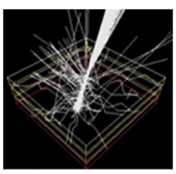
ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

CISBAT 11

CLEANTECH FOR SUSTAINABLE BUILDINGS
From Nano to Urban Scale

PROCEEDINGS VOL. I

International Scientific Conference
Lausanne, 14-16 September 2011

LESO-PB
LABORATOIRE D'ENERGIE SOLAIRE
PHYSIQUE DU BÂTIMENT

Cambridge University

MIT

IBPSA - CH

LESO-PB
LABORATOIRE D'ENERGIE SOLAIRE
PHYSIQUE DU BÂTIMENT

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

CISBAT 2011

PROCEEDINGS VOL. I

CLEANTECH FOR SUSTAINABLE BUILDINGS
From Nano to Urban Scale

14-16 September 2011
EPFL, Lausanne, Switzerland

cisbat

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Federal Office of Energy SFOE

IBPSA-CH

Cambridge University

MIT

CISBAT 2011

International Conference
14-16 September 2011, EPFL, Lausanne, Switzerland

CLEANTECH FOR SUSTAINABLE BUILDINGS –
FROM NANO TO URBAN SCALE

ISBN Print-version: Vol.I: 978-2-8399-0907-5 Vol.II: 978-2-8399-0918-1
ISBN CD-ROM version: 978-2-8399-0906-8

Conference Host / Editor
Solar Energy and Building Physics Laboratory (LESO-PB)
Ecole Polytechnique Fédérale de Lausanne (EPFL)
Station 18, CH-1015 Lausanne / Switzerland
leso@epfl.ch
http://leso.epfl.ch
Conference Chair: Prof. J.-L. Scartezzini
Conference administration: Barbara Smith

Scientific partners:
Cambridge University, UK
Massachusetts Institute of Technology, USA
IBPSA-CH, Switzerland

With the support of
Ecole Polytechnique Fédérale de Lausanne
Swiss Federal Office of Energy (SFOE)

Private sponsors:
Romande Energie
Julius Bär Swiss Private Banking group

PREFACE

The vocation of the CISBAT international conference cycle is to present new perspectives offered by renewable energies in the built environment as well as the latest results of research and development in sustainable building technology in a setting that encourages interdisciplinary dialogue and networking at the international level. The 2011 edition gathered on the EPFL campus the largest number of scientists, engineers and architects of its 20 year long history. Travelled from all over the World in an effort to promote clean technologies for sustainable buildings and cities, the participants presented 171 scientific papers during three intense days of conference.

Major international events, such as the “Deepwater Horizon” oil spill in the Gulf of Mexico and the Fukushima-Daiichi nuclear accident, which occurred in the last few years, certainly account for the growing interest of the scientific community - as well as the interest of stakeholders - for energy efficient technologies and decentralized energy systems in the built environment, such as promoted by the conference.

CISBAT was organized for the fourth consecutive time in scientific partnership with the Massachusetts Institute of Technology (MIT) and Cambridge University. Furthermore, the organizing committee is proud to have been supported again by a renowned international team of scientists in order to ensure the scientific quality and rigor expected from the conference. CISBAT 2011 also teamed up with the Swiss Chapter of the International Building Performance Simulation Association (IBPSA-CH) to strengthen the subject of “Building and Urban Simulation”, one of the conference's leading topics.

Thanks to the financial support of a growing number of institutional and private partners, such as the Swiss federal Office of Energy (SFOE), Bank Julius Bär and the public utility Romande Energie, the CISBAT international conference cycle has undoubtedly gained maturity and recognition on the international scene for its 20th Birthday Anniversary, and deserves a promising sunny future.

Prof. Dr Jean-Louis Scartezzini
Conference Chairman
Solar Energy and Building Physics Laboratory
Swiss Federal Institute of Technology Lausanne

CONTENTS VOL. I

Author index at the back.

Keynotes

Outlook on Climate Change and Renewables – the IPCC Special Report
Prof Dr Olav Hohmeyer, University of Flensburg, Germany 3

Five Easy Pieces – Towards Zero Emissions Architecture
Prof. Dr arch. Marc Angélil, ETH Zurich, agps architecture, Switzerland. 9

Sustainable Lighting: Let's talk about Value
Prof. Dr Mark Rea, Rensselaer Polytechnic Institute Lighting Research Centre, Troy, USA 11

Nanostructured Materials for Renewable Energies

H1 Flexible and lightweight solar modules for new concepts in building integrated photovoltaics
Buecheler S., Chirila A., Perrenoud J., Kranz L., Gretener C., Blösch P., Pianezzi F., Seyrling S., Tiwari A.N. 25

H2 Coloured coatings for glazing of active solar thermal façades by reactive magnetron sputtering
Mertin S., Hody-Le Caër V., Joly M., Scartezzini J.-L., Schüler A. 31

H3 Efficiency of silicon thin-film photovoltaic modules with a front coloured glass
Pélisset S., Joly M., Chapuis V., Schüler A., Mertin S., Hody-Le Caër V., Ballif C., Perret-Aebi L.-E. 37

P93 Characterisation of CuInSe2 thin films
Aissaoui O., Mehdaoui S., Benabdeslem M., Bechiri L., Benslim N., Morales M., Portier X., Ihlal A. 43

P94 Formation of ball-milled CuIn0.25Ga0.75Se2 nanoparticles. Microstructural characterisation using X-ray diffraction line broadening
Benabdeslem M., Hamida F., Bouasla A., Mehdaoui S., Benslim N., Aissaoui O., Bechiri L., Djekoun A., Portier X. 49

