

Research Group

Energy Efficiency & Environment - E3

Reference year:

2024

Scientific Coordinator:

SIBILIO SERGIO / Full Professor / Department of Architecture and Industrial Design (DADI) / University of Campania “Luigi Vanvitelli”

Group members:

All members of the research group belong to the Department of Architecture and Industrial Design / University of Campania “Luigi Vanvitelli”

Academic Staff

MAFFEI Luigi / Full Professor
ROSATO Antonio / Full Professor
SPASIANO Mario / Full Professor
IANNACE Gino / Associate Professor
MASULLO Massimiliano / Associate Professor
CIAMPI Giovanni / Associate Professor
SCORPIO Michelangelo / Assistant Professor
CIERVO Antonio / Research Associate

Research Fellow / PhD Student

CIOFFI Federico / Research Fellow
TOMA Roxana Adina / Research Fellow
IULIANO Sabrina / Research Fellow
LI Jian / PhD Student
EL YOUSSEF Mohammad / PhD Student
TEIMOORZADEH Ainoor / PhD Student
MOKHTARI Niluofar / PhD Student
BOUCHERIT Samiha / PhD Student
CARLEO Davide / PhD Student
GARGIULO Martina / PhD Student
SALAMONE Francesco / PhD Student
SABET Parinaz / PhD Student
ISTIANI Noor Fajrina Farah / PhD Student
TUFANO Luigi / PhD Student
LUSTRISSIMI Emiliano / PhD Student
PERROTTA Achille / PhD Student
ANSARI Muhammad Azhar / PhD Student
GARRET FATELA Joao / PhD Student

KAIHOUL Ahmed / PhD Student
KHELIL Allah Eddine / PhD Student
CIOFFI Federico / PhD Student
BASHIR Mirco / PhD Student
MERCURI Rita / PhD Student
CAPASSO Mario Alberto / PhD Student
CERMOLA Daria / PhD Student
FERRARA Corrado Vittorio / PhD Student
GRAVINA Nicola / PhD Student
JAMIL Maryam / PhD Student
REA Giusi / PhD Student
LODICO Dana / PhD Student

Technical Administrative Staff:

CIABURRO Giuseppe

Description of research lines:

- *SMART FAÇADES* - The research line on the Smart Façades is focused on the analysis and characterization of the building envelope performances, as well as on the development of adaptive and interactive dynamic (SMART) façades. In particular, the research aim is to analyze and characterize all building envelope components that help in reaching the built environment thermo-hygrometric, visual and acoustic comfort and reducing the energy consumption, while developing methodologies and simulation models for the innovative dynamic and bioclimatic components, such as the ventilated façade printed by 3D technology. The research line also investigates the "intelligent" façades and their components, studying how they can take advantages of sources and dynamic natural energy, their adaptiveness to the external stimuli, as well as how it is possible to transmit interactive messages into urban scenarios.

- *SOLAR DISTRICT HEATING AND COOLING* - This research line focuses on the analysis of district heating and cooling systems, serving small/micro-scale typical Italian districts, based on the exploitation of solar energy and integrated with a seasonal borehole thermal energy storage as well as short-term thermal energy storage. The research activities are performed from a simulation point of view by means of the dynamic simulation software TRNSYS (carried out at Ri.A.S. laboratory) upon varying the boundary conditions (size and technology of components, control logics, thermo-physical properties, back-up systems, climatic conditions, layout of components, etc.), as well as experimental measurements on short-term thermal energy storage (carried out at SENS i-Lab laboratory).

- *INTEGRATED SOLUTIONS FOR DAYLIGHT AND ELECTRIC LIGHTING* - This research line concerns the analysis of solutions for the integration of artificial lighting with natural light through shielding systems and LED sources, in order to ensure visual comfort conditions through a Human Centric Lighting (HCL) approach. Through the preparation of a living-lab, a low-cost commercial intelligent system will be studied, integrating two motorized shading devices and six dimmable LED fixtures with different selection of related color temperatures (CCT).

