in Daylighting and Perception supported by the VELUX Foundation at EPFL (2009-2013) and the promotion of Post-Doctoral Fellow Dr Mirjam Münch to Lecturer and Senior Researcher at University Hospital La Charité in Berlin (Germany). Further analyses of a large amount of data regarding the Non-Image Forming Effects of Light, collected during experimental campaigns, will be carried out in 2014 in the course of Post-Doctoral studies of the newly promoted PhDs.

Current Projects

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.

Comparison of non-visual light-dependent functions in healthy subjects & patients with retinal ganglion cell loss

Funding: Swiss National Science Foundation (SNSF) (project in collaboration with Hôpital Ophtalmique Jules-Gonin, Lausanne, PD MER Dr. med. Aki Kawasaki)

Duration: 2011-2013

This project aims to characterize alertness, cognitive performance and hormonal secretion in response to light exposure in patients with neuroretinal disease as well as healthy controls, and to correlate such changes to the pupil light reflex.

Circadian Light for Humans with Dementia

Funding: Sonnweid Foundation (Switzerland), Age-Foundation (Switzerland)

Duration: 2012-2013

The study aims to demonstrate that the increase of circadian amplitude induced by efficient light with the right spectral composition serves not only psychological factors such as mood and well-being, but also influences important regulatory health functions in demented patients.

Integrated Multifunctional Glazing for Dynamical Daylighting

Funding: Swiss Federal Office of Energy (SFOE)

Duration: 2009-2013

The project is aiming to set the bases for an integrated multi-functional glazing for dynamic daylighting using novel microstructures which will redirect sunlight into office rooms.

Postdoctoral Fellowship in Daylighting & Perception

Funding: VELUX Foundation (Switzerland)

Duration: 2013-2014

This project is aiming to strengthen the education and research activities in the fields of building science and chronobiology. It is expected moreover to initiate 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*, EPFL PhD thesis #6007, 2013
- *Energetic, visual and non-visual aspects of office lighting*, Friedrich Linhart, EPFL PhD Thesis #4587, 2010
- *Comparing physical and virtual methods for daylight performance modelling including complex fenestration systems*, Anothai Thanachareonkit, EPFL PhD Thesis #4130, 2008
- *Bayesian optimisation of visual comfort*, David Lindelof, EPFL PhD Thesis #3918, 2007

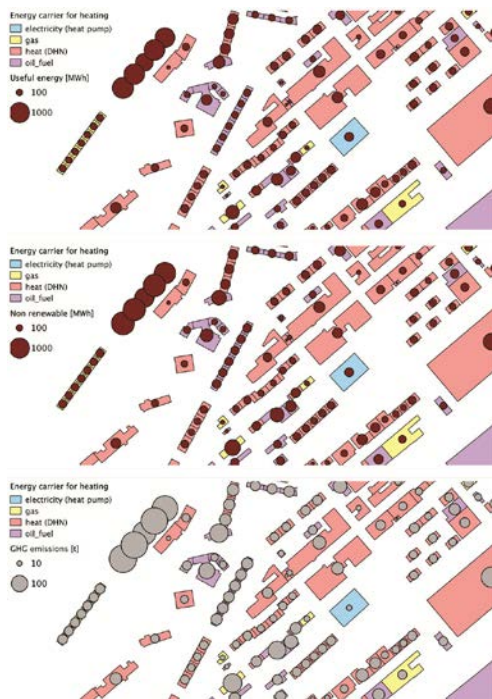
Awards in this domain

- Marilyn Andersen, EPFL PhD Thesis #2941 (2004), Chorafas Award 2005

SUSTAINABLE URBAN DEVELOPMENT

Group leader: Dr Jérôme Kämpf

PhD students: Diane Perez, Govinda Upadhyay, Silvia Coccolo



Useful energy demand, non-renewable primary energy use, and associated greenhouse gas emissions for the space heating service.

The principal mission of this group is, through the simulation of physical processes, to better understand how to optimise the sustainability of **urban systems**, predominantly from environmental but also from social and economic perspectives.

Specific research interests include:

- Simulation and evaluation of resource fluxes (energy and matter) in urban systems
- Demand and supply side control of urban energy flows
- Urban microclimatology
- External environmental comfort and social wellbeing
- Stochastic modelling of human behaviour

Published work relates to

- Modelling and optimisation of urban energy fluxes
- Occupant behaviour and comfort
- Sustainable urban design
- Thermodynamics in the city
- Radiosity algorithms and internal illumination prediction

2013 Activities

A CCEM project “Integration of Decentralized Energy Adaptive Systems for cities” was initiated in 2013 to study the adequacy between the renewable energy production and storage through the possibility of groups of buildings to function as islanded from the resource networks (electricity, gas and heat). This project is a new collaboration between EPFL, ETHZ and EMPA in the field of “Urban Physics”.

The 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 Swiss municipalities.

Current Projects

QUAD - Sustainable Districts

Funding: Research Center for Energy and Municipalities (CREM)

Duration: 2011-2013

Development of a prototype decision aid tool for architects, construction companies and city councils. This tool will allow urban design competition participants to define building specifications incorporating energy efficiency criteria.

Innovative Planning and Management Instruments of Urban Energy Systems

Funding: EPFL Energy Center

Duration: 2009-2013

In this project we will work closely with municipalities, the EPFL Energy Centre as well as the Industrial Energy Systems Laboratory at EPFL to develop a new urban energy planning tool for use by municipalities. The purpose of this tool will be to support municipalities' urban energy planning and investment decisions.

