Research Group

Carbon Neutral Built Environment (CNBe)

Reference year:

2025

Scientific Coordinator:

VIOLANO Antonella / Associate Professor / Dipartimento di Architettura e Disegno Industriale / Università degli Studi della Campania "Luigi Vanvitelli"

Group members:

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DAVOLI Pietromaria / Full Professor / Università di Ferrara
ESPOSITO Monica / Architetto
FERCHICHI Souha/ MEDREC / Mediterranean Renewable Energy Centre
FUMO Marina/ Full Professor /Università degli Studi di Napoli "Federico II"

GALLO Paola / Full Professor / Università degli studi di Firenze
GAMBARDELLA Claudio / Full Professor / Symbola
GIORDANO Roberto/ Full Professor /Politecnico di Torino
HATPULUGIL Timucin / Associate Professor/ Cancaya University, Ankara (Turchia)
IBRIK Imad / Professor /An-Najah National University - Energy Research Centre (ERC), Palestine
LOPEZ-IZQUIERDO Pia/ Professor/ Universidad Politecnica de Madrid (ES)
LUCIANO Antonio / Architetto
MAIO Antonio/Direttore scientifico/ Museo Diffuso Diamare Sessa Aurunca (MUDISE)
MOLINA José L./ Professor / Universidad de Sevilla, Departamento de Ingeniería Energética, Escuela Técnica Superior de Ingenieros
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PEPINO Ilaria/ Designer
PEREZ-HERNANDEZ Julio Cesar/Associate Professor/School of Architecture/ University of Notre Dame (USA)
RACOLTA Andrei-Gheorghe/ Associate Professor /Università Politecnica di Timisoara (Romania)
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SATIROPOULOU Alexandrà/ Professor/National Technical University of Athens (GR)
SPOSITO Cesare/ Associate Professor / Università di Palermo
TRIANTIS Euphrosine/ Professor/Department of Architecture/University of Patras (GR)
TUCCI Fabrizio / Full Professor / Università La Sapienza di Roma

Description of research lines:

The Research Group investigates, with a multidisciplinary and multi-scalar approach, technological and environmental strategies for the decarbonisation of the built environment, adopting circular and regenerative logics. The aim is to reduce, rationalise and optimise energy consumption, promoting the integration of renewable sources and the development of innovative technological solutions, alongside the innovative use of traditional technologies. The approach is based on three key principles for a real ecological transition: reducing carbon dependency by minimising the ecological footprint, promoting the recycling of carbon from biomass and waste to achieve negative emissions, and removing excess carbon to achieve embodied carbon neutrality.

Focus 1. Carbon Neutral Buildings

Carbon neutral buildings represent the new frontier for the ecological transition of the built environment, minimising CO_2 emissions throughout the entire life cycle and integrating advanced energy efficiency strategies and the use of low-impact materials