

11th Nordic Symposium on Building Physics (NSB 2017)

Energy Procedia Volume 132

Trondheim, Norway
11 – 14 June 2017

Part 1 of 2

Editors:

**Stig Geving
Berit Time**

ISBN: 978-1-5108-5006-4

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© by Elsevier B.V.
All rights reserved.

Printed by Curran Associates, Inc. (2017)

For permission requests, please contact Elsevier B.V.
at the address below.

Elsevier B.V.
Radarweg 29
Amsterdam 1043 NX
The Netherlands

Phone: +31 20 485 3911
Fax: +31 20 485 2457

<http://www.elsevierpublishingsolutions.com/contact.asp>

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2633
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

PART 1

EDITORIAL TO THE PROCEEDINGS OF NSB2017	1
<i>Stig Geving, Berit Time</i>	
METHOD FOR PROBABILISTIC ENERGY CALCULATIONS – VARIABLE PARAMETERS	3
<i>Stephen Burke, Johnny Kronvall, Magnus Wiktorsson, Per Sahlin</i>	
EVALUATION OF A SINGLE FAMILY LOW ENERGY BUILDING IN COLD CLIMATE	9
<i>Ronny Östin</i>	
INFLUENCE OF PV-POWERED THERMOELECTRIC SURFACES FOR USER-INDIVIDUAL RADIATIVE COOLING ON THE COOLING ENERGY DEMAND OF BUILDINGS	15
<i>Mathias Kimmling, Sabine Hoffmann</i>	
A WORLD CLASS ENERGY EFFICIENT UNIVERSITY BUILDING BY DANISH 2020 STANDARDS	21
<i>Muhyiddine Jradi, Fisayo Caleb Sangogboye, Claudio Giovanni Mattera, Mikkel Baun Kjærgaard, Christian Veje, Bo Nørregaard Jørgensen</i>	
CALCULATION AND COMPLIANCE PROCEDURES OF THERMAL BRIDGES IN ENERGY CALCULATIONS IN VARIOUS EUROPEAN COUNTRIES	27
<i>Kalle Kuusk, Jarek Kurnitski, Targo Kalamees</i>	
CRITICAL DISCUSSION OF A SHADING CALCULATION METHOD FOR LOW ENERGY BUILDING AND PASSIVE HOUSE DESIGN	33
<i>Matthias Winkler, Florian Antretter, Jan Radon</i>	
THERMAL MASS AND ENERGY RECOVERY UTILIZATION FOR PEAK LOAD REDUCTION	39
<i>Jevgeni Fadejev, Raimo Simson, Jarek Kurnitski, Mark Bomberg</i>	
METHOD TO DIVIDE HEATING ENERGY IN ENERGY EFFICIENT BUILDING WITHOUT DIRECT MEASURING	45
<i>Anti Hamburg, Targo Kalamees</i>	
ACHIEVED ENERGY AND CLIMATE GOALS IN PROJECT ÅLIDHEM: AN EVALUATION OF A REFURBISHMENT OF 21 SWEDISH MULTIFAMILY BUILDINGS	51
<i>Jimmy Vesterberg, Staffan Andersson</i>	
IMPACTS OF PARAMETER VALUES INTERACTIONS ON SIMULATED ENERGY BALANCE OF RESIDENTIAL BUILDINGS	57
<i>Uniben Y. A. Tettey, Ambrose Dodoo, Leif Gustavsson</i>	
INFRARED DRONES IN THE CONSTRUCTION INDUSTRY: DESIGNING A PROTOCOL FOR BUILDING THERMOGRAPHY PROCEDURES	63
<i>A. G. Entrop, A. Vasenev</i>	
POSSIBLE EXPLANATIONS FOR THE GAP BETWEEN CALCULATED AND MEASURED ENERGY CONSUMPTION OF NEW HOUSES	69
<i>Jesper Kragh, Jørgen Rose, Henrik N. Knudsen, Ole Michael Jensen</i>	
INFLUENCE OF TIME CONSTANTS ON LOW ENERGY BUILDINGS’ HEATING CONTROL	75
<i>Tuule Mall Kull, Raimo Simson, Martin Thalfeldt, Jarek Kurnitski</i>	
FIRST STEPS TOWARDS LOW ENERGY BUILDINGS: HOW FAR ARE CHILEAN DWELLINGS FROM NEARLY ZERO-ENERGY PERFORMANCES?	81
<i>Daniela Besser, Frank U. Vogdt</i>	
BRIDGING THE GAP BETWEEN ENERGY CONSUMPTION AND THE INDOOR ENVIRONMENTAL QUALITY OF A 1960S EDUCATIONAL BUILDING	87
<i>Xi Wen Leong, Emmanuel A. Essah</i>	
INTEGRATED BUILDING ENERGY DESIGN OF A DANISH OFFICE BUILDING BASED ON MONTE CARLO SIMULATION METHOD	93
<i>Mathias J. Sørensen, Sindre H. Myhre, Kasper K. Hansen, Morten H. Silkjær, Anna J. Marszał-Pomianowska, Li Liu</i>	
THE IMPORTANCE OF BUILDING PHYSICS IN IMPROVING THE QUALITY CONTROL OF BUILDINGS – THE ROLE OF PUBLIC AUTHORITY	99
<i>Markku Hienonen, Ilkka Rääinä, Eveliina Tackett, Timo Kauppinen</i>	
DESIGN AND PERFORMANCE ASSESSMENT OF BUILDING COUNTER-WALLS INTEGRATING MOISTURE BUFFERING “ACTIVE” DEVICES	105
<i>Andrea Gianangeli, Elisa Di Giuseppe, Marco D’Orazio</i>	