IDEAS4cities – Integration of Decentralized Energy Adaptive Systems for cities

Funding: Competence Center Energy and Mobility (CCEM)

Duration: 2013-2016

This project is centred at 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 at LESO-PB in this domain

- *Towards a unified model of occupants' behaviour and comfort for building energy simulation* F. Haldi, EPFL PhD Thesis #4587, 2010
 - *On the Modelling and Optimization of Urban Energy Fluxes*, J. Kaempf, EPFL PhD Thesis #4548, 2009
 - *Multiscale Modelling of Urban Climate*, A. Rasheed, EPFL PhD Thesis #4531, 2009
 - *Simulating occupant presence and behaviour in buildings*, Jessen Page, EPFL PhD Thesis #3900, 2007
-

Awards in this domain

- Frédéric Haldi, Darren Robinson: Best Paper, *Journal of Building Performance Simulation*: 2011.
- Frédéric Haldi, Darren Robinson: Best Paper, *Building and Environment Journal*: 2009.
- Darren Robinson: *Ken Dale Travel Bursary*, CIBSE, 2008.
- Darren Robinson and Andrew Stone: *Napier-Shaw Medal*, CIBSE, 2007.

BIO-MIMETIC BUILDING CONTROL

Group leader: Dr Nicolas Morel

PhD student: Nikos Zarkadis



Self-adaptive control system

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).

2013 Activities

The LESO-PB contributed to the CCEM project on renovation of historical buildings (SuRHIB) with a study on the optimal use of heating, cooling and ventilation services in such buildings.

The group's work focused on the project Green-Mod supported by the Hasler Foundation; it aims at the elaboration 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 and user wishes and preferences.

Current Projects in Biomimetic Building Control

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

Funding: *Hasler Foundation*

Duration: *2012-2014*

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.

CCEM-SuRHiB: Sustainable Renovation of Historical Buildings

Funding: *Swiss Competence Center for Energy and Mobility (CCEM)*

Duration: *2009-2013*

Historical buildings, if normally heated, cause relatively high energy consumption. As their façades need to be conserved, the thermal insulation of such buildings is difficult and risky. The moisture balance of walls has to be carefully considered besides the energy balance. Internal insulation that could effectively reduce thermal losses would hinder the drying process of walls. A careful risk assessment and robust guidelines have to be developed. A highly insulating light weight plaster finish based on aerogel particles, which insulates like polystyrene – inside or outside - but is open for moisture diffusion, is developed and tested in this project. Furthermore, appropriate heating systems and optimal solar integration are studied by LESO-PB.

PhD theses published in this domain at LESO-PB

- *On the adaptation of building controls to the envelope and the occupants*, David Daum, EPFL PhD Thesis #4935 (2010)
- *Bayesian optimisation of visual comfort*, David Lindelöf, EPFL PhD Thesis #3918 (2007)
- *Simulating occupant presence and behaviour in buildings*, Jessen Page, EPFL PhD Thesis #3900 (2007)
- *Using Genetic Algorithms to Take into Account User Wishes in an Advanced Building Control System*, Antoine Guillemin, EPFL PhD Thesis #2778 (2003)

Awards in this domain

- Antoine Guillemin, EPFL PhD Thesis #2778 (2003), Chorafas Award 2004

BUILDING INTEGRATION OF RENEWABLE ENERGIES

Group leader: MSc. EPFL Christian Roecker

Postdoctoral researcher: Dr Maria Cristina Munari Probst

Research assistants: Georges Meylan



Façade integrated evacuated solar collectors (Sunny Woods, arch. Beat Kämpfen)

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. This is why the research group "Renewables Integration into the Built Environment" addresses the issue of optimal architectural integration of photovoltaic and thermal solar systems.

Major progress has been made in photovoltaics integration in the framework of several international projects over the last years. Currently, the group focuses on the integration of solar thermal technology and is co-leading the new IEA Task 51 "Solar Energy in Urban Planning".

Published work relates to

- Façade integration of solar thermal systems
- Criteria for successful architectural integration of active solar systems (PV & ST)
- Criteria and recommendations for solar installations authorisation
- Façade and roof integration systems for photovoltaics (pilot installations /development of new systems)
- Ergonomic interface for simulation software and "wizard" expert system

2013 Activities

One main activity of the group was the lead of working group in "Processes, methods and tools" in the IEA SHCP Task 51 "Solar Energy in Urban Planning".

Specific teaching on architectural integration of active+e solar systems continued through a dedicated ENAC Learning Unit (UEE 04, "Intégration architecturale de l'Energie Solaire") and participation in theoretical courses. Participation for architectural integration specifications in the project Archinsolar, contribution to tile design. Architectural integration research work continued in collaboration with several Swiss institutions (SUPSI, HSLU, Swissolar). Further development and preparation of an application documents for the practical implementation of the "LESO-QSV" method.

Current Projects

IEA SHC Task 51 Solar Energy in Urban Planning

Funding: Swiss Federal Office of Energy (SFOE)

Duration: 2013 - 2017

The main goal of Task 51 is to help achieving high quality architecture for buildings integrating solar energy systems, mainly by improving architects' qualifications and enhancing solar thermal manufacturers' awareness of building integration issues.