- *LOW CARBON, HIGH COMFORT INTEGRATED LIGHTING* - The research line scope is on general lighting systems for indoor environments and the impact of buildings' facades on their urban



environment. The focus is laid on lighting appliances in non-domestic buildings. Technically the research line deals with integrating: (i) daylight utilization by enhanced facade technologies and other architectural solutions, (ii) electric lighting schemes addressing technology and design strategies in the context of progressing digitalization, as well as (iii) lighting control systems and strategies related to visual and non-visual user needs with special emphasis on the interface of day- and electric lighting. All the above-mentioned aspects will be considered under the constraint of low carbon emission in a circular economy context.

- *FAULT DETECTION AND DIAGNOSIS* - This research line is focused on the development and application of a methodology for the fault analysis, fault detection and fault identification of typical heating, ventilation and air-conditioning plants including an air-handling units. The research activities of this research line are carried out by means of experimental (at SENS i-Lab laboratory) and numerical (at Ri.A.S. laboratory) approaches, comparing the on-site experimental behavior of the systems with the performance predicted by mathematical models developed through Artificial Intelligence techniques and dynamic simulation software (TRNSYS).
- *THERMOPHYSICAL PROPERTIES OF MATERIALS* - The research activity focuses on the experimental assessment of thermophysical properties (thermal conductivity, specific heat, and thermal diffusivity) of innovative materials for the building sector and heating, ventilation, and air-conditioning systems. In particular, the activity is carried out with reference to phase-change materials and materials obtained through 3D printing at the Ri.A.S. laboratory.
- *MICRO-WIND TURBINES* - The research activity aims to analyze the performance of micro-wind turbines (electric power generated less than 7 kW) upon varying boundary conditions such as wind speed, electric demand profiles, etc. The activities are carried out with a simulation-based approach using the dynamic simulation software TRNSYS at the Ri.A.S. laboratory.
- *POLYMER/ORGANIC SOLAR CELLS* – The research line focuses on developing prototypes of organic photovoltaic cells for their integration in buildings. The research is carried out through numerical analysis (conducted at the Ri.A.S. laboratory) and experimental tests carried out in collaboration with foreign research centers and universities.
- *GENESIS* - The multidisciplinary research line aims to develop innovative procedures and techniques for characterizing the state of conservation of degraded external surfaces of historical buildings on a territorial scale through non-destructive monitoring techniques. The research activities also aim to define an information technology platform for the management/conservation/enhancement of the cultural, artistic, and landscape heritage under investigation..
- *IMMERSIVE VIRTUAL REALITY FOR LIGHTING DESIGN* - immersive virtual reality can play an important role in lighting design, thanks to its ability to allow for a quick assessment between different design choices based on spaces, colours, and light. However, immersive virtual reality (iVR) has to guarantee immersive virtual environments with high perceived visual quality of the scene and simulate light distribution in a photometrically correct manner, in order to be effectively used for lighting design. The research activities aim to understand how iVR can be used for lighting design.
- *NEW FRAMEWORK FOR USER WELLBEING* - The research line aims to investigate new

approaches for the analysis of environmental quality both inside and outside buildings. In particular, it aims to develop new technological solutions, hardware and software, based on a human-centred approach that can overcome the limitations of classical comfort assessment models. The application of these solutions involving users in real contexts will make it possible to study aspects in addition to those considered so far (just to name a few: subjective, cultural, social and even behavioral, psychological and physiological, the latter in relation to personal response to environmental stimuli). The data collected in this way can be analyzed using techniques from the field of Artificial Intelligence to identify the main parameters that have some influence on the subjective perception of the environmental quality of the built environment.