HYGRO-THERMAL AND MOULD GROWTH RISK ANALYSIS OF COMMON FOUNDATION STRUCTURES	111
<i>Filip Fedorik, Antti Haapala</i>	
IMPACT OF AIR-GAP DESIGN TO HYGRO-THERMAL PROPERTIES AND MOULD GROWTH RISK BETWEEN CONCRETE FOUNDATION AND CLT FRAME	117
<i>Filip Fedorik, Antti Haapala</i>	
EXPERIMENTAL ANALYSIS OF INDOOR TEMPERATURE OF RESIDENTIAL BUILDINGS AS AN INPUT FOR BUILDING SIMULATION TOOLS	123
<i>E. Lambie, M. Senave, I. Van De Vyver, D. Saelens</i>	
FANGER'S MODEL OF THERMAL COMFORT: A MODEL SUITABLE JUST FOR MEN?	129
<i>Falk Schaudienst, Frank U. Vogdt</i>	
NEW CALCULATION METHOD TO SOLVE MOISTURE BALANCE IN THE ROOM WITH REGENERATOR HEAT RECOVERY AND INFILTRATION	135
<i>Michal Pomianowski, Per Heisleberg, Christian Drivsholm</i>	
MOISTURE SUPPLY IN DANISH SINGLE-FAMILY HOUSES – THE INFLUENCE OF OCCUPANT BEHAVIOR AND TYPE OF ROOM	141
<i>Eva B. Møller, Ernst Jan De Place Hansen</i>	
MOISTURE SUPPLY IN DANISH SINGLE-FAMILY HOUSES – THE INFLUENCE OF BUILDING STYLE	147
<i>Ernst Jan De Place Hansen, Eva B. Møller</i>	
THERMAL COMFORT CONDITION ASSESSMENT IN TEST BUILDINGS WITH DIFFERENT HEATING/COOLING SYSTEMS AND WALL ENVELOPES	153
<i>Stanislavs Gendelis, Andris Jakovics, Janis Ratnieks</i>	
INFLUENCING FACTORS OF MOISTURE MEASUREMENT WHEN USING MICROWAVE REFLECTION METHOD	159
<i>Lembit Kurik, Targo Kalamees, Urve Kallavus, Veljo Sinivee</i>	
THE EFFECT OF POSITIVE PRESSURE ON INDOOR AIR QUALITY IN A DEEPLY RENOVATED SCHOOL BUILDING – A CASE STUDY	165
<i>Camilla Vornanen-Winqvist, Sander Toomla, Kaiser Ahmed, Jarek Kurnitski, Raimo Mikkola, Heidi Salonen</i>	
CONDITIONS FOR MOULD GROWTH ON TYPICAL INTERIOR SURFACES	171
<i>Eva B. Møller, Birgitte Andersen, Carsten Rode, Ruut Peuhkuri</i>	
MOULD MODELS APPLICABLE TO WOOD-BASED MATERIALS – A GENERIC FRAMEWORK	177
<i>Klodian Gradeci, Nathalie Labonnote, Jochen Köhler, Berit Time</i>	
ANALYSIS OF THE SUITABILITY OF MOULD GROWTH MODELS FOR THE RISK ASSESSMENT OF WOODFIBRE INTERNAL WALL INSULATION	183
<i>Valentina Marincioni, Hector Altamirano-Medina</i>	
COMPARISON OF SALT SOLUTION AND AIR DRYING METHODS FOR MOISTURE FIXATION IN HIGHLY POROUS BUILDING MATERIALS	189
<i>Yovko Ivanov Antonov, Rasmus Lund Jensen, Per Møldrup, Michal Pomianowski</i>	
COMBINING THREE MAIN MODELING METHODOLOGIES FOR HEAT, AIR, MOISTURE AND POLLUTION MODELING	195
<i>A. W. M. (Jos) Van Schijndel</i>	
ADVANCED MODELLING OF VAPOR RESISTANCE OF MOISTURE DEPENDENT VAPOR RETARDER	201
<i>Heiko Fechner, Frank Meißner</i>	
ASSESSMENT OF DURABILITY OF ENVIRONMENTALLY FRIENDLY WOOD-BASED PANELS	207
<i>Urve Kallavus, Hele Järv, Targo Kalamees, Lembit Kurik</i>	
ASSESSING THE HUMIDIFICATION PROCESS OF LIGHTWEIGHT CONCRETE SPECIMENS THROUGH INFRARED THERMOGRAPHY	213
<i>Eva Barreira, Ricardo M. S. F. Almeida, João P. B. Ferreira</i>	
IDENTIFICATION OF MOISTURE DIFFUSIVITY OF AUTOCLAVED AERATED CONCRETE IN THE FORM OF SMOOTH TWO-VARIABLE FUNCTION	219
<i>Jan Kocí, Tomáš Korecký, Robert Cerný</i>	
VALIDATION OF A 3D PORE SCALE PREDICTION MODEL FOR THE THERMAL CONDUCTIVITY OF POROUS BUILDING MATERIALS	225
<i>Wouter Van De Walle, Hans Janssen</i>	
AIR-FILLED NANOPORE BASED HIGH-PERFORMANCE THERMAL INSULATION MATERIALS	231
<i>Haakon Fossen Gangåseter, Bjørn Petter Jelle, Sohrab Alex Mofid, Tao Gao</i>	