ARCHINSOLAR - Unique and Innovative Solution for Building Integration of Thin Film Silicon PV modules

Funding: Competence Center Energy and Mobility (CCEM-CH)

Duration: 2009-2013

The Archinsolar project aims at the development of a new generation of photovoltaic elements based on thin film silicon technology (single amorphous and tandem amorphous/microcrystalline cells). Specific issues to ensure a good "integrability" of the developed products are central focus for the group.

LESO QSV method

Funding: Swiss Federal Office of Energy (SFOE)

Duration 2011-2013

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.

Documents published in this domain

Architectural integration and design of solar thermal systems, Maria Cristina Munari Probst, Ch. Roecker, PPUR Routledge, 2011, ISBN 978-0-415-66791-3

Solar Energy Systems in Architecture – Integration criteria and guidelines, Maria Cristina Munari Probst, Ch. Roecker Editors, IEA SHC Task 41 Report T.41.A.2 SHC, Solar Heating & Cooling Programme, International Energy Agency, p.1-228, September 2012.

Solar Energy and Architecture – Designing Solar Thermal Systems for Architectural Integration, Maria Cristina Munari Probst, Christian Roecker Editors, Solar Heating & Cooling Programme, International Energy Agency, p.1-104, November 2013.

Solar Energy and Architecture - The Communication Process', Gabriele Labaccaro, Poltecnico Milano, Maria Wall, Lund University, Editors, Solar Heating & Cooling Programme, International Energy Agency, p.1-35, September 2012.

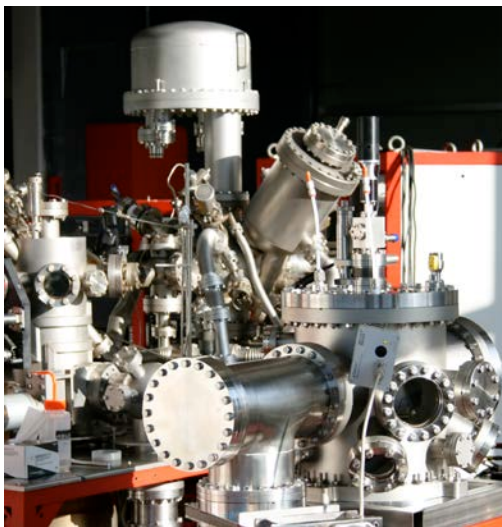
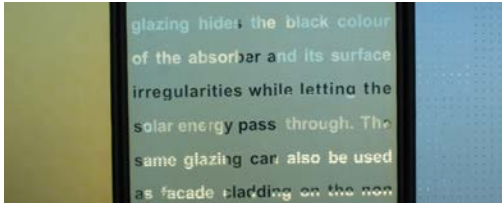
Christian Roecker, Maria Cristina Munari Probst, responsables du site web pour les Task 41 et Task 51
[Web-site: Innovative solar products for architectural integration](#)

NANOTECHNOLOGY FOR SOLAR ENERGY CONVERSION

Group leader: Dr Andreas Schüler

Postdoctoral researcher: Dr Martin Joly; Research Engineers: Olivia Bouvard, Matthieu Perrenoud

PhD students: Antonio Paone, André Kostro; Internship student: Mario Geiger



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, colored coatings with high solar transmittance for novel glazing of solar thermal façades, photoluminescent quantum dot solar concentrators for photovoltaic 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

- Colored glazed solar collectors, active solar thermal façades
- Quantum dot solar concentrators
- Highly durable selective solar absorber coatings
- Novel thermochromic solar absorber coatings for overheating protection

2013 Activities

Highlights from LESO-PB activities in Nanotechnology include:

- Novel colored glazing for roof-integrated photovoltaic modules (project ARCHINSOLAR)
- Novel project on microstructured glazing for daylighting under investigation (SFOE)
- Studies on energy-efficiency of public transportation in collaboration with University of Basel, Lucerne University of Applied Sciences and major Swiss transportation companies
- Collaboration with industry in the field of receiver tubes for parabolic trough collectors

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

Current Projects

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 wellbeing of occupants.

Technology Transfer of Coloured Solar Thermal Collectors

Funding: SwissINSO Trade & Invest Ltd

Duration: 2009-2013

At LESO, novel nanocomposite coatings on architectural glazing for solar active thermal façades have been developed. The electronic and optical properties of the novel nanocomposite materials are thoroughly characterized. LESO-PB provides the transfer of the developed technology from science to market - including the upscaling of the processes to industrial production. The novel glazing will allow a perfect architectural integration of solar thermal collectors into the building envelope, thereby creating new possibilities for water and space heating as well as for solar cooling.

Integrated Multifunctional Glazing for Dynamical Daylighting

Funding: Swiss Federal Office of Energy (SFOE)

Duration: 2009-2013

The project is aiming to set the bases for an integrated multi-functional glazing for dynamic daylighting using novel microstructures which will redirect sunlight into office rooms.

Unique and Innovative Solution for Building Integration of Thin Film Silicon PV modules

ARCHINSOLAR

Funding: SwissElectric Research (SER), Swiss Federal Office of Energy (SFOE), Competence Center Energy and Mobility (CCEM-CH), Services Industriels de Genève (SIG)

Duration: 2009-2013

The Archinsolar project aims at the development of a new generation of photovoltaic elements based on thin film silicon technology (single amorphous and tandem amorph/microcrystalline cells). These new elements will be ultra-reliable. They will make possible very low manufacturing costs and unique architectural integration, and be respectful of the environment, landscape, buildings and traditions.