- *WINDOW VIEW QUALITY IN BUILDINGS* – The research line focuses on the window view quality, through the transparent elements, of visual connection between the building and the urban environment, in order to evaluate a primary element of visual connection with the outside and its influence on the pleasant experience of the environment, well-being, comfort, and stress recovery. Window view quality is both subjective and objective parameter namely, depends on the observer and, therefore, on contextual factors. These factors can be: (i) geometric (number of windows viewed, size of windows viewed, distance of windows viewed, etc.), (ii) temporal (timing of viewing, duration of viewing, etc.), and (iii) psychological (mood, occupant satisfaction, emotions, etc.). The research is carried out using simulation software, and subjective experimental tests in real and virtual reality environments.

Relationships with other research groups of the University of Campania L. Vanvitelli during the last three years:

The “Smart Façades”, “Fault Detection and Diagnosis” and “Immersive virtual reality as a tool for lighting design” researchlines have been carried out in collaboration with the Research Group of prof. Maffei from DADI.

The “GENESIS” researchline has been carried out in collaboration with the Research Groups of prof. Zerlenga, prof. De Matteis, prof. Faella and prof. Jacazzi from DADI.

Participation in research projects during the last three years:

- *Project title:* Solar smart Energy Networks integrated with borehole thermal Energy storagesserving small-scale districts in the Campania region (S.E.N.E.CA.)
Scientific Coordinator: ROSATO Antonio
Call title: V:ALERE program (VAnviteLli pEr la RicErca)
Abstract: the project’s research activity is part of the "Solar District Heating and Cooling" research line. In particular, it concerns the study of district heating/cooling systems with seasonal thermal energy storage for 10 small districts with domestic/school users located in the Campania region, by means of a dynamic simulation software. The analysis of the proposed system is carried out from energy, environmental and economic points of view upon varying the boundary conditions, such as the climatic conditions, the energy requirements, the technologies, the components’ capacity, operating schemes and control patterns. The simulation results of the proposed systems are compared with those associated with conventional heating/cooling systems serving the same districts, in order to assess the



potential benefits.

Involved persons: ROSATO Antonio, IANNACE Gino, CALABRÒ Marco, CIERVO Antonio, TOMA Roxana Adina, PELLEGRINO Rossana, PIETROSANTI Anton Giulio, DAOUD Hussein Sa'id Hussein.

Status: Funded

Project submission/start/end date: 13-02-2019 / 01-12-2019 / 02-12-2022

- *Project title:* Integrated PRocedure for assEssing and improVing the resiliENce of existing masonrybell Towers at territorial scale (PREVENT)

Scientific Coordinator: DE MATTEIS Gianfranco

Call title: V:ALERE program (VAnvitelli pEr la RicErca)

Abstract: the project aim is to develop innovative procedures and techniques to characterize the conservation status of the degraded outdoor surfaces of bell towers on a territorial scale, using non-destructive monitoring techniques.

Involved persons: DE MATTEIS Gianfranco, ZERLENGA Ornella, SIBILIO Sergio, CENNAMO Claudia, ZIZI Mattia, BENCIVENGA Pasquale, CIAMPI Giovanni, CIRILLO Vincenzo, CICALA Margherita, IADEROSA Rosina, SPANODIMITRIOU Yorgos.

Others involved persons: SPURIA Letteria / Researcher / Ministry of Cultural Heritage and Activities, LATTE BOVIO Giuseppe / Researcher / SUNTA S.r.l., FALANGA Bruna / Researcher / PROTOM GROUP S.p.a., PERNA Mirko / Researcher / VIRTO360

Partners: Ministry of Cultural Heritage and Activities, SUNTA S.r.l., PROTOM GROUP S.p.a., VIRTO360

Status: Funded

Project submission/start/end date: 13-02-2019 / 01-12-2019 / 02-12-2022

- *Project title:* UTMOST FDD: an aUToMated, Open, Scalable and Transparent Fault Detection and Diagnosis process for air-handling units based on a hybrid expert and artificial intelligence approach. From experimental open-data to transfer model learning for the enhancement of energy management and indoor environmental quality in buildings.