THE IMPACT OF TEMPERATURE DEPENDENCY OF THE BUILDING INSULATION THERMAL CONDUCTIVITY IN THE CANADIAN CLIMATE	237
<i>Umberto Berardi</i>	
TOTAL SOLAR TRANSMITTANCE QUANTIFYING OF TRANSPARENT INSULATION BUILDING MATERIALS BASED ON REAL CLIMATE OUTDOOR MEASUREMENTS	243
<i>Miroslav Cekon, Richard Slávik</i>	
EXPERIMENTAL INVESTIGATION OF LATENT THERMAL ENERGY STORAGE IN HIGH-RISE RESIDENTIAL BUILDINGS IN TORONTO.....	249
<i>Shahrzad Soudian, Umberto Berardi</i>	
THE IMPACT OF WORKMANSHIP ON THE THERMAL PERFORMANCE OF CAVITY WALLS WITH RIGID INSULATION BOARDS: WHERE ARE WE TODAY?.....	255
<i>Jelle Langmans, Margaux Indekeu, Staf Roels</i>	
EXPERIMENTAL INVESTIGATION OF MOISTURE PROPERTIES OF HISTORIC BUILDING MATERIAL WITH HYDROPHOBIZATION TREATMENT.....	261
<i>Jianhua Zhao, Frank Meissener</i>	
DETERMINATION OF HYGROTHERMAL PERFORMANCE OF CLAY-SAND PLASTER: INFLUENCE OF COVERING ON SORPTION AND WATER VAPOUR PERMEABILITY	267
<i>Olgerd Vares, Aime Ruus, Jane Raamets, Ernst Tungal</i>	
HYGRIC PROPERTY ESTIMATION OF POROUS BUILDING MATERIALS WITH MULTISCALE PORE STRUCTURES.....	273
<i>Muhammad Islahuddin, Hans Janssen</i>	
HYGRIC PROPERTY DETERMINATION BASED ON DYNAMIC MEASUREMENT TECHNIQUES AND METAHEURISTIC STRATEGIES.....	279
<i>Evy Vereecken, Staf Roels, Hans Janssen</i>	
IMPLEMENTATION OF SALT TRANSPORT MODULES IN A SOLVER FRAMEWORK FOR HEAT AND MASS TRANSPORT IN POROUS MATERIALS	285
<i>Andreas Nicolai</i>	
IMPACT OF TIME AND PERSONNEL ON MEASUREMENTS OF THE HYGRIC PROPERTIES OF BUILDING MATERIALS.....	291
<i>Chi Feng, Jelena Todorovic, Hans Janssen</i>	
TOWARDS HYGROTHERMAL CHARACTERIZATION OF RAMMED EARTH WITH SMALL-SCALE DYNAMIC METHODS.....	297
<i>Margaux Indekeu, Monika Woloszyn, Anne-Cécile Grillet, Lucile Soudani, Antonin Fabbri</i>	
LONG-TERM PERFORMANCE OF AEROGEL-ENHANCED MATERIALS	303
<i>Roya Nosrati, Umberto Berardi</i>	
INFLUENCE OF OXIDATION ON RADIATIVE HEAT TRANSFER IN POLYURETHANE INSULATION USED FOR DISTRICT HEATING PIPES	309
<i>Fredrik Domhagen, Bijan Adl-Zarrabi</i>	
MATERIAL CHARACTERIZATION MODELS AND TEST METHODS FOR HISTORIC BUILDING MATERIALS	315
<i>Tessa Hansen, Ruut Hannele Peuhkuri, Eva B. Møller, Søren Peter Bjarløv, Tommy Odgaard</i>	
IMPACT OF BUILDING ENVELOPE AND MECHANICAL COMPONENT DEGRADATION ON THE WHOLE BUILDING PERFORMANCE: A REVIEW PAPER	321
<i>Georgios Eleftheriadis, Mohamed Hamdy</i>	
FEASIBILITY STUDY OF NOVEL INTEGRATED AEROGEL SOLUTIONS	327
<i>Malin Slemes, Bjørn Petter Jelle, Birgit Risholt</i>	
THERMAL INSULATION PERFORMANCE OF REFLECTIVE FOILS IN FLOOR CAVITIES - HOT BOX MEASUREMENTS AND CALCULATIONS	333
<i>Sivert Uvsløkk, Christian Schlemminger, Silje Aspøhaug</i>	
ON SITE THERMAL PERFORMANCE CHARACTERIZATION OF BUILDING ENVELOPES: HOW IMPORTANT ARE HEAT EXCHANGES WITH NEIGHBOURING ZONES	339
<i>Geert Bauwens, Staf Roels</i>	
AN INVESTIGATION INTO THE HYGROTHERMAL PERFORMANCE OF A MINERAL WOOL BASED EXTERNALLY INSULATED ENCLOSURE IN A COLD CLIMATE.....	345
<i>Mark A. Flynn, Russell Richman, Mark Gorgolewski, Kelsey Saunders, Craig Race</i>	
THE AS-BUILT THERMAL QUALITY OF BUILDING COMPONENTS: CHARACTERISING NON-STATIONARY PHENOMENA THROUGH INVERSE MODELLING	351
<i>An-Heleen Deconinck, Staf Roels</i>	
MEASUREMENT OF THE ENVIRONMENTAL TEMPERATURE USING THE SOL-AIR THERMOMETER	357
<i>Thomas Olofsson, K. E. Anders Ohlsson, Ronny Östin</i>	