P95 Nanomaterials for advanced glazing technologies
Gao T., Jelle B.P., Gustavsen A. 55

P96 Thin film silicon technology and BIPV applications
Terrazzoni-Daudrix V., Pelisset S., Sculatti Meillaud F., Despeisse M., Ding L., Nicolay S., Perret-Aebi L.-E., Ballif C. 61

Sustainable Building Envelopes

A1 Development of a CO2 emissions accounting method for zero emission buildings (ZEB)
Houlihan Wiberg A. A-M., Hestnes A.G. 69

A2 Energy efficient building envelopes - The role of the periodic thermal transmittance and the internal areal heat capacity to reach a high level of indoor comfort
Rossi M., Rocco V.M. 75

A3 DReSS: A climate and occupant responsive residential envelope system
Thün G., Velikov K., Lee Ivan YT, Lomanowski A., Bartram L. 81

A4 Solar thermal energy conversion and photovoltaics in a multifunctional façade
Windholz B., Zauner C., Rennhofer M., Schranzhofer H. 87

A5 The impact of climate on moisture within non-ventilated flat roofs in timber-frame construction
Bachinger J., Krec K. 93

A6 Building simulation study of a residential double-row house with seasonal PCM-translucent façade
Frontini F., Pfafferot J., Herkel S., Schwarz D. 99

A7 A study on heat and moisture balance of a sustainable building envelope for subtropical regions
Goto Y., Frank Th., Ghazi Wakili K., Ostermeyer Y., Stahl Th., Wallbaum H. 105

A8 Comparison of sampling methods for air tightness measurements in new French residential buildings
Moujalled B., Richieri F., Carrié R.-F., Litvak A. 111

A9 What is a “natural insulation material”? Assessment model based on the life cycle
Trachte S., Evrard A., Regniers V., Aubecq C. 117

A10 The carbon negative building façade
Boyd R., Overend M., Jin Q., ...123

A11 Glazing structures with a maximum seasonal contrast ratio and the simulation of such building envelopes
Mathez S.A., Sachs W. 129

P1 Thermal evaluation of envelopes of non air-conditioned buildings
Barrios G., Huelsz G., Rojas J. 135

P2 Energy performances of an ETFE roof applied to a swimming pool
Bellazzi A., Galli S. 141

P3 Sustainable retrofit of a social housing building supported by an assessment tool
Elizondo M.F., Guerrero L.F., Mendoza L.A. 147

P4 Sustainable impacts between conventional building and vernacular architecture: comparative analysis methodology
Elizondo M.F., Guerrero L.F., Mendoza L.A. 153

P5 Dynamic thermal behaviour of ventilated wooden roofs
Fantozzi F., Leccese F., Salvadori G. 159

P6 Energy performance assessment of a responsive building envelope component: results from a numerical analysis
Favoino F., Goia F., Perino M., Serra V. 165

P7 Numerical assessment of various PCM glazing system configurations
Goia F., Perino M., Haase M. 171

P8 Zero emission building envelopes - Comparison of wall constructions with PCM and concrete in a life cycle perspective
Haavi T., Gustavsen A., Kuznik F. 177

P9 Al-Bahr towers solar adaptive façade
Karanouh A., Miranda P., Lyle J. 183

P10 Overcoming the additive-integrative paradox: Using responsive building modeling to conceive new approaches to the integrated façade
Ko J., Widder L. 189

P11 Towards a Minergie-standard for tropical climates
Kriesi R., Aabid F., Roulet C.-A., Vigliotti F., Scartezzini J.-L. 195

P12 Optimization of indoor daylight qualities and thermal comfort:a case study of educational building envelope design under tropical Savanna climate
Liu N., Jobard J. 201

P13 Phenomenological and literal transparency in the building envelopes: the environmental contribution of the veranda in hot humid climates
Maragno G.V., Coch H. 207

P14 Textile membranes as building envelope
Marques Monteiro L., Peinado Alucci M. 213

P15 Thermal effects of creepers and turfgrass wall cladding on building envelope
Mazzali U., Olivieri M., Peron F., Tatano V. 219

P16 Impact of building component lifespan on the energy indicator value according to the choice of technical solutions
Méquignon M., Ait Haddou H., Adolphe L., Bonneaud F. 225

P17 A tool to choose environmentally-friendly finishing products
Oberti I., Baglioni A., Plantamura F. 231

P18 Different strategies for refurbishment
Osterhage T., Cali D., Müller D. 237

P19 LCA based comparative evaluation of building envelope systems
Pittau F., De Angelis E., Masera G., Dotelli G. 243

P20 Analysis of the building geometry influence on energy efficient integration of small wind turbines in building envelopes
Popovac M., Teppner R., Rudoph M. 249

P21 The new information communication technology centre of Lucca
Sala M., Romano R. 255

P22 Wide conception of “zero” ecobuildings and ecocities on base of ecological infrastructure
Tetior A. 261

P23 TEENERGY SCHOOLS - High energy efficient school buildings in the Mediterranean Area
Trombadore A., Toshikazu Winter R., Romano R. 267

P24 Life cycle assessment (LCA) of buildings applied on an Italian context
Villa N., De Angelis E., Iannaccone G., Zampori L., Dotelli G. 273

P25 Energy efficiency of building envelope for drywall systems in hot-humid climate - Principles, technologies and systems construction
Villalta M. 279