Principal Investigator: CAPOZZOLI Alfonso / Professore Associato / Politecnico di Torino

Co-Principal Investigator: ROSATO Antonio

Call title: PROGETTI DI RICERCA DI RILEVANTE INTERESSE NAZIONALE – Bando 2022

Abstract: HVAC systems equipped with air-handling units (AHUs) are frequently operated in faulty conditions due to lack of proper maintenance, failure of components or incorrect installation. Faulty operation in AHUs leads to uncomfortable indoor environment, poor indoor air quality and serious energy wastes. To this purpose a Fault Detection and Diagnosis (FDD) process makes it possible to automatically recognize fault occurrence and identify the causes and the location of that fault contributing to enhance both energy efficiency and indoor environmental quality during building operation. In this context, this project proposes the development of an automated, open, scalable and transparent FDD process for AHUs based on a hybrid expert and artificial intelligence-based approach. The initial goal is the construction of an open reference dataset based on experimental campaigns characterized by high resolution measurements of both normal and faulty operation under different operation modes to be conducted on an existing monitored AHU

system. The experimental dataset will represent a valuable source of knowledge for assessing the real impact of a number of typical faults in terms of cost, energy consumption and indoor comfort/air quality. Moreover, the data set will be exploited to calibrate a digital twin capable to mimic the observed operation of a typical AHU in both faulty and normal conditions and will make it possible to conduct robust fault impact scenarios and to enrich the experimental dataset extending the operating ranges of training data. A novel hybrid FDD strategies including both data-driven and knowledge-based models will be then developed based on the obtained experimental and simulation datasets. The hybrid FDD framework will make it possible to exploit the potentialities of physics-based models for description and interpretation of faults occurrence and of artificial intelligence to extract non-trivial knowledge from experimental and simulated data. Both the experimental dataset produced in the project together with the digital twin will be made publicly available on data repository well recognized by researchers opening the opportunity for the scientific community to perform replicability and benchmark studies on FDD processes for AHUs. The final objective is then testing the transferability and scalability of the conceived FDD strategy exploiting ontology schema and applying a transfer learning framework considering as a target system an AHU different from the one used for the development of the FDD strategy itself. The project will represent a cutting-edge experience considering the proposed holistic approach to the resolution of the main challenging issues in the field of FDD for AHUs. The flow of activities can be replicated also for other systems with the aim of supporting an easier penetration of advanced automatic FDD tools in the automation industry as a key and low-cost solution to enhance energy management in buildings.

Involved persons: ROSATO Antonio, MASULLO Massimiliano, SCORPIO Michelangelo, EL YOUSSEF Mohammad, MERCURI Rita.

Others involved persons: CAPOZZOLI Alfonso / Associate Professor / Politecnico di Torino, TRONVIL Paolo Maria / Associate Professor / Politecnico di Torino, CHIOSA Roberto / PhD Student / Politecnico di Torino

Partners: Politecnico di Torino

Status: Funded

Project submission/start/end date: 31/03/2022 / 28-09-2023 / 30-09-2025

- *Project title:* GESTIONE del rischio SISmico per la valorizzazione turistica dei centri storici del Mezzogiorno (GENESIS)

Principal Investigator: DE MATTEIS Gianfranco

Call title: Avviso per la presentazione di progetti di ricerca industriale e sviluppo sperimentale nelle 12 aree di specializzazione individuate dal PNR 2015-2020

Abstract: The main objective of the research project is the development of an information technology platform for the management and mitigation of seismic risk aimed at the conservation and enhancement of the historical-monumental heritage. The project is organized into six Realization Objectives (RO) and involves the selection of nine case studies in Italian territory.