HYGROTHERMAL BEHAVIOUR OF TIMBER FRAME WALLS FINISHED WITH A BRICK VENEER CLADDING	363
<i>Michiel Vanpachtenbeke, Jelle Langmans, Jan Van Den Bulcke, Joris Van Acker, Staf Roels</i>	
APPROACHES FOR THE BOUNDARY ENVELOPE DESIGN OF AN ENHANCED FAÇADE TEST FACILITY	369
<i>Frank Meißner, Eric Stöcker, Stefan Vogelsang</i>	
LONG TERM MONITORING OF REPAIRED EXTERNAL WALL ASSEMBLY	375
<i>Susanna Ahola, Jukka Lahdensivu</i>	
MOISTURE ROBUSTNESS ASSESSMENT OF A WINDOW WITH INTEGRATED SOLAR SCREEN USING NUMERICAL AND EXPERIMENTAL METHODS	381
<i>Steinar Grynning, Christian Schlemminger, Sivert Uvsløkk</i>	
RAIN INTRUSION RATES AT FAÇADE DETAILS – A SUMMARY OF RESULTS FROM FOUR LABORATORY STUDIES	387
<i>Lars Olsson</i>	
A PROBABILISTIC-BASED APPROACH FOR PREDICTING MOULD GROWTH IN TIMBER BUILDING ENVELOPES: COMPARISON OF THREE MOULD MODELS	393
<i> Klodian Gradeci, Nathalie Labonnote, Berit Time, Jochen Köhler</i>	
APPLICATION OF THE WOOD DEGRADATION MODEL TO AN ACTUAL ROOF ASSEMBLY SUBJECTED TO RAIN PENETRATION	399
<i>Hiroaki Saito</i>	
CALIBRATION OF HYGROTHERMAL SIMULATIONS BY THE HELP OF A GENERIC OPTIMIZATION TOOL	405
<i>P. Freudenberg, U. Ruisinger, E. Stöcker</i>	
VENTILATION OF LOW SLOPE ROOF SYSTEMS IN NORTHERN CLIMATES	411
<i>Thomas W. Hutchinson</i>	
MOISTURE-RESILIENT UPGRADING TO BLUE-GREEN ROOFS	417
<i>Petter Martin Skjeldrum, Tore Kvande</i>	
PASSIVE SNOW REPULSION: A STATE-OF-THE-ART REVIEW ILLUMINATING RESEARCH GAPS AND POSSIBILITIES	423
<i>Per-Olof Andersson, Bjørn Petter Jelle, Zhiliang Zhang</i>	
SIMULATING THE COMPLETE HAMSTAD BENCHMARK USING A SINGLE MODEL IMPLEMENTED IN COMSOL	429
<i>A. W. M. Van Schijndel, S. Goesten, H. L. Schellen</i>	
EVALUATION OF REDUCTION EFFECT ON THERMAL LOAD INSIDE AND OUTSIDE OF CONCRETE BUILDING WITH WOODEN DECORATION BY NUMERICAL ANALYSIS	435
<i>Atsumasa Yoshida, Shinichi Shoho, Sinichi Kinoshita</i>	
LONG TERM ENERGY EFFICIENCY STUDY ON DIFFERENT WALL ENVELOPES IN LATVIAN CLIMATE CONDITIONS	441
<i>Janis Ratnieks, Andris Jakovics, Stanislavs Gendelis</i>	
INFLUENCE OF DIFFERENT PIGMENTS ON THE FACADE SURFACE TEMPERATURES	447
<i>Ayman Bishara, Helge Kramberger-Kaplan, Volker Ptatschek</i>	
THE THERMAL CHARACTERISTICS OF ROOFS: POLICY, INSTALLATION AND PERFORMANCE	454
<i>Clifford A Elwell, Harper Robertson, Jez Wingfield, Phillip Biddulph, Virginia Gori</i>	
RESEARCH INTO THE STRUCTURE AND TECHNOLOGIES OF THE BUILDING ENVELOPE	460
<i>Ruta Miniotaite</i>	
CASE STUDY OF A COLD ATTIC IN A PITCHED ROOF WITH MINIMAL VENTILATION	466
<i>Kimmo Kurkinen</i>	
EXPERIMENTAL AND NUMERICAL ANALYSIS OF MODELLING OF SOLAR SHADING	472
<i>Frederik V. Winther, Mingzhe Liu, Per Heiselberg, Rasmus L. Jensen</i>	
INVESTIGATION OF DIFFERENT CONFIGURATIONS OF A VENTILATED WINDOW TO OPTIMIZE BOTH ENERGY EFFICIENCY AND THERMAL COMFORT	478
<i>Mingzhe Liu, Per Kvols Heiselberg, Olena K. Larsen, Lone Mortensen, Jørgen Rose</i>	
OPTIMIZED FACADE DESIGN - ENERGY EFFICIENCY, COMFORT AND DAYLIGHT IN EARLY DESIGN PHASE	484
<i>Matthias Haase, Steinar Grynning</i>	
SEASONAL OPTIMIZATION OF A FIXED EXTERIOR COMPLEX FENESTRATION SYSTEM CONSIDERING VISUAL COMFORT AND ENERGY PERFORMANCE CRITERIA	490
<i>Daniel Uribe, Waldo Bustamante, Sergio Vera</i>	
ADVANCED TRANSPARENT FACADES: MARKET AVAILABLE PRODUCTS AND ASSOCIATED CHALLENGES IN BUILDING PERFORMANCE SIMULATION	496
<i>Ellika Taveres-Cachat, Steinar Grynning, Oddvar Almas, Francesco Goia</i>	