Solar Active and Passive Cooling

D1 Passive cooling approaches in net-zero energy solar buildings: lessons learned from demonstration buildings
Aelenei L.E., Lollini R., Gonçalves H., Aelenei D., Noguchi M., Donn M., Garde F. 287

D2 Using solar thermal flat plate collectors for active solar cooling of computer server rooms
Brünig M., Tschan T., Haller A. 293

D3 Improvement of natural ventilation as passive design strategy in a school building
Mazzali U., Peron F., Romagnoni P. 299

P58 Analysis of passive cooling and heating potential in Vietnam using graphical method and Typical Meteorological Year (TMY) weather files
Nguyen A.-T., Reiter S. 305

P55 Fluid dynamic efficiency of a dynamic glazing system
Danza L., Bellazzi A. 311

P56 The generation of subsurface temperature profiles for Yazd
Emadian Razavi S.Z., Fakhroddin Tafti M.M. 317

P57 Air cooling powered by façade integrated coloured opaque solar thermal panels
Mack I., Mertin S., Le Caër V., Ducommun Y., Schüler A. 323

P54 Summer comfort in a low inertia building with a new passive cooling system using thermal phase-shifting
Brun A., Wurtz E., Quenard D., Hollmuller P. 329

Daylighting and Electric Lighting

C1 Limits and potentials of different daylighting design approaches based on dynamic simulations
Pellegrino A., Lo Verso V.R.M., Cammarano S. 337

C2 Sustainable Lighting: More than just lumens per watt
Figueiro M.G., Rea M.S. 343

C3 Ray-tracing simulation of complex fenestration systems based on digitally processed BTDF data
Kämpf J., Scartezzini J.-L. 349

C4 Redirection of sunlight by micro structured components
Klammt S., Müller H.F.O., Neyer A. 355

C5 Comparison of objective and subjective visual comfort and associations with non-visual functions in young subjects
Borisuit A., Linhart F., Kämpf J., Scartezzini J.-L., Münch M. 361

C6 Integration of eye-tracking methods in visual comfort assessments
Sarey Khanie M., Andersen M., Hart B.M. 't, Stoll J., Einhäuser-Treyer W. 367

C7 Glazing colour types, daylight quality, arousal and switch-on patterns for electric lights
Arsenault H., Hébert M., Dubois M.-C. 373

C8 Performance indicators of virtual natural lighting solutions
Mangkuto R.A., Aries M.B.C., van Loenen E.J., Hensen J.L.M. 379

P34 Climate-based daylight performance: balancing visual and non-visual aspects of light input
Andersen M., Mardaljevic J., Roy N., Christoffersen J. 385

P33 Informing well-balanced daylight design using Lightsolve
Andersen M., Gagne J.L., Kleindienst S. 391

P35 Daylight optimization of buildings and application of advanced daylighting systems in central Mexico
Basurto C., Borisuit A., Kämpf J., Münch M., Scartezzini J.-L. 397

P36 Regulation and control of indoor environment daylight quality. A case study
Bellazzi A., Galli S. 403

P37 Plasma lighting technology
Calame L., Meyer A., Courret G. 409

P38 Streamlining access to informative performance metrics for complex fenestration systems
Dave S., Andersen M. 415

P39 Energy saving potential and strategies for electric lighting in future low energy office buildings: a literature review
Dubois M.-C., Blomsterberg A. 421

P40 Numerical Simulation of Daylighting using the software CODYRUN
Fakra A.H., Moosafeer M., Boyer H., Miranville F. 427

P41 A study on day lighting condition in classrooms of Iranian schools in Tehran - Measurements and analysis of illuminance distribution
Farzam R. 433

P42 Energy efficient control of daylight in an office room under Norwegian climate
Haase M. 439

P43 Using satellite data to predict sky conditions and zenith luminance in Hong Kong
He Z.J., Ng E. 445

P44 CODYRUN: Artifcial lighting simulation software for visual comfort and energy saving optimization
Jean A.P., Fakra A.H., Boyer H., Miranville F. 451

P45 Towards microstructured glazing for daylighting and thermal control
Kostro A., Geiger M., Scartezzini J.-L., Schüler A. 457

P46 LED Lighting in museums: the New Diocesan Museum in Piombino (Italy)
Leccese F., Salvadori G., Colli A. 461

P47 Using wind-towers shaft for daylighting in Brazilian terrace houses
Martins T.A.L., Didoné E.L., Bittencourt L.S., Barroso-Krause C. 467

P48 Optical characterization of a tubular daylighting system for evaluation of its suitability for Swedish climates
Nilsson A.M., Roos A. 475

P49 Assessment of Iranian traditional door-windows, a proposal to improve daylighting system in classrooms
Tahbaz M., Djalilian Sh., Mousavi F. 479

P50 Digital camera for continual luminance mapping for daylighting performance assessment
Thanachareonkit A., Fernandes L.L., Papamichael K. 485

P51 Solar fibre optic lights - Daylight to office desks and corridors
Volotinen T., Nilsson N., Johansson D., Widen J., Kräuchi Ph. 491

P52 Reliable daylight sensing for daylight harvesting in side-lit spaces
Xu J., Papamichael K. 497

Indoor Environment Quality and Health

I1 Adaptive control strategies for single room heating
Adolph M., Kopmann N., Müller D., Böwer B., Linden J. 505

I2 Air temperature and CO2 variation in a university office building with double-skin façade
Altan H., Refaee M., Mohelnikova J. 511