DADI Involved persons: Ornella Zerlenga, Giuseppe Faella, Sergio Sibilio, Danila Jacazzi, Giorgio Frunzio, Riccardo Serraglio, Marina D'Aprile, Giovanni Ciampi, Mariateresa Guadagnuolo, Corrado Chisari, Vincenzo Cirillo, Mattia Zizi

Partners: University of Reggio Calabria, Telenia S.r.l., Rielco Impianti S.r.l., Municipality of Caserta, University of L'Aquila, University of Pisa, University G. D'Annunzio of Chieti-Pescara, University of Basilicata, IUAV University of Venice, University of Bergamo, TAB Consulting S.r.l., Asdea S.r.l., Zugari Guido and C. S.r.l.,



Target Euro S.r.l., Kibernetes S.r.l., Fip-industriale S.p.A., Pro.ge.77 S.r.l., Sisia S.r.l., Boviar S.r.l., Consortium C.i.p.a.e., BASF CC Italia spa, EtnaHitechS.C.p.A., FIBRE NET S.r.l., Council for Public Works, ANCE – National Association of Building Contractors, Matera-Basilicata 2019 Foundation, Municipality of Matera, Municipality of Cosenza, Municipality of Potenza, Municipality of Fiumefreddo Bruzio, Municipality of Tricarico, Municipality of Piazza Armerina, Abruzzo Region, Basilicata Region, Tuscany Region, Diocese of Piazza Armerina, Pittini Group

Status: Funded

Submission/Project Start/End Dates: 22/12/2022 / 01/01/2023 / 01/07/2025

- *Project title:* Design and Assessment of Innovative Textile and 3D-Printed Systems for Human-Centered Spaces (DANTEHUM)
Principal Investigator: Giovanni Ciampi
Call title: Bando per il finanziamento di progetti di ricerca fondamentale ed applicata dedicato ai giovani Ricercatori – Università degli Studi della Campania “Luigi Vanvitelli”
Abstract: The project aims to evaluate the performance of innovative systems based on flexible materials (textiles and 3D printing) for solar irradiation control and the improvement of building envelope performance in terms of thermal and visual aspects, as well as enhancing occupant comfort. The project consists of three main phases: 1) definition of the state of the art, 2) experimental characterization, and 3) simulation and analysis of the designed façade systems. Throughout the entire project, research activities will be conducted at the Ri.A.S. Lab and SENS i-Lab laboratories.
Involved persons: Giovanni Ciampi, Sergio Sibilio, Michelangelo Scorpio, Martina Gargiulo, Davide Carleo, Parinaz Sabet, Niloufar Mokhtari, Ainoor Teimoorzadeh.
Status: Funded
Submission/Project Start/End Dates: 07/07/2022 / 01/09/2023 / 30/04/2024

- *Project title:* New movable systems for smart/co-working taking advantage of life quality, sustainability and energy efficiency (RESTANZA)
Principal Investigator: CIERVO Antonio
Call title: Bando per il finanziamento di progetti di ricerca fondamentale ed applicata dedicato ai giovani Ricercatori – Università degli Studi della Campania “Luigi Vanvitelli”
Abstract: The aim of the research project is to design a Prefabricated Movable Building (PMB) for smart/co-working a renewable energy-based, self-sustaining in energy use, eco-friendly, modular, and flexible in set-up, and its performance will be analyzed while operating in a selected suitable small village of the Campania region (Italy). The PMB will be developed to optimize occupants’ well-being, energy performance, and integration of the indoor environment with outdoor architectural/historical/landscape elements via innovative design methods (immersive virtual reality and dynamic simulation models). The project aims at 1) promoting the exploitation of renewable energy and energy-efficient systems via innovative design methods, 2) reducing the environmental/ecological footprint associated with both building and transport sectors, 3) suggesting an alternative lifestyle combining tradition and modernity, 4) facilitating social/economic rebirth of small villages with significant regenerative potential. The project provides relevant environmental/social/territorial/economic impacts, together with significant results for engineers, architects, manufacturers of PMBs, the scientific community, and policymakers.
Involved persons: CIERVO Antonio, ROSATO Antonio, CASTANÒ Francesca,

MASULLO Massimiliano, MORELLI Maria Dolores, MARZOCCHI Raffaella,
BOUCHERIT Samiha.