EXPERIMENTAL ANALYSIS OF TRANSPARENT INSULATION BASED ON POLY-CARBONATE MULTI-WALL SYSTEMS: THERMAL AND OPTICAL PERFORMANCE	502
<i>Miroslav Cekon, Richard Slávik, Jirí Zach</i>	

PART 2

LONG-TERM EXPERIMENTAL PERFORMANCE EVALUATION OF AEROGEL INSULATION PLASTER.....	508
<i>M. Schuss, U. Pont, A. Mahdavi</i>	
EFFECT OF WEATHER DATA SELECTION ON SIMULATED MOISTURE AND TEMPERATURE FIELDS IN BUILDING ENVELOPES IN CENTRAL EUROPE.....	514
<i>Jan Kocí, Robert Cerný</i>	
WHAT IS 'INFRASTRUCTURE PHYSICS'?	520
<i>Bijan Adl-Zarrabi</i>	
EFFECT OF FREEZING AND THAWING ON THE PERFORMANCE OF "CAPILLARY ACTIVE" INSULATION SYSTEMS: A COMPARISON OF RESULTS FROM CLIMATE CHAMBER STUDY TO HAM MODELLING.....	525
<i>Paul Klóšeiiko, Kadi Varda, Targo Kalamees</i>	
THE ZEB TEST CELL LABORATORY. A FACILITY FOR CHARACTERIZATION OF BUILDING ENVELOPE SYSTEMS UNDER REAL OUTDOOR CONDITIONS.....	531
<i>Francesco Goia, Christian Schlemminger, Arild Gustavsen</i>	
CHARACTERIZATION OF THE THERMAL STRUCTURE OF DIFFERENT BUILDING CONSTRUCTIONS USING IN-SITU MEASUREMENTS AND BAYESIAN ANALYSIS	537
<i>Virginia Gori, Clifford A. Elwell</i>	
COMPARISON OF THE PLANNED AND THE REAL ENERGY CONSUMPTION OF THE WORLD'S FIRST (PLUS-)PLUS-ENERGY OFFICE HIGH-RISE BUILDING	543
<i>Alexander David, Markus Leeb, Thomas Bednar</i>	
TRANSFORMING SOCIAL HOUSING NEIGHBOURHOODS INTO SUSTAINABLE CARBON NEUTRAL DISTRICTS	549
<i>Arnold Janssens, Julio Vaillant Rebollar, Eline Himpe, Marc Delghust</i>	
METAMODELING ENERGY INDICATORS IN NEIGHBORHOODS WITH GROWING DEPLOYMENT OF HEAT PUMPS AND ROOFTOP PHOTOVOLTAICS	555
<i>Christina Protopapadaki, Dirk Saelens</i>	
IMPACT OF SPATIAL ACCURACY ON DISTRICT ENERGY SIMULATIONS.....	561
<i>Ina De Jaeger, Glenn Reynders, Dirk Saelens</i>	
ENERGY MEASUREMENTS AT SKARPNES ZERO ENERGY HOMES IN SOUTHERN NORWAY: DO THE LOADS MATCH UP WITH THE ON-SITE ENERGY PRODUCTION?	567
<i>Åse Lekang Sørensen, Anne Gerd Imenes, Steinar Grynning, Tor Helge Dokka</i>	
PERFORMANCE OF OFF-GRID PHOTOVOLTAIC COOLING SYSTEM WITH TWO-STAGE ENERGY STORAGE COMBINING BATTERY AND COLD WATER TANK	574
<i>Dengjia Wang, Liang Hu, Yanfeng Liu, Jiaping Liu</i>	
ZERO EMISSION OFFICE BUILDING IN BERGEN: EXPERIENCES FROM FIRST YEAR OF OPERATION.....	580
<i>Åse Lekang Sørensen, Mads Mysen, Inger Andresen, Bjarte Hårklau, Arild Lunde</i>	
ENERGY PERFORMANCE ASSESSMENT OF A SEMI-INTEGRATED PV SYSTEM IN A ZERO EMISSION BUILDING THROUGH PERIODIC LINEAR REGRESSION METHOD.....	586
<i>Francesco Goia, Arild Gustavsen</i>	
ANALYSIS OF REDUCTION OF ENERGY DEMANDS FOR ZERO EMISSION RENOVATED OFFICE BUILDING BY USING THERMAL MASS AND VENTILATIVE COOLING	592
<i>Maria Justo Alonso, Hans Martin Mathisen</i>	
STUDY ON COMPREHENSIVE ENERGY-SAVING OF SHADING AND PHOTOVOLTAICS OF ROOF ADDED PV MODULE	598
<i>Yue Wang, Dengjia Wang, Yanfeng Liu</i>	
SIMPLIFIED SPACE-HEATING DISTRIBUTION USING RADIATORS IN SUPER-INSULATED TERRACED HOUSES.....	604
<i>Laurent Georges, Fredrik Håheim, Maria Justo Alonso</i>	
ANALYSIS OF THE IMPACT RESOLUTION HAS ON LOAD MATCHING IN THE NORWEGIAN CONTEXT.....	610
<i>Kari Sørnes, Eyvind Fredriksen, Ketil Tunheim, Igor Sartori</i>	