I3 Environmental study of water-cistern and ice-house in arid regions through case studies in Yazd, Iran
Jafari S., Baker N. 517

I4 Optimization of glazing area for human thermal comfort for cold stations of Indian region
Jha R., Jindal N., Baghel S. 523

I5 Sustainability in the historic built environment. Upgrade of environmental performance of listed structures. The historic churches in the UK
Marques Monteiro L., Peinado Alucci M. 529

I6 Adaptive issues on outdoor thermal comfort
Marques Monteiro L., Peinado Alucci M. 535

P97 Light transmittance range of glass for visual comfort in an office environment
Aarts M., Chraibi S., Aries M., van Loenen E., Mangkuto R.A., Wagenaar T. 541

P98 Potential for energy saving in transitional spaces in commercial buildings
Alonso C., Aguilar A., Coch H., Isalgué A. 547

P99 Experimental evaluation of indoor visual comfort conditions in office buildings with the integration of external blinds
Axarli K., Tsikaloudaki K., Ilioudi C. 553

P100 Simulating occupant behaviour and energy performance of dwellings: a sensitivity analysis of presence patterns in different dwelling types
Bedir M., Harputlugil G.U. 559

P101 Indoor environment quality - Casas de Santo Antonio, Barreiro
Carrapiço I., Amado M.P. 565

P102 Coupling thermal and daylighting dynamic simulations for an optimized solar screen control in passive office buildings
Dartevelle O., Deltour J., Bodart M. 571

P103 Indoor environmental quality of the first European ModelHome 2020: Home for life
Foldbjerg P., Hammershoj G.G., Feifer L., Hansen E.K. 577

P104 Study of comfort condition of a rehabilitated Amirchakhmagh water-cistern in Yazd, Iran
Jafari S., Baker N. 583

P105 Integrating visual and energy criteria for optimal window design in temperate climates
Ochoa C.E., Aries M.B.C., Aarts M.P.J., van Loenen E.J., Hensen J.L.M. 589

P106 An analysis of school building design evaluation tools
Pereira P.R.P., Kowaltowski D.C.C.K. 595

P107 Occupant satisfaction as an indicator for the socio-cultural dimension of sustainable office buildings
Schakib-Ekbatan K., Wagner A. 601

P108 Responsive envelopes and air design: the Stratus project
Thün G., Velikov K., Ripley C., O'Malley M. 607

CONTENTS VOL. II

Advanced Building Control Systems

P70 Smart electric blinds
Bützberger F., Truffer C. 615

P71 Optical characterization and energy simulations on metal-hydride switchable mirrors
Jonsson A., Roos A., Yasusei Y. 621

P72 Thermal model predictive control for demand side management strategies in prefabricated buildings
Romanos P., Trianti E., Papanikolaou K., Koustae E., Papamichail T., Pavli P., Donou A., Schmid J., Nestle D. 627

Urban Ecology and Metabolism

B1 Spatial planning as a driver for change in both mobility and residential energy consumptions
Dujardin S., Marique A.-F., Teller J. 635

B2 How shopping online can modify the mobility of the private individuals and reduce the environmental impacts linked to transports
Paule B., Nguyen B. 641

P26 Impact of vegetation on thermal conditions outside, thermal modelling of urban microclimate - Case of street of the republic, checkered colonial Biskra
Boukhabla M., Alkama D. 647

P27 The Ziban as sustainable city in the Sahara
Bouzaher Lalouani S., Alkama D. 653

P28 Strategies for sustainable existing neighborhoods
Messari-Becker L. 659

P29 Performative landscapes: public space as framework for community evolution
North A. 665

P30 Designing material and energy flows for a urban ecosystem
Palumbo M.L., Scognamiglio A. 671

P31 The resilience as indicator of urban quality
Saporiti G., Rogora A. 677

P32 Ecodistricts
Vanderstraeten P., Bottieau V., Bellefontaine L., Meuris C., Léonard F. 683

Integration of Renewables in the Built Environment

K1 Key innovations of Stuttgart's project Home+ for the Solar Decathlon Europe 2010 in Madrid
Cremers J., Binder M. 689

K2 An energy concept for multifunctional buildings with geothermal energy and photovoltaics
Fuetterer J., Constantin A., Mueller D. 695

K3 Calculating embodied energy of buildings with MINERGIE-ECO 2011
Kellenberger D., Citherlet S. 701

K4 Interdisciplinary research on thin film photovoltaic facades and building standards
Muntwyler U., Joss D., Reber N., Bützer D., Schüpbach E., Winkler M. 707

K5 Project "Energie und Baudenkmal" EnBau - Optimization of energy interventions in buildings of historical-architectonical value
Zanetti I., Frontini F. 713

K6 SELF- The independent house
Zimmermann M. 719

P109 Exergy analysis of office buildings using geothermal heat pumps
Badakhshani A., Hoh A., Müller D. 725

P110 Gis based thematic maps as design tool to support integration of renewable energy and improve the energy efficiency of existing buildings
Clementi M. 731

P111 Hybrid photovoltaic-thermal (PV-T) solar co-generation at the building's scale
Dupeyrat P., Ménézo C., Bai Y., Kwiatkowski G., Rommel M., Stryi-Hipp G. 737

P112 Investigation of the space-heating using wood stoves in very low-energy houses
Georges L., Massart C., De Herde A., Novakovic V. 743

P113 Evaluation of alternative neighborhood patterns for BIPV potential and energy performance
Hachem C., Athienitis A., Fazio P. 749