Status: Funded

Submission/Project Start/End Dates: 07/07/2022 / 01/09/2023 / 30/04/2024

Scientific products of the last three years:

10 scientific publications on Class A journals and/or indexed in the Scopus/WoS databases:

- [1] Masullo, M., Cioffi, F., Li, J., Maffei, L., Ciampi, G., Sibilio, S., Scorpio, M. Urban Park Lighting Quality Perception: An Immersive Virtual Reality Experiment. SUSTAINABILITY, vol. 15, 2023, art. n. 2069, DOI: 10.3390/su15032069
- [2] Sokol, N., Martyniuk-Peczek, J., Matusiak, B., Amorim, C.N.D., Waczynska, M., Kurek, J., Vasquez, N.G., Sibilio, S., Kanno, J.R., Scorpio, M., Nazari, M., Koga, Y., ‘Personas for lighting’. Three methods to develop personas for the indoor lighting environment, Energy and Buildings, vol. 278, 2023, art. n. 112580, DOI: 10.1016/j.enbuild.2022.112580
- [3] Rosato, A., Guarino, F., El Youssef, M., Capozzoli, A., Masullo, M., Maffei, L., Experimental assessment of ground-truth faults in a typical single-duct dual-fan air-handling unit under Mediterranean climatic conditions: Impact scenarios of sensors’ offset and fans’ failure, Energy and Buildings, vol. 275, 2022, art. n. 112492, DOI: 10.1016/j.enbuild.2022.112492
- [4] Spanodimitriou, Y., Ciampi, G., Tufano, L., Scorpio, M., Flexible and Lightweight Solutions for Energy Improvement in Construction: A Literature Review, Energies, vol. 16, 2023, art. n. 6637, DOI: 10.3390/en16186637
- [5] Ansari, M.A., Ciampi, G., Sibilio, S. Tackling Efficiency Challenges and Exploring Greenhouse-Integrated Organic Photovoltaics, Energies, vol. 16, 2023, art. n. 6076, DOI: 10.3390/en16166076
- [6] Salamone, F., Sibilio, S., Masullo, M., Assessment of the Performance of a Portable, Low-Cost and Open-Source Device for Luminance Mapping through a DIY Approach for Massive Application from a Human-Centred Perspective, Sensors, vol. 22(20), 2022, art. n. 7706, DOI: 10.3390/s22207706
- [7] Rosato, A., Guarino, F., El Youssef, M., Capozzoli, A., Masullo, M., Maffei, L., Faulty Operation of Coils’ and Humidifier Valves in a Typical Air-Handling Unit: Experimental Impact Assessment of Indoor Comfort and Patterns of Operating Parameters under Mediterranean Climatic Conditions, Energies, vol. 15(18), 2022, art. n. 6781, DOI: 10.3390/en15186781
- [8] Gentile, N., Lee, E.S., Osterhaus, W., Altomonte, S., Naves David Amorim, C., Ciampi, G., Garcia-Hansen, V., Maskarenj, M., Scorpio, M., Sibilio, S., Evaluation of integrated daylighting and electric lighting design projects: Lessons learned from international case studies, Energy and Buildings, vol. 268, 2022, art. n. 112191, DOI: 10.1016/j.enbuild.2022.112191
- [9] Scorpio, M., Laffi, R., Teimoorzadeh, A., Ciampi, G., Masullo, M., Sibilio, S., A calibration methodology for light sources aimed at using immersive virtual reality game engine as a tool for lighting design in buildings, Journal of Building Engineering, vol. 48, 2022, art. n. 103998, DOI: 10.1016/j.job.2022.103998

- [10] Spanodimitriou, Y., Ciampi, G., Scorpio, M., Mokhtari, N., Teimoorzadeh, A., Laffi, R., Sibilio, S., Passive Strategies for Building Retrofitting: Performances Analysis and Incentive Policies for the Iranian Scenario, *Energies*, vol. 15(5), 2022, art. n. 1628, DOI: 10.3390/en15051628

Additional 10 scientific products:

- [1] Scorpio, M., Ciampi, G., Gentile, N., Sibilio, S., Effectiveness of low-cost non-invasive solutions for daylight and electric lighting integration to improve energy efficiency in historical buildings, *Energy and Buildings*, vol. 270, 2022, art. n. 112281, DOI: 10.1016/j.enbuild.2022.112281
- [2] Vasquez, N.G., Amorim, C.N.D., Matusiak, B., Kanno, J., Sokol, N., Martyniuk-Peczek, J., Sibilio, S., Scorpio, M., Koga, Y., Lighting conditions in home office and occupant's perception: Exploring drivers of satisfaction, *Energy and Buildings*, vol. 261, 2022, art. n. 111977, DOI: 10.1016/j.enbuild.2022.111977
- [3] Salamone, F., Chinazzo, G., Miller, C., Sibilio, S., Masullo, M., Editorial: Innovative Human-Centric Investigations and Technologies for Human Wellbeing and Health in the Built Environment, *Frontiers in Built Environment*, vol. 8, 2022, art. n. 918643, DOI: 10.3389/fbuil.2022.918643
- [4] Rosato, A., El Youssef, M., Guarino, F., Ciervo, A., Sibilio, S., Experimental studies of air-handling units' faulty operation for the development of data-driven fault detection and diagnosis tools: A systematic review, *Energy Reports*, vol. 8, 2022, pp. 494-503, DOI: 10.1016/j.egyr.2022.10.087
- [5] Salamone, F., Chinazzo, G., Danza, L., Miller, C., Sibilio, S., Masullo, M., Low-Cost Thermohygrometers to Assess Thermal Comfort in the Built Environment: A Laboratory Evaluation of Their Measurement Performance, *Buildings*, vol. 12(5), 2022, art. n. 579, DOI: 10.3390/buildings12050579
- [6] Amorim, C.N.D., Vasquez, N.G., Matusiak, B., Kanno, J., Sokol, N., Martyniuk-Peczek, J., Sibilio, S., Koga, Y., Ciampi, G., Waczynska, M., Lighting conditions in home office and occupant's perception: An international study, *Energy and Buildings*, vol. 261, 2022, art. n. 111957, DOI: 10.1016/j.enbuild.2022.111957
- [7] Rosato, A., Sibilio, S., Guarino, F., El Youssef, M., Entchev, E., Maffei, L., Field Performance of HVAC System Under Healthy and Faulty Conditions During the Summer: Preliminary Development of a Simulation Model Based on Artificial Neural Networks, *Smart Innovation, Systems and Technologies*, vol. 263, 2022, pp. 183-196, Proceedings of: 13th KES International Conference on Sustainability and Energy in Buildings, SEB 2021, 15-17 September 2021, Split (Croatia), DOI: 10.1007/978-981-16-6269-0_16
- [8] Ciampi, G., Spanodimitriou, Y., Scorpio, M., Rosato, A., Sibilio, S., Energy performance of PVC-Coated polyester fabric as novel material for the building envelope: Model validation and a refurbishment case study, *Journal of Building Engineering*, vol. 41, 2021, art. n. 102437, DOI: 10.1016/j.jobee.2021.102437
- [9] Rosato, A., Guarino, F., Youssef, M.E., Sibilio, S., Maffei, L., Preliminary symptoms assessment of typical faults related to the fans and humidifiers of HVAC systems based on experimental data collected during Italian summer and winter, *IOP Conference Series: Earth and Environmental Science*, vol. 897(1), 2021, art. n. 12009, Proceedings of: 4th International Conference on Renewable Energy and Environment Engineering, REEE 2021, 27-30 August 2021, Florence (Italy), DOI: 10.1088/1755-1315/897/1/012009

[10] Rosato, A., Guarino, F., Sibilio, S., Entchev, E., Masullo, M., Maffei, L., Healthy and faulty experimental performance of a typical HVAC system under Italian climatic conditions: Artificial neural network-based model and fault impact assessment, *Energies*, vol. 14(17), 2021, art. n. 5362, DOI: 10.3390/en14175362

Relationships with international and national Companies, Institutions, Research Centers, Universities during the last three years:

Research topic SMART FAÇADES:

- ✓ Scientific collaboration with Dr. Lars Gullbrekken from the Department of Architecture, Materials and Structures, SINTEF Community, SINTEF AS (Trondheim, Norway) with regard to the research: "Smart Façades".
- ✓ Industrial research collaboration with COSMIND s.r.l. with regard to the research: "Smart Façades" associated to the activities of the Industrial PhD in Technologies for Resilient Living Environments

Research topic ricerca Solar District Heating and Cooling:

- ✓ Scientific collaboration with the research group of the "Tokyo University of Agriculture and Technology" (Tokyo, Giappone), led by prof. A. Akisawa.
- ✓ Scientific collaboration with the research group, led by Prof. Evgeniy Entchev, of the research center Canmet Energy Research Centre - Natural Resources Canada (Ottawa, Canada).
- ✓ Scientific collaboration with the research group, led by prof. Walaa Al-Smadi, of the Department of Mechanical Engineering - National University College of Technology (Amman, Jordan).

Research topic LOW CARBON, HIGH COMFORT INTEGRATED LIGHTING:

- ✓ Scientific collaboration with Dr. Jan de Boer, Fraunhofer IBP (Germany) and Prof. Niko Gentile, Lund University (Sweden), with regard to the research: "Applications and case studies"
- ✓ Scientific collaboration with Dr. Jan de Boer, Fraunhofer IBP (Germany), Dr. Barbara Szybinska Matusiak, NTNU (Norway) and Jan Wienold, EPFL (Switzerland) with regard to the research: "Visual and non-visual requirements".
- ✓ Scientific collaboration with Dr. Jan de Boer, Fraunhofer IBP (Germany) and David Geisler-Moroder, Bartenbach (Austria), with regard to the research: "Digitalized Lighting Solutions (Technology & Design Tools / Process)".

Research topic Fault Detection and Diagnosis:

- ✓ Scientific collaboration between the Department of Architecture and Industrial Design and the research group, led by Prof. Evgeniy Entchev, of the center Canmet Energy Research Centre - Natural Resources Canada (Ottawa, Canada).
- ✓ Scientific collaboration between the Department of Architecture and Industrial Design and the research group, led by Prof. Capozzoli Alfonso, of the Politecnico di Torino.

Research topic GENESIS:

- ✓ Industrial research collaboration with TELENIA s.r.l. within the framework of the project "Seismic Risk Management for the Touristic Enhancement of Historical Centers in the Southern Italy (GENESIS)."

ISI Web of Science Subject Categories:

Architecture
Computer Science, Software Engineering
Engineering, Environmental
Engineering, Multidisciplinary
Environmental Studies
Ergonomics
Optics
Physics, Applied
Public, Environmental & Occupational Health
Thermodynamics

Scientific-Disciplinary Sectors:

ING-IND/10
ING-IND/11
IUS/10
ICAR/17

Keywords:

Solar Energy
District heating and cooling systems
Seasonal thermal energy storage
TRNSYS
HVAC systems
Smart façades
Fault diagnosis and detection
Thermo-physical properties of materials
Mico-wind turbines
Smart window
Daylighting
Low Carbon, High Comfort Integrated Lighting
Airborne monitoring techniques
Immersive virtual reality for lighting design
Wearables
Internet of Things – IoT

ERC Categories:

PE2_15 - Thermodynamics
PE6_12 - Scientific computing, simulation and modelling tools
PE6_9 - Human computer interaction and interface, visualization
PE7_3 - Simulation engineering and modelling
PE8_11 - Environmental engineering, e.g. sustainable design, waste and water treatment, recycling, regeneration or recovery of compounds, carbon capture & storage

PE8_6 - Energy processes engineering

PE8_3 - Civil engineering, architecture, offshore construction, lightweight construction, geotechnics

SH7_5 - Sustainability sciences, environment and resources, ecosystem services

PE6_7 - Artificial intelligence, intelligent systems, natural language processing

PE8_10 - Manufacturing engineering and industrial design