USING TYPICAL AND EXTREME WEATHER FILES FOR IMPACT ASSESSMENT OF CLIMATE CHANGE ON BUILDINGS	616
<i>Vahid M. Nik, Jesper Arfvidsson</i>	
CLIMATE ADAPTATION OF BUILDINGS THROUGH MOM- AND UPGRADING - STATE OF THE ART AND RESEARCH NEEDS	622
<i>Steinar Grynning, Elisabeth Wærnes, Tore Kvande, Berit Time</i>	
CLIMATE ADAPTATION FRAMEWORK FOR MOISTURE-RESILIENT BUILDINGS IN NORWAY	628
<i>Kim Robert Lisø, Tore Kvande, Berit Time</i>	
SENSITIVITY ANALYSIS OF METEOROLOGICAL PARAMETERS ON BUILDING ENERGY CONSUMPTION	634
<i>Dalong Liu, Wenqin Wang, Jiaping Liu</i>	
CRITICAL ANALYSIS OF SOFTWARE TOOLS AIMED AT GENERATING FUTURE WEATHER FILES WITH A VIEW TO THEIR USE IN BUILDING PERFORMANCE SIMULATION	640
<i>Amin Moazami, Salvatore Carlucci, Stig Geving</i>	
A SIMULATION AND MAPPING TOOL FOR THE EVALUATION OF BUILDING SYSTEMS FOR FUTURE CLIMATE SCENARIOS ON EUROPEAN SCALE	646
<i>A. W. M. (Jos) Van Schijndel</i>	
HYGROTHERMAL PERFORMANCE OF WOODEN BEAM HEADS IN INSIDE INSULATED WALLS CONSIDERING AIR FLOWS	652
<i>Paul Wegerer, Thomas Bednar</i>	
SIMULATING THE EFFECTS OF SOLAR POWERED VENTILATION SYSTEMS ON ENERGY AND MOISTURE CONDITIONS IN CRAWL SPACES	658
<i>Britt Haker Høegh</i>	
WOODEN BEAM ENDS IN COMBINATION WITH INTERIOR INSULATION: THE IMPORTANCE OF AN AIRTIGHT SEALING	664
<i>Evy Vereecken, Staf Roels</i>	
INFLUENCE OF CHEMICAL DAMP PROOF CREAM ON THE CAPILLARY ACTION AND MICROSTRUCTURE OF MORTARS	670
<i>Robert Wójcik, Arkadiusz Panus, Maria Tunkiewicz, Mohamed Hamdy</i>	
TOWARDS UNDERSTANDING RAIN INFILTRATION IN HISTORIC BRICKWORK	676
<i>K. Calle, N. Van Den Bossche</i>	
EXPERIMENTAL INVESTIGATIONS OF WOODEN BEAM ENDS IN MASONRY WITH INTERNAL INSULATION	682
<i>Pavel Kopecký, Kamil Stanek, Michal Bureš, Jan Richter, Jan Tywoniak</i>	
CAN CRAWL SPACE TEMPERATURE AND MOISTURE CONDITIONS BE CALCULATED WITH A WHOLE-BUILDING HYGROTHERMAL SIMULATION TOOL?	688
<i>Lies Vanhoutteghem, Martin Morelli, Lars Schjøtt Sørensen</i>	
MODELLING HYGROTHERMAL PERFORMANCE OF ROOF AND FLOOR STRUCTURES WITH AN ENERGY-EFFICIENT CONSTANT OUTPUT HEATING	694
<i>Jarkko Piironen, Juha Vinha, Mihkel Kiviste</i>	
IMPACTS OF ENERGY RETROFITS ON HYGROTHERMAL BEHAVIOR OF FINNISH MULTI-FAMILY BUILDINGS	700
<i>Virpi Leivo, Mihkel Kiviste, Anu Aaltonen, Mari Turunen, Ulla Haverinen-Shaughnessy</i>	
QUASI-MONTE-CARLO-BASED PROBABILISTIC ASSESSMENT OF WALL HEAT LOSS	705
<i>Tianfeng Hou, Dirk Nuyens, Staf Roels, Hans Janssen</i>	
TEMPERATURE AND RELATIVE HUMIDITY MEASUREMENTS AND DATA ANALYSIS OF FIVE CRAWL SPACES	711
<i>Anssi Laukkarinen, Juha Vinha</i>	
A SIMPLIFIED DYNAMIC ZONE MODEL FOR A PROBABILISTIC ASSESSMENT OF HYGROTHERMAL RISKS IN BUILDING COMPONENTS	717
<i>Astrid Tijssens, Hans Janssen, Staf Roels</i>	
COMPARISON OF TDR AND X-RAY METHOD FOR DETERMINING MOISTURE TRANSPORT PARAMETERS	723
<i>Matus Holubek, Olga Koronthalyova</i>	
NUMERICAL SIMULATION AND MEASUREMENTS OF DRYING OF FINNISH CONCRETE GRADES	729
<i>Pauli Sekki, Timo Karvinen</i>	
MOISTURE BEHAVIOR INSIDE BUILDING MATERIALS TREATED WITH SILANE WATER REPELLENT	735
<i>Kazuma Fukui, Chiemi Iba, Shuichi Hokoi</i>	