P114 Simulation and comparison of different district heating networks in combination with cogeneration plants
Jahangiri P., Badakshani A., Hoh A., Müller D. 755

P115 New challenges in solar architectural innovation
Perret-Aebi L.-E., Heinstein P., Chapuis V., Pélisset S., Roecker C., Schüler A., Lumsden K., Leterrier Y., Scartezzini J.-L.,Manson J.-A., Ballif C. 761

P116 Identifying opportunities of passive thermal storage in residential buildings for electrical grid measures
Reynders G., Baetens R., Saelens D. 767

P117 Adequacy of photovoltaic energy in office environment
Viitanen J., Puolakka M., Halonen L. 773

Building and Urban Simulation

G1 Heating and cooling demand estimation using a self-learning thermal building model
Ashouri A., Benz M.J., Stettler R., Fux S.F., Guzzella L. 781

G2 Simulation models of refurbished residential housing - Validation through field test data
Calì D., Osterhage G., Constantin A., Mueller D. 787

G3 The application of sensitivity analysis in building energy simulations
Garcia Sanchez D., Lacarrière B., Bourges B., Musy M. 793

G4 How important is the implementing of stochastic and variable internal boundary conditions in dynamic building simulation?
Parys W., Saelens D., Roels S., Hens H. 799

G5 Assessment of modeling approaches for louver shading devices in office buildings
Saelens D., Parys W., Roofthooft J., Tablada de la Torre A. 805

G6 Stochastic activity modeling in residential buildings
Wilke U., Haldi F., Robinson D. 811

G7 Differential sensitivity of the energy demand for an efficient office to selected architectural design parameters
Struck C., Menti U.-P., Sidler F., Plüss I., Hönger C., Moosberger S. 817

G8 Modelling system flows in building and city design
Geyer P., Buchholz M. 823

G9 Modelling the uptake of low carbon technologies in the UK residential building sector
Mavrogianni A., Raslan R., Oreszczyn T. 829

G10 Towards formulating an urban climatic map for high density cities - an experience from Hongkong
Ng E. 835

G11 Estimating resource consumption using urban typologies
Quinn D., Wiesmann D., Sarralde J.J. 841

G12 Passive cooling operation by activated outer surfaces – Feasibility study for Switzerland
Wemhoener C., Gengkinger A., Afjei T., Bichsel J., Mueller D. 847

G13 Quantification of retrofit measures on a multi-family residential building for different European climates with detailed and simplified calculation tools
Zweifel G. 853

P73 Influence of the urban microclimate on the energy demand of buildings
Allegrini J., Dorer V., Carmeliet J. 859

P74 Oeiras Masterplan: A methdology to approach urban design to sustainable development
Amado M.P., Poggi F. 865

P75 Urban outlines 2D abstraction for flexible and comprehensive analysis of thermal exchanges
Beckers B. 871

P76 Simulating physical rebound in retrofitted dwellings
Deurinck M., Saelens D., Roels S. 877

P77 Heating and passive cooling with heat pumps – comparison of simulation, calculation method & field measurement results
Dott R., Gengkinger A., Wemhoener C., Afjei T. 883

P78 Comparing control-oriented thermal models for a passive solar house
Fux S.F., Benz M.J., Guzzella L. 889

P79 Solar energy quantification for the whole French urban area
Ghanassia E., Laurent M.-H., Maïzia M., Beckers B. 895

P80 Life cycle assessment applied to urban settlements and urban morphology studies
Herfray G., Vorger E., Peuportier B. 901

P81 Enhancing results of a heat pump field test by means of dynamic simulations
Huchtemann K., Müller D. 907

P82 Balancing diversity and evaluation time in building energy system evolutionary algorithms
Jones M. 913

P83 Simulation of thermal solar collectors, latent heat storage and heat pump system for space heating
Leonhardt C., Müller D. 919

P84 Energy requirements and solar availability in suburban areas: the influence of density in an existing district
Marique A.-F., de Meester T., Reiter S. 925

P85 Quality indicators for district heating networks
Pacot P.-E., Reiter S. 931

P86 CitySim simulation: the case study of Alt-Wiedikon, a neighbourhood of Zürich City
Perez D., Kämpf J., Wilke U., Papadopoulou M., Robinson D. 937

P87 Impact of urban morphology on building energy needs: a review on knowledge gained from modeling and monitoring activities
Pol O., Robinson D. 943

P88 Evaluation of wind-driven ventilation in building energy simulation: sensitivity to pressure coefficients
Ramponi R., Cóstola D., Angelotti A., Blocken B., Hensen J.L.M. 949

P89 Co-simulation for building controller development: the case study of a modern office building
Sagerschnig C., Gyalistras D., Seerig A., Privara S., Cigler J., Vana Z. 955

P90 External and internal solar-climatic performance analysis of building geometries using SOLARCHVISION
Samimi M., Nili M.-Y., Nasrollahi F., Parvizsedghy L, Vahabi-Moghaddam D. 961

P91 Towards more effective communication of integrated system performance data
Struck C., Bossart R., Menti U.-P., Aebersold R., Steimer M. 967

P92 Towards assessing the robustness of building systems with positive energy balance – A case study
Struck C., Maderspacher J., Menti U.-P., Zweifel G., Plüss I. 973

Information Technologies and Software

E1 Tools and methods used by architects for solar design: results of an international survey in 14 countries
Dubois M.-C., Horvat M., Kanters J. 981