Thermochromic coatings for overheating protection of solar thermal collectors: temperature matching and triggering

Funding: Swiss Federal Office of Energy (SFOE)

Duration: 2012-2013

Overheating and the resulting stagnation of solar thermal collectors is a common problem even in central European latitudes. A promising way to protect solar thermal systems without any mechanical device (e.g. for shading or for pressure release) is to provide them with a coating which exhibits a change in optical properties at a critical temperature T_c . This project aims at the development of such coatings with thermochromic, "intelligent" properties.

Energy efficiency of public transportation

Funding: SwissElectric Research (SER), Swiss Federal Office of Energy (SFOE), Federal Office of Transport (FOT)

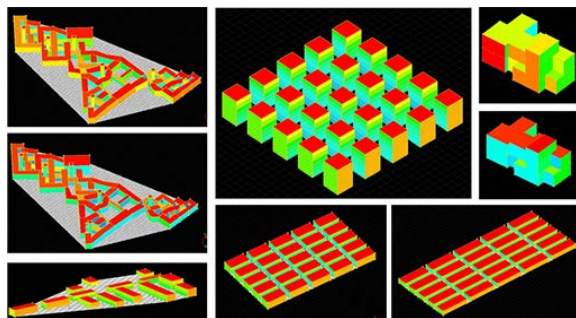
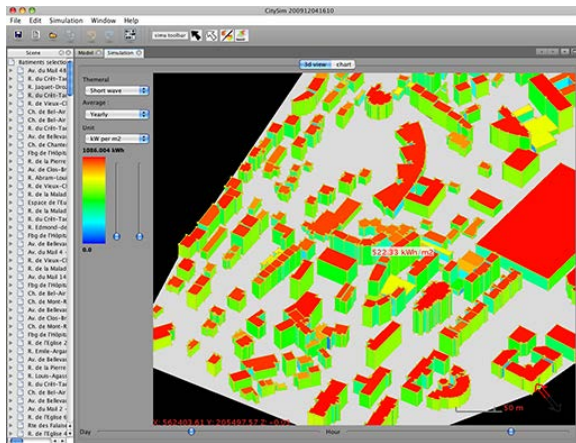
Duration: 2012-2015

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, we focus on improvement of the envelope of the trains and trolleybuses.

COMPUTER MODELLING OF COMPLEX SYSTEMS

Group leader: Dr Jérôme Kaempf

PhD student: Urs Wilke



City Sim Model

By itself, building and urban physics is concerned with rather elementary physics laws. But the construction, operation and demolition of a building are connected with many different aspects, and their interactions makes the complete system complex. The complexity is even increased when dealing with a whole district or a city instead of only one building.

This research domain includes two different aspects:

- modelling of building behaviour where non-deterministic aspects must be considered, such as user behaviour (occupancy, individual preferences relative to comfort, etc) or the stochastic nature of weather conditions;
- modelling of large groups of elementary buildings, where the complexity arises from the numerous interactions between the individual objects (buildings).

This domain is closely linked with the domain Sustainable Urban Development: notably, both domains cover the study of similar objects (urban districts or a whole city), and they are concerned with the modelling of similar phenomena (ecosystemic modelling, interaction with the environment).

Published work relates to

- Urban sustainable planning tools with 3D models (Suntool)

2013 Activities

The activities in this domain were formally completed at the end of the SNSF project “An investigation of strategies leading to a 2000 Watts society using bottom-up models of urban energy flows”. It came to a fruitful conclusion with the successful presentation of Dr Urs Wilke’s PhD thesis dedicated to a Probabilistic Bottom-up Modelling of Occupancy and Activities in Residential Buildings.

Latest Projects

An Investigation of Strategies leading to a 2000W City using Bottom-up Models of Urban Energy Flows

Funding: Swiss National Science Foundation (SNSF)

Duration: 2009-2012

In this project we will develop a detailed spatially explicit model of the dynamic flows of energy and matter within a city due to transportation, the operation of buildings and the activities accommodated by them. This will involve the further development and integration of CitySim -- the most fully developed model available for explicit simulation of building-related energy flows in urban settlements --and MATSIM --a detailed transport micro-simulation model. The resulting platform should allow the simulation of all key physical urban resource flows. Once integrated, calibrated and validated, it will be applied to the city of Zürich to produce new guidance for its development up until 2050, with a view to achieving a 2000W/capita city.

PhD thesis published in this domain at LESO-PB

- Probabilistic Bottom-up Modelling of Occupancy and Activities to Predict Electricity Demand in Residential Buildings U. Wilke, EPFL PhD Thesis #5673, 2013