IMPACT OF CRACKS TO THE HYGROTHERMAL PROPERTIES OF CLT WATER VAPOUR RESISTANCE AND AIR PERMEABILITY	741
<i>V. Kukk, R. Horta, M. Püssa, G. Luciani, H. Kallakas, T. Kalamees, J. Kers</i>	
EXPERIMENTAL AND NUMERICAL STUDY OF WOOD-BASED MATERIALS: FROM MATERIAL TO ROOM SCALE.....	747
<i>Thomas Busser, Amandine Piot, Mickael Pailha, Simon Rouchier, Monika Woloszyn</i>	
HYGROTHERMAL ASSESSMENT OF INTERNAL INSULATION SYSTEMS OF BRICK WALLS THROUGH NUMERICAL SIMULATION AND FULL-SCALE LABORATORY TESTING	753
<i>Timo De Mets, Antoine Tilmans, Xavier Loncour</i>	
PERFORMANCE ANALYSIS OF COUPLED QUASI-STEADY STATE AIR FLOW CALCULATION AND DYNAMIC SIMULATION OF HYGROTHERMAL TRANSPORT INSIDE POROUS MATERIALS	759
<i>Anne Paepcke, Andreas Nicolai</i>	
MOISTURE DAMAGE WITH MAGNESIUM OXIDE BOARDS IN DANISH FACADE STRUCTURES	765
<i>Carsten Rode, Tommy Bunch-Nielsen, Kurt Kielsgaard Hansen, Bent Grell</i>	
COMPARATIVE STUDY OF HYGROTHERMAL SIMULATIONS OF A MASONRY WALL FILLIN	771
<i>Jon Ivar Knarud, Stig Geving</i>	
VENTILATED WOODEN ROOFS: INFLUENCE OF LOCAL WEATHER CONDITIONS - MEASUREMENTS	777
<i>Lars Gullbrekken, Tore Kvande, Berit Time</i>	
EXPERIMENTAL VALIDATION OF A HYGROTHERMAL SIMULATION TOOL USING GAMMA RAY	783
<i>A. S. Guimarães, I. M. Ribeiro, V. P. De Freitas</i>	
MEASURED TEMPERATURE AND MOISTURE CONDITIONS IN THE ROOF ATTIC OF A ONE-AND-A-HALF STORY HOUSE.....	789
<i>Anker Nielsen, Martin Morelli</i>	
MOISTURE PERFORMANCE OF MINERAL WOOL INSULATION PRODUCTS IN HIGHLY INSULATED STRUCTURES	795
<i>Tuomo Ojanen</i>	
FIELD MEASUREMENTS OF MOISTURE VARIATION IN COLD VENTILATED ATTICS WITH DIFFERENT CEILING CONSTRUCTIONS	801
<i>Thor Hansen, Eva B. Møller</i>	
NEW NATIONAL MUSEUM IN OSLO. ANALYSIS OF RISK FOR CONDENSATION AND POSSIBLE MOLD GROWTH IN INTERNAL CLIMATIC SECTIONING WALLS AND FLOORS.....	807
<i>Rein Kristian Klich Raaholdt, Erik Algaard</i>	
HYGROTHERMAL BEHAVIOUR OF COMPACT ROOFS IN WOOD FRAME CONSTRUCTIONS THROUGH ON-SITE MEASUREMENTS.....	813
<i>Charline Langerock, Antoine Tilmans, Timo De Mets, Xavier Loncour, Evelyne Nguyen, Stéphane Charron, Benoît Michaux</i>	
RADON BARRIER: METHOD OF TESTING AIRTIGHTNESS - 2. EDITION.....	819
<i>Torben Valdbjørn Rasmussen, Thomas Cornelius</i>	
AIR TIGHTNESS MEASUREMENTS IN OLDER DANISH SINGLE-FAMILY HOUSES	825
<i>Lone H. Mortensen, Niels C. Bergsøe</i>	
ASSESSING THE VARIABILITY OF THE AIR CHANGE RATE THROUGH TRACER GAS MEASUREMENTS.....	831
<i>Ricardo M. S. F. Almeida, Eva Barreira, Pedro Moreira</i>	
OCCUPANT INFLUENCE ON RESIDENTIAL VENTILATION PATTERNS IN MILD CLIMATE CONDITIONS	837
<i>Pedro F. Pereira, Nuno M. M. Ramos, Ricardo M. S. F. Almeida, M. Lurdes Simões, Eva Barreira</i>	
EVALUATING THE EFFECTIVENESS OF IMPROVED WORKMANSHIP QUALITY ON THE AIRTIGHTNESS OF DUTCH DETACHED HOUSES.....	843
<i>M. Colijn, A. G. Entrop, M. E. Toxopeus</i>	
INFLUENCE OF WIND-TIGHTNESS QUALITY AT THE WALL-ROOF INTERSECTION ON THE HEAT FLOW THROUGH LIGHTWEIGHT ROOF CONSTRUCTIONS	849
<i>Julia Bachinger, Jozef Bednar, Bernd Nusser</i>	
CFD MODELLING OF FORCED CONVECTION AT A BUILDING COMPONENT SURFACE AND COUPLING TO DYNAMIC HAM SIMULATION – ASSESSMENT AND EVALUATION OF METHODS AND ACCURACY	855
<i>Nadja Bishara, Andrea Gasparella</i>	