E2 Volumetric insolation analysis
Leidi M., Schlüter A. 987

E3 A procedural modelling approach for automatic generation of LoD building models
Besuievsky G., Patow G. 993

P59 Web based building modelling and simulation
Abromeit A., Wagner A...999

P60 A renewable energy platform
Ait Haddou H., Bonhomme M., Adolphe L. 1005

P63 Information technology meets scientific research on the web. DOCETpro2010 and XClimaEurope: The Italian experience on diagnosis and energy certification
Belussi L., Danza L., Lanz G., Meroni I....1011

P65 Computer-based tool « PETRA » for decision-making in networks about the maintenance and renovation of a mixed building estate
Colombo L., Rudel R., Branca G., Tamborini D., Streppavara D., Ortelli L., Thalmann P., Flourentzou F., Genre J.-L., Kaehr P. 1017

P66 A method to compare computational fluid dynamics and multizonal dynamics simulations
in buildings physics
Deltour J., Van Moeseke G., Barbason M., Reiter S. 1023

P64 Modal architecture: an integrated approach to building information model, simulation based design and Leed environmental rating
Di Munno E., Temportin V., Rapone M., Taccalozzi L., Diez M., Spigai V., Peron F., Specher A....1029

P67 Comparison of simulation results with measurements of the Decthlon buiding of the University of Rosenheim
Maderspacher J., Moosberger S. 1035

P68 Parametric scripting for early design performance simulation
Nembrini J., Labelle G., Nytsch-Geusen C. 1041

P61 DIAL+ Suite - A complete but simple suite of tools to optimize the global performance of buildings openings - Daylight / Natural Ventilation / Overheating Risks
Paule B., Flourentzou f., Pantet S., Boutillier J. 1047

P62 Solar radiation and uncertainty information of Meteonorm Version 7
Remund J., Müller S.C. 1053

P69 Design support tools with technical, ecological and sensible apertures in the choice of materials
Tornay N., Bonneaud F., Adolphe L...1059

Author index 1065

THE NEW INFORMATION COMMUNICATION TECHNOLOGY CENTRE OF LUCCA

Prof. Marco Sala[1], Arch. PhD. Rosa Romano[2]

1 ABITA Inter University Research Center Florence, Department of Architecture Technology and Design, University of Florence marco_sala@unifi.it, 2 ABITA Inter University Research Center Florence, Department of Architecture Technology and Design, University of Florence rosa.romano@taed.unifi.i

ABSTRACT

The Information Communication Technology Centre project was commissioned by the Chamber of Commerce of Lucca. The ABITA Centre was in charge of the green design of the project. This allowed us to test new technologies related to energy efficiency of the office building. The project focused on: the development of components and advanced energy saving systems, integration of dynamic facades to reduce heat loss through the building envelope, and energy production through renewable energy sources. Currently the building is under construction, and will be completed by the end of 2011.

Three buildings are connected by a central atrium, which is covered by a large glass and steel roof, (on the east-west axis), while the laboratories are covered by a green roof.

The project is focused on the adoption of intelligent facade systems to control the solar radiation in summer and heat loss in winter. All the windows have mobile aluminium shutters, which allow sun protection. The south facing glass roof of greenhouse is made of semi-transparent polycrystalline silicon photovoltaic panels. Those panels are integrated also on the south wall of building one. The selective low-E glass skylight and transparent surfaces have been designed to ensure excellent natural lighting inside the building. Solar pipes have been integrated in the roof of the laboratories. Air exchange is provided by a natural ventilation system.

The building will be certified – according to national legislation – as class A, thanks to the choice of materials. The materials are ecological and sourced from the project site. The choice of the building envelope uses a metal wall system with a low U value, thermal inertia and the integration on renewable energy system. In fact, the building's annual consumption is around 20 kWh/m^2 compared to 170kWh/m^2 in a traditional office building.

1. INTRODUCTION

The New ICT of Lucca project has been developed with the aim of spreading sustainable construction methodology in Italy. The aim is to reach the goals of 20/20/20 and to diffuse regulations that govern energy efficiency in buildings. The European Union established these regulation through the *Energy Performance Building 2002/91/CE* and *EU Directive 2010/31*. These aim to diffuse local and national regulations to guarantee high the efficient buildings, using appropriate policies which consider local climate conditions. From 31st December 2018, we must start building *zero energy* public buildings.

In Southern Europe, we must think about on winter and summer conditions and avoid copy in Northern Europe energy efficiency architectural solutions, to create appropriate solutions in energy efficient buildings. Southern Europe has specific climatic conditions, with the problems of indoor summer comfort, and the consumption of water resources and natural resources. Therefore it is necessary to improve research into new technologies for envelope solutions with regard to the energy consumption.

In Italy, the constant dependency on fossil fuels, oil and methane gas is still high in housing and office buildings sector. At a national level, Italy has adopted the European Directive 2002/91 with the dlgs 192/2005, that has been integrated and modified over the years. So, in 2009 the energy certification of buildings was made compulsory. In July 2009 the National Guide Lines, about the energy certification of buildings were issued. The *UNI TS 11300,* that follow the CEN regulations, were adopted. These propose a new and improved calculation method, including which incorporates energy consumption. The new regulation introduce new parameters of evaluation, like the periodic thermal transmittance or the indices of summer energy consumption.

In this paper we report on the strategies and technologies that we adopted to improve the energy performance of the new Lucca office building, to reduce the costs of heating, cooling and lighting, responding to national and international energy laws.