EDUCATION AND TEACHING

COURSES AND STUDENT NUMBERS 2012/2013

Bachelor/Master Programmes

Course title	Lecturer	Students	Students numbers
Building Physics I	Prof. J.-L. Scartezzini	AR BA SEM1	316
Building Physics II	Dr A. Schueler	AR BA SEM2	302
Building Physics III	Dr J. Kaempf	AR BA SEM3	160
Building Physics IV	Dr J. Kaempf	AR BA SEM4	157
Building Physics V	Prof. J.-L. Scartezzini	AR BA SEM5	145
Building Physics VI	Prof. J.-L. Scartezzini, MSc J.-C. Hadorn	AR BA SEM6	109
Indoor Environment Quality	Prof. M. Andersen P. Zurbrügg Dr B. Karamata Dr M.C. Munari Probst	AR MA SEM1	14
Energy within Buildings	Dr N. Morel Prof. tit. E. Gnansounou	GC MA SEM 1+3	57
Sustainable Urban Development, Infrastructures	Prof. J.-L. Scartezzini Dr J. Kaempf S. Cocco	AR/GC/SIE BA SEM6 (ENAC Learning Units)	18
Building Integration of Renewable Energy	MSc. Meylan Georges Dr M.C. Munari Probst MSc C. Roecker	AR/GC BA SEM6 (ENAC Learning Units)	16
Monitoring within ENAC	Dr M. Bensimon MSc O. Burdet MSc. M. Deront M. Kradolfer Dr N. Morel	AR/GC/SIE BA SEM4 (ENAC Weeks)	25

PhD Theses 2013

Title	Name	Advisers	End	# EPFL-Thesis
Bioclimatic Design of Sustainable Campuses using Advanced Optimisation Methods	S. Coccolo	Prof. J.-L. Scartezzini Dr J. Kämpf	2016	N/A
Urban Multiscale Energy Modelling	G.Upadhyay	Prof. J.-L. Scartezzini Dr J. Kämpf	2016	N/A
Solar Architecture Facades	R. Xu	Prof. J.-L. Scartezzini Prof. S. Wittkopf (NUS/HSLU Luzern)	2016	N/A
Multifunctional microstructured glazing for seasonal thermal control and daylighting	A. Kostro	Prof. J.-L. Scartezzini Dr A. Schueler	2014	N/A
Automatic control of electrochromic Windows	N. Zarkadis	Prof. J.-L. Scartezzini Dr N. Morel	2014	N/A
Optimization of daylight in educational buildings in prevailing clear sky conditions and its consequent influence on energy efficiency	C. Basurto Davilla	Prof. J.-L. Scartezzini Dr J. Kaempf	2014	N/A
Nano-structured Multilayer Coatings on Architectural Glazing for active Solar Energy Facades	S. Mertin	Prof. J.-L. Scartezzini Dr A. Schueler	2014	N/A
Urban resource Flow Modelling: from the Neighbourhood to the City	D. Perez	Prof. J.-L. Scartezzini Dr J. Kaempf	2014	N/A
The impact of Light Including Non-Image Forming Effects on Visual Comfort	A. Borisuit	Prof. J.-L. Scartezzini Dr M. Münch	2013	6007
Switchable Selective Absorber Coatings for Overheating Protection of Solar Collectors	A. Paone	Prof. J.-L. Scartezzini Dr A. Schueler	2013	5878
Probabilistic Bottom-up Modelling of Occupancy and Activities to Predict Electricity Demand in Residential Buildings	U. Wilke	Prof. J.-L. Scartezzini Dr F. Haldi	2013	5673

PhD External Committees

Involvement	Name	University	Adviser	Year
Co-supervisor PhD thesis	L. Maierova	Czech Univ. Prague	Dr M. Münch	2012-2014
Co-supervisor PhD thesis	J. Bunyesc	Universitat Politècnica de Catalunya Barcelona	Dr J. Kaempf	2009-2013

Outside Teaching

Title	Institution	Year
Integrated approach to energy systems, Doctoral course, Dr J. Kämpf (32 students)	EuroTech PhD Summer School	2013
Integrated approach to energy systems, Doctoral course, Dr M.C. Munari Probst (32 students)	EuroTech PhD Summer School	2013

Master Theses 2013

Title	Student/Institution	Year	Programme
Un écoquartier pour le plus grand nombre	Y. Mezzour (EPFL) J.D. Vesco (EPFL)	2012- 2013	MSc Architecture
Masterplan EPFL Research Center in Ras al Khainah (UAE)	S. Coccolo (Politecnico di Torino)	2012- 2013	MSc Architecture

STUDENTS FROM FOREIGN UNIVERSITIES, INTERNS AND GRANT HOLDERS

LESO-PB Research Group	Student/Institution	Year	Programme
Use of city energy simulator (CitySim) in the urban form optimisation	Th. Vermeulen, Univ. Compiègne (UTC), France	2013	PhD Student
Influence of Daylight on the Indoor Environment Quality	L. Maierova, Czech Tech. Univ. Prague	2011-2013	PhD Student Sciex-NMS
Energy Saving Potential of Appropriate Passive Design Strategies for Residential Buildings in Hot Summer and Cold Winter Climatic Region	S. Gou, Tongji University Shanghai	2013-2014	PhD Student
Sustainable Urban Development and Modelling	S. Coccolo, Politecnico di Torino, Italy	2012-2013	Master Student
Sustainable Urban Development and Modelling	E. Walter	2013	Semester Student
IT Support	R. Jufer (ETML)	2013-2014	Trainee
IT Support	M. Delafontaine (ETML)	2012-2013	Trainee
Nanotechnology support	M. Perrenoud	2013	Civil Service
IT Support	F. Aeby	2013	Civil Service

PUBLICATIONS 2013

REFEREED SCIENTIFIC JOURNALS

C. Cajochen, S. Altanay-Ekici, M. Muench, S. Frey and V. Knoblauch et al. Evidence that the Lunar Cycle Influences Human Sleep, in *Current Biology*, vol. 23, num. 15, p. 1485-1488, 2013.