AIRTIGHTNESS IMPROVEMENT SOLUTIONS FOR LOG WALL JOINTS	861
<i>Üllar Alev, Andres Uus, Targo Kalamees</i>	
A COMPARTMENTALIZATION & VENTILATION SYSTEM RETROFIT STRATEGY FOR HIGH-RISE RESIDENTIAL BUILDINGS IN COLD CLIMATES	867
<i>Mathew Carlsson, Marianne Touchie, Russell Richman</i>	
CONSEQUENCES OF VARYING AIRTIGHTNESS IN WOODEN BUILDINGS	873
<i>Fredrik Domhagen, Paula Wahlgren</i>	
AIR PRESSURE DIFFERENCE MEASUREMENTS IN FINNISH MUNICIPAL SERVICE BUILDINGS	879
<i>Mihkel Kiviste, Juha Vinha</i>	
AIR FLOWS BETWEEN PREFABRICATED INSULATION MODULES AND THE EXISTING FAÇADE: A NUMERICAL ANALYSIS OF THE ADAPTION LAYER	885
<i>Katrien Maroy, Marijke Steeman, Nathan Van Den Bossche</i>	
ENERGY EFFICIENT HVAC CONTROL IN HISTORICAL BUILDINGS: A CASE STUDY FOR THE AMSTERDAM MUSEUM	891
<i>Karin Kompatscher, Silke Seuren, Rick Kramer, Jos Van Schijndel, Henk Schellen</i>	
EXPLAINING VARIABILITY IN METERED ENERGY USE FOR SIMILAR BUILDINGS USING BAYESIAN INFERENCE	897
<i>Martin Heine Kristensen, Steffen Petersen</i>	
CONSEQUENCES OF ENERGY RETROFITTING ON THE DAYLIGHT AVAILABILITY IN NORWEGIAN APARTMENTS	903
<i>Nicola Lolli, Matthias Haase</i>	
A COMPLEMENTARY APPROACH FOR ENERGY EFFICIENCY AND COMFORT EVALUATION OF RENOVATED DWELLINGS IN SOUTHERN EUROPE	909
<i>Sílvia A. Magalhães, Vasco P. De Freitas</i>	
A METHOD TO DETERMINE HEATING POWER AND HEAT UP TIME FOR INTERMITTENT HEATING OF CHURCHES	915
<i>Magnus Wessberg, Tor Broström, Tomas Vyhldal</i>	
SUGGESTIONS FOR ADJUSTMENT OF BYGGAF TO IMPROVE THE CURRENT USE AND SUIT THE PROCESS OF RENOVATION	921
<i>Patrik Olsson, Elin Tjäder</i>	
ON REHABILITATION OF BUILDINGS WITH HISTORICAL FAÇADES	927
<i>Wójcik Robert, Kosinski Piotr</i>	
EVALUATING THE HYGROTHERMAL PERFORMANCE OF PREFABRICATED TIMBER FRAME FAÇADE ELEMENTS USED IN BUILDING RENOVATION	933
<i>Charlotte Coupillie, Marijke Steeman, Nathan Van Den Bossche, Katrien Maroy</i>	
STATUS DETERMINATION OF A HISTORICAL BUILDING INCLUDING MEASURES FOR THREE DIFFERENT SCENARIOS	939
<i>Jesper Arfvidsson, Björn Bjelke-Holtermann, Johan Mattsson</i>	
DETERIORATION AND PRESERVATION OF CITY WALL IN NANJING	945
<i>Wakana Araoka, Shuichi Hokoï, Daisuke Ogura, Chiemi Iba, Yonghui Li, Shi Hu</i>	
RENOVATION OF BUILDINGS FROM BEFORE 1945: STATUS ASSESSMENT AND ENERGY EFFICIENCY MEASURES	951
<i>Pär Johansson, Paula Wahlgren</i>	
A SIMPLE ADAPTIVE VENTILATION CONTROLLER FOR MEDIAEVAL CHURCH	957
<i>Veljo Sinivee, Lembit Kurik, Targo Kalamees</i>	
PERFORMANCE OF VENTILATION IN ESTONIAN APARTMENT BUILDINGS	963
<i>Alo Mikola, Targo Kalamees, Teet-Andrus Kõiv</i>	
A SIMULATION EXERCISE TO IMPROVE BUILDING ENERGY PERFORMANCE CHARACTERIZATION VIA ON-BOARD MONITORING	969
<i>Marieline Senave, Glenn Reynders, Stijn Verbeke, Dirk Saelens</i>	
DYNAMIC MODEL-DRIVEN ENERGY RETROFIT OF BØGEVANGEN AND RUNEVEJ DAYCARE CENTERS IN AARHUS	975
<i>Muhyiddine Jradi, Pierre Lecuelle, Karen Margrethe Høj Madsen, Christian Veje, Bo Nørregaard Jørgensen</i>	
EVALUATION OF GREY-BOX MODEL PARAMETER ESTIMATES INTENDED FOR THERMAL CHARACTERIZATION OF BUILDINGS	982
<i>Rasmus Elbæk Hedegaard, Steffen Petersen</i>	
BUILDING PROFESSIONALS' VIEWS ON ENERGY EFFICIENCY COMPLIANCE REQUIREMENTS	988
<i>Gireesh Nair, Ingrid Allard, Anders Åstrand, Thomas Olofsson</i>	

A MANAGEMENT PERSPECTIVE ON ENERGY EFFICIENT RENOVATIONS IN SWEDISH MULTI-FAMILY BUILDINGS	994
<i>Gireesh Nair, Shoaib Azizi, Thomas Olofsson</i>	
CHARACTERISTICS OF A DATABASE FOR ENERGY PERFORMANCE CERTIFICATES	1000
<i>M. Prieler, M. Leeb, T. Reiter</i>	
NZEB RENOVATION WITH PREFABRICATED MODULAR PANELS	1006
<i>Peep Pihelo, Targo Kalamees, Kalle Kuusk</i>	
DISTRIBUTION OF HEATING COSTS IN MULTI-STORY APARTMENT BUILDINGS	1012
<i>Jørgen Rose, Jesper Kragh</i>	
QUALITY LABELS FOR RETROFIT CAVITY WALL INSULATION; A COMPARATIVE ANALYSIS	1018
<i>T. J. H. Rovers, A. G. Entrop, J. I. M. Halman</i>	
Author Index	