Fig. 1: East facade with Smart Skin Envelope

2. APPROACH

2.1 OFFICE IN ITALY: THE ENERGY SITUATION

The standard practice in Italian office buildings shows the following situation:

- full dependency on air conditioning systems to compensate deficiencies in the design's buildings
- high maintenance costs for the buildings and plants
- high electricity consumption
- an inexistent indoor environmental control system

Moreover it's important to note that energy consumption data is rarely available.

This is symptomatic of the lack of objectives to improve the quality of the environment:

- outdated environmental conditions in terms of air quality, visual quality and thermal performance
- environmentally-friendly and energy conscious design have been completely ignored due to a lack of knowledge about handling natural resources like natural day-light and ventilation;
- no environmental monitoring and control.

For these reasons this research needed project for a sustainable future in southern Europe, deals with successful solutions to decrease the growing effects of energy consumption trough air conditioning in urban buildings. In this contest, the ICT of Lucca offers great margins for energy improvement to promote a sustainable approach.

2.2 OBJECTIVES OF THE PROJECT

The reduction of energy consumption and the attention to environmental requirements are the main objectives of our project. The design concept of the building has been characterized by the adoption of solutions which improve solar gains and natural ventilation, and guarantee the integration of technologies to produce renewable energies with the building envelope. During the stage of design we simulated every energy performance of the building, choosing the system which would most reduce energy consumption. During the first design stage we employed an energy concept which corresponded to the features of the functional plan, the site, the local conditions weather and climate. On the basis of those parameters, the shape and consequently the structure were defined.

The project objectives of the new ICT Centre of Lucca are:

- To implement a concept design and a building construction based on technological solutions for passive cooling, natural lighting and ventilation, renewable energies, geothermal systems, greenhouses and a smart skin envelope
- To apply and test new and innovative energy saving technologies in order to improve the energy performance and the indoor environment of office buildings
- To realize a 50% reduction energy consumption and CO2 emissions
- To set a new standard for energy consumption and CO2 emissions in offices, while fully maintaining comfort conditions for workers
- To demonstrate, that energy efficient and sustainable office buildings can fully meet all the architectural, functional, comfort, control and safety features required, through the application of innovative and intelligent and integrated design. This demonstration could contribute to greater acceptance of innovative and renewable technologies in public buildings
- To diffuse and capitalize the results to increase the awareness of energy saving practices (in the medium and long term), and to integrate and improve policies for energy performance in buildings in Italy
- To use a monitoring system to compare the energy performance of buildings and define a new energy standard, in accordance with EU Energy Labels for the Mediterranean Area.

2.3 HOW CAN WE REDUCE ENERGY CONSUMPTION?

The construction of this new office building incorporates energy efficient measures, which are not only current innovations for the actual state of art but are also replicable in other offices in Italy. The importance of this project, with regards to our current situation, is the introduction of some specific, innovative, energy saving techniques, which set new energy, environmental and health standards for office buildings. In this framework, the following measures have been incorporated:

- An appropriate orientation of the building and envelope design.
- Smart façades and highly insulated building.
- Use of natural ventilation thought a good design.
- The sun space between the buildings acts as a buffer zone to reduce heat loss.
- Use of skylights for even distribution of daylight.
- Use of a geothermal system with a heat pump for cooling and heating.
- Integration of renewable energy, in the form of photovoltaic and solar thermal panels in the building envelope.

Thanks to its materials and innovative technologies, this building aims to spread the use of renewable resources and bio-architecture strategies.

3. SUSTAINABLE STRATEGIES

3.1 CLIMATIC ANALYSIS

Lucca is located at latitude 43° north and longitude 10° East, and has a typically Mediterranean climate with a cold winter (average temperatures ranging between -1.7-15.6°C) and hot summer (average temperatures ranging between 13-30°C), and rainfall mainly between November and March (precipitations of 125 mm/month).

Global radiation on a horizontal plane in summer may rise above 24 MJ/m^{2}day, while a winter value may rise above 4.5 MJ/m^{2}day. This data allows us to use active and passive strategies to reduce the energy consumption in the building. So, we have integrated PV panels in the roof of the big sun space and in the south façade.

The climate is dry with an average humidity in summer of about 70%, so we have adopted solutions about to control the humidity value inside the building in these months.

Finally, this climatic analysis has showed that the Lucca climate requires both heating (in December, January, February and March) and cooling (in June, July and August). Throughout the design process the aim has been to maximize heat gain in winter and minimize it in summer, and to encourage heat loss in the summer and limited in winter. In the intermediate months (April, May, September and October) the building won’t be heated or cooled with artificial systems.

3.2 INTEGRATION OF PV SYSTEMS IN THE BUILDING ENVELOPE

In this project, to reduce the electricity needs, we integrated in the building envelope of a system:
- The sunspace roof; 48 glass PV panels integrated in half of the sunspace roof to improve the shading of the open space, this system produced 11.52 kWp.
- South façade; 84 opaque PV panels are integrated in the opaque modules of the vertical envelope (2.92 x 1.48 m), this system produced 15.96 kWp.
- The building roofs; this system is integrated in the roofs of buildings 1 and 3 and is made to 108 PV panels with amorphous cells, and it produced of 17.00 kWp

3.3 GEOTHERMAL HEATING AND COOLING

The ITC of Lucca is equipped with a geothermal system. The geothermal system is made to:
- 18 geothermal probes (90.00 m. Long).
- A heat pump with a cooling capacity about of 43.5 kw and heating capacity about of 45.00 kw.
- Radiant ceiling with an area of 5000.00 m^2.