A. Gudmundsson and N. Mohajeri. Entropy and order in urban street networks, in *Nature Scientific Reports*, vol. 3, num. 3324, 2013

M. Joly, Y. Antonetti, M. Python, M. Gonzalez and T. Gascou et al., Novel black selective coating for tubular solar absorbers based on a sol-gel method, in *Solar Energy*, vol. 94, p. 233-239, 2013.

M. V. Hody-Le Caër, E. De Chambrier, S. Mertin, M. Joly and M. Schaer et al. Optical and morphological characterisation of low refractive index materials for coatings on solar collector glazing, in *Renewable Energy*, num. 53, p. 27-34, 2013.

A. Kawasaki, S. Collomb, L. Leon, L., M. Münch, 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, 2013

S. 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*, [E-publication ahead of print in Jan. 2013].

M. Münch, A. Kawasaki, Intrinsically photosensitive retinal ganglion cells: classification, function and clinical implications, in *Current Opinion In Neurology*, vol. 26, num. 1, p. 45-51, 2013.

A. Putilov, M. Münch, C. Cajochen, Principal component structuring of the Non-REM sleep EEG spectrum in older adults yields age - related changes in the sleep and wake drives, in *Current Aging Science*. 6(3), pp 280-293, 2013.

U. Wilke, F. Haldi, J.-L. Scartezzini, D. Robinson. A bottom-up stochastic model to predict building occupants' time-dependent activities, in *Building and Environment*, Vol. 60, pp. 254-264, 2013.

CONFERENCE PROCEEDINGS

J. Allegrini, J. H. Kämpf, V. Dorer and J. Carmeliet. Modelling the Urban Microclimate and its Influence on Building Energy Demands of an Urban Neighbourhood. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.

C. Basurto Dávila, J. H. Kämpf and J.-L. Scartezzini. Simulating Daylight Propagation through Complex Fenestration Systems in a Urban Context Using Variable Sampling Subdivision Scheme. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.

A. Borisuit, L. Deschamps, J. Kämpf, J.-L. Scartezzini and M. Münch. Assessment of Circadian Weighted Radiance Distribution Using a Camera-Like Light Sensor. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.

A. Borisuit, L. Deschamps, J. Kämpf, J.-L. Scartezzini and M. Münch. Assessment of Circadian Weighted Radiance Distribution Using a Camera-Like Light Sensor. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.

Conference Proceedings [cont'd]

- G. Caruso and J. H. Kämpf. Air-Conditioning Energy Production through a Building Shape Optimization. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.
- S. Coccolo, J. H. Kämpf and J.-L. Scartezzini. Design in the desert. A bioclimatic project with urban energy modelling. *13th Conference of the International Building Performance Simulation Association*, Chambéry, France, 26-28 August 2013.
- A. Cuéllar Cifuentes, V., J.H. Kämpf. Urban Energy Simulation of a Social Housing Neighbourhood in Bogota, Colombia. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.
- V. Dorer, J. Allegrini, K. Orehounig, P. Moonen and G. Upadhyay et al. Modelling the urban microclimate and its impact on the energy demand of buildings and building clusters. *13th Conference of the International Building Performance Simulation Association*, Chambéry, France, 26-28 August 2013.
- M. Joly, Y. Antonetti, M. Python, M. Gonzalez and T. Gascou et al. Energy-Efficient Sol-Gel Process for Production of Nanocomposite Absorber Coatings for Tubular Solar Thermal Collectors. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.
- M. Joly, Y. Antonetti, M. Python, M. Gonzales, T. Gascou, A. Hessler-Wyser, J.-L. Scartezzini, A. Schüler. Selective solar absorber coatings on receiver tubes for CSP - energy-efficient production process by sol-gel dip-coating and subsequent induction heating. *ISES Solar World Congress*, Cancun, Mexico, November 3-7, 2013.
- A. Kostro, J.-L. Scartezzini and A. Schueler. Mixed-Dimensionality Approach for Advanced Ray Tracing of Lamellar Structures for Daylighting and Thermal Control. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.
- L. Maierova, A. Borisuit, J.-L. Scartezzini, M. Münch. Indoor lighting conditions and inter-individual light preferences: effects on subjective alertness, physical wellbeing and electrical energy consumption. *CLIMA Conference*, Prague, 16-18 June 2013.
- C. Pascual, J. de Castro, A. Schueler, A. Vasilopoulos and T. Keller. Total Light Transmittance of Glass Fiber-Reinforced Polymer Laminates for Multifunctional Load-Bearing Structures. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.
- D. Perez, J. H. Kämpf and J.-L. Scartezzini. Simulation of Urban Energy Flow: A Graph Theory Inspired Approach. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.
- L.-E. Perret-Aebi, P. Heinstejn, V. Chapuis, C. Schlumpf, H.-Y. Li, C. Roecker, A. Schüler, V. Le Caër, M. Joly, R. Tween, Y. Leterrier, J.-A. Manson, J.-L. Scartezzini, C. Baillif. Innovative Solution for Building Integrated Photovoltaics. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.
- G. Reber, P. Oelhafen, L. Burnier and A. Schueler. Angular Dependent Solar Gain for Multiple Glazing from Optical and Thermal Data. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.
- A. Ridi, N. Zarkadis, G. Bovet, N. Morel and J. Hennebert. Towards Reliable Stochastic Data-Driven Models Applied to the Energy Saving in Buildings. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.
- T. Vermeulen, J. H. Kämpf and B. Beckers. Urban Form Optimization for the Energy Performance of Buildings Using Citysim. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.
- R. Xu and S. K. Wittkopf. BIPV Visual Assessment for Architecture Retrofitting. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.
- N. Zarkadis and N. Morel. Advanced Control of Electrochromic Windows. *CISBAT 2013*, Lausanne, Switzerland, September 4-6, 2013.