The purpose of using the geothermal energy for cooling and heating ensure the decrease of the environmental impact of the building, in fact, this system produces renewable energy, it saves

about 50 % of the heating costs and supplies the energy needs for heating, cooling and water thought the year.
For energy consumption control, each office and laboratory is equipped with a heating, electricity and water meter so that the office user can see their energy consumption.

3.4 SUN SPACES

The sun space in the ICT Centre of Lucca has a surface of 1000,00 m^2, and was designed as an active roof, permitting the integration and flexible management of all mechanisms designed for heat and soundproofing, natural light and ventilation.

The design objective has considered not only the energy and environmental aspects but also the social impact: the primary objective is to create a pleasant, social atmosphere space which can be used for semi-outdoor activities through much of the year without any extra energy consumption.

Moreover, each office, is opens into the greenhouse, to improve daylight and to reduce the energy needs for lighting.

Particular attention was given to the design of the sun space envelope. The roof has a specific shape, with an angle of about 30% facing south, to ensure the integration of the PV panels, thus providing an overhanging surface which shadows the glazed roof from the sun. A motorized adjustable venetian blind is integrated in to the south and north façade, to improve ventilation in the summer. The main structure of the glass of the entrance hall as crescent shape, and is made of square steel beams, and tubular steel elements

4. FACADE ENGINEERING

The envelope of the building has two types of surface, according to the different orientation:

- Type 1 is the north and west façade, this uses a ventilated façade and has a U value of 0.28 W m^2
- Type 2 is the south and east façade, this is a smart façade with an internal transparent surface which has a U value of 1.2 W m^2 and a solar factor equal to 40%; the internal opaque model has a U value of 0.3 W m^2; external glazed surface has a U value of 4.00 W m^2 and solar factor equal to 57%; the PV cells are placed above the south façade, in front of the opaque module.

4.1 Smart facade

The south and the east façade have been designed as a smart skin that can change performance with the outdoor climatic conditions. The smart skin is a mobile double skin with a 50% opaque module, where a PV or solar thermal panel can be integrated, and a 50% transparent module. The façade consists of several parts assembled "dry" with a window frame whit an aluminum metal coating.

The modules are dynamic and can change configuration because the façade is integrated with two mobile pannels with a shading device and a glass pannel. In front of the trasparent module a metallic mosquito net is installated that allows the window of the transparent module to be opened at night to improvenight cooling in the building, in summer.

In winter a mobile glass panel is placed in front of the transparent module. So the smart facade will have the shape of double skin facade with a buffer zone that increase its U value to 0.8 W/m^2K.

In summer a panel with a shading device is placed in front of the transparent module, to regulate direct solar radiation and increase heat loss in the office.

5. Conclusion

The ICT Centre demonstrates that the energy efficient in the office buildings can fully meet all the requirements of the sustainability (architectural, functional, comfort and control) trough the application of innovative, intelligent and integrated design. This experimental project could contribute to a better dissemination of innovative and renewable technologies in public buildings in Italy.

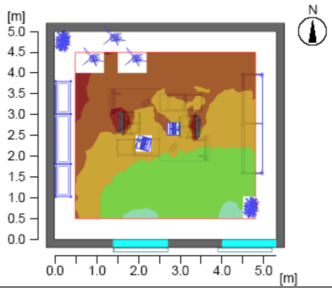
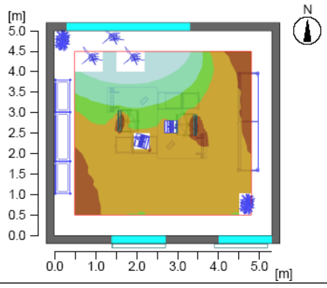
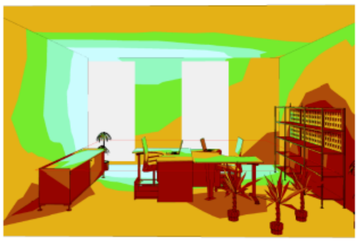
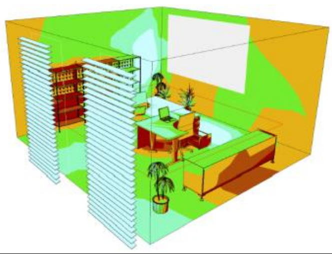
Office 1		**Office 2**	
			
			
E. Medium	267 lx	**E. Medium**	784 lx
E. Min	84 lx	**E. Min**	360 lx
E. Max	619 lx	**E. Max**	2450 lx

*Table 1: **Office Daylight Analysis.** We have integrated a window in the wall to the atrium to improve the natural lighting in the office.*

References

1. Banham, R., The Architecture of the Well – Tempered Environment, Architectural Press, London, 1969
2. Hammad, F. Abu-Hijleh, B., The energy savings potential of using dynamic external louvers in an office building, in Energy and Buildings. An international journal devoted to investigations of energy use and efficiency in buildings, v. 42, p. 1888 1895, ELSEVIER, 2010
3. Hausladen, G., De Saldanha, M., Liedl, P., Sager, C., Climate Design: Solutions for Buildings that Can Do More with Less Technology, Hardcover, 2005
4. Jones D. L., Hudson, J., Architecture and the environment. Bioclimatic building design, Laurence King Publishing, London, 1998
5. Oesterle L., Lutz, H., Double-Skin facades: integrated planning, Prestel, Munich – London – New York, 2001