EXTENDED CONFERENCE ABSTRACTS

S. Coccolo, J. Jaempf, J.-L. Scartezzini, R. Bedrone. Designin in the desert. A bioclimatic approach at the urban scale, *UAE Swiss Research day, Frontiers in Water, Energy and Sustainability*, 2013.

Münch M, Bieler K, Goldbach R, Schmieder M. Der Einfluss von dynamischer Beleuchtung bei Demenzpatienten. *Deutsche Gesellschaft für Schlafforschung und Schlafmedizin. 21. Jahrestagung, Wiesbaden, October 17-19, 2013.*

Kawasaki A, Leon L, Collomb S, Münch M. Non-visual responses mediated by intrinsically photosensitive retinal ganglion cells in patients with hereditary optic neuropathy. *American Academy of Ophthalmology (AAO): New Orleans, November 16-19, 2013.*

Münch M, Leon L, Collomb S, Kawasaki A. Comparison of non-visual, light-dependent function in healthy subjects and patients with hereditary optic neuropathy. *Annual Meeting of the Society for Light Treatment and Biological Rhythms, Geneva, June 21-23, 2013.*

Duffy JF, Scheuermaier K, Münch M, Ronda J. Two hours of evening light produces significant circadian phase delay shifts in older adults. *World Association of Sleep Medicine (WASM), 5th Annual Meeting, Valencia (Spain), September 28 - October 2, 2013.*

OTHER PUBLICATIONS, REVIEWS, PATENTS, REPORTS

M.C. Munari Probst, C. Roecker. Designing Solar Thermal Systems for Architectural Integration, Criteria and guidelines for product and system developers, Report T.41 A.3/1 of IEA SHC 41 Solar Energy and Architecture, November 2013.

M.C. Munari Probst, C. Roecker, F. Frontini, A. Scognamiglio, K. Farkas, L. Maturi, I. Zanetti, Solar Energy systems in architecture – Integration criteria and guidelines, *IEA SHC 41 Solar Energy and Architecture* 2013.

Klaudia Farkas, M.C. Munari Probst, C. Roecker, contributors, Designing Photovoltaics Systems for Architectural Integration, Criteria and guidelines for product and system developers, Report T.41 A.3/2 of IEA SHC 41 Solar Energy and Architecture, August 2013.

A. Schüler, A. Kostro, Ecole Polytechnique Fédérale de Lausanne: International patent application WO 2014024146 A1, filed on 7 August 2013. "Two Components Embedded System for Strong Angular Dependent Transmittance and Light Redirection". Industrial partners: BASF, Solar Control SA.

M. Joly, A. Schüler, Ecole Polytechnique Fédérale de Lausanne: International patent application No PCT/IB2013/058707, filed on 20 September 2013. "Procédé de fabrication d'éléments de capteurs solaires et éléments obtenus au moyen de ce procédé". Industrial partner : Zettl GmbH.

V. Hody Le Caer, A. Schüler, Ecole Polytechnique Fédérale de Lausanne: International patent application No PCT/IB2013/058115, filed on August 30, 2013. "Laminated glazing with coloured reflection and high solar transmittance suitable for solar energy systems". Industrial partner: SwissINSO.

A. Schüler, M. Joly, V. Hody Le Caer, Ecole Polytechnique Fédérale de Lausanne: International patent application No PCT/IB2013/058158, filed on 30 August 2013. "Interference filter with angular independent orange colour of reflection and high solar transmittance, suitable for roof-integration of solar energy systems". Industrial partner: SwissINSO.

BOOKS, PHD THESES

A. Paone, Switchable Selective Absorber Coatings for Overheating Protection of Solar Collectors, *EPFL Thesis No 5878*, Lausanne, 2013.

A. Borisuit, The impact of Light Including Non-Image Forming Effects on Visual Comfort, *EPFL Thesis No 6007*, Lausanne, 2013.

U. Wilke, Probabilistic Bottom-up Modelling of Occupancy and Activities to Predict Electricity Demand in Residential Buildings, *EPFL Thesis No 5673*, Lausanne, 2013.

J.-L. Scartezzini (Ed.). *CISBAT 2013 Proceedings Vol. I - Cleantech for Smart Cities and Buildings*. EPFL Solar Energy and Building Physics Laboratory, Lausanne, Switzerland, 978-2-8399-1281-5, 2013.

J.-L. Scartezzini (Ed.). *CISBAT 2013 Proceedings Vol. II - Cleantech for Smart Cities and Buildings*. EPFL Solar Energy and Building Physics Laboratory, Lausanne, Switzerland, 978-2-8399-1282-2, 2013.

INVITED PRESENTATIONS

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

Roulet C.-A., Indoor environment quality and energy in buildings. Application to Mediterranean climate ASHRAE Hellenic Chapter, Conference “Energy in Buildings 2013”, November 9th 2013, Athens (Greece)

Roulet C.-A., Contexte des Bâtiments à Energie Positive, Opening address, Journées Collaboratives Tenerrdis Bâtiment.

Scartezzini J.-L., Opening address, CISBAT 2013 International Conference “Cleantech for Smart Cities and Buildings – From Nano to Urban Scale, EPFL, 4-6 September 2013, Lausanne (Switzerland)

Scartezzini J.-L., Toward Zero Energy Buildings: from Nano to Urban Scale, *Invited Lecture*, ASHRAE Hellenic Chapter, November 9th 2013, Athens (Greece)

Scartezzini J.-L., Daylight and Humans, *Invited Lecture*, Collegium Helveticum, November 18th 2013, Zürich, Switzerland

MEDIA

Scartezzini J.-L., Interview for SIA Prize Umsicht / Regard / Sguardo 2013, Schwarz pictures, April 21, 2013

LESO LUNCHTIME LECTURES

Title	Lecturer	Date
Singapore: The conflict between modern technology and sustainability	Ran Xu (EPFL and Lucerne University of Applied Sciences and Arts)	15.03.2013
Diametric strategies for ultra-efficient photovoltaics	Prof. Jeffrey Gordon (Ben Gurion University of the Negev, Israël)	23.07.2013
LEDsafari – A low-cost-easy-to-make electric lamp for developing countries	Govinda Upadhyay (EPFL)	08.11.2013
The evolution and complexities of urban structures	Nahid Mohajeri (EPFL)	06.12.2013

REPRESENTATION

EPFL INTERNAL

Name	Board, committee etc.	Start	End
Prof. J.-L. Scartezzini	Member of EPFL Excellence Fellowship Committee	2012	-
Prof. J.-L. Scartezzini	Member of SAR Academic Committee	2012	-
Prof. J.-L. Scartezzini	CISBAT 2013 Scientific Committee	2013	-
Prof. J.-L. Scartezzini	EPFL Doctoral Programme in Energy (EDEY), Member of Doctoral Committee	2010	-
Prof. J.-L. Scartezzini	Member of Working Group on Excellence in Doctoral Education	2008	2013
Dr J. Kämpf	CISBAT 2013 Scientific Committees	2013	-
Dr N. Morel	CISBAT 2013 Scientific Committees	2013	-
Dr M.C. Munari Probs	Member of CISBAT 2013 Scientific Committees	2013	
Dr A. Schueler	Member of SAR Teaching Committee	2013	-
Dr. A. Schueler	Coordinator for Security COSEC for LESO-PB	2011	-
Dr. A. Schueler	CISBAT 2013 Scientific Committee	2013	-
MSc C. Roecker	Member of ESOPP Scientific and Piloting Committees	2010	-
MSc C. Roecker	Member of programming group Swiss PV days	2013	2014
MSc C. Roecker	Member of CISBAT 2013 Scientific Committees	2013	

EPFL EXTERNAL

Name	Organisation, Function	Start	End
Prof. J.-L. Scartezzini	Solar Energy International Journal, Associate Editor	2000	-
Prof. J.-L. Scartezzini	IPCC Working Group III – Mitigation, Scoping Meeting for Renewable Energy, Expert Reviewer	2008	-
Prof. J.-L. Scartezzini	Qatar National Research Fund (QNRF), National Priorities Research Program (NRRP), Peer Reviewer	2007	-
Prof. J.-L. Scartezzini	SIA Regards 2013 – National award for sustainable and promising achievements, Swiss Society for Engineers and Architects (SIA), Zurich, Member of Jury Panel	2013	2014
Prof. J.-L. Scartezzini	Swiss Competence Centre for Energy and Mobility (CCEM-CH), Research Committee Chair	2005	2014
Prof. J.-L. Scartezzini	International Council for Research and Innovation in Building and Construction, EPFL Representative	2004	-
Prof. J.-L. Scartezzini	European Renewable Energy Research Centres Agency (EUREC), College of Members, EPFL Representative	2004	-
Prof. J.-L. Scartezzini	Canadian Foundation for Innovation (CFI), Expert Reviewer	2010	-
Prof. J.-L. Scartezzini	Canadian Natural Science and Engineering Research Council (NSERC), Expert Reviewer	2012	-
Prof. J.-L. Scartezzini	Italian National Agency for the Evaluation of Universities and Research Institutes (ANVUR), Expert Reviewer	2012	-

EPFL external representation [cont'd]

Prof. J.-L. Scartezzini	CLIMA 2013 International Conference (Prague), Member of Scientific Committee and Session Chairman	2012	2013
Dr M.C. Munari Probst	IEA Task 51 Solar Energy and Urbanism, Subtask leader	2013	2017
Dr M.C. Munari Probst	Swissolar Association (Bern), Member of Architecture Group	2010	-
Dr M. Münch	Society for Light Treatment and Biological Rhythms Scientific Board	2013	-
MSc C. Roecker	IEA Task 51 Solar Energy and Urbanism, Subtask B leader group	2013	2017
MSc C. Roecker	Swiss PV days programming group	2013	-
Dr J. Kämpf	IEA – Task 50 "Advanced Lighting Solutions for Retrofitting Buildings, Subtask co-leader	2012	2014

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Civil Engineering Institute (IIC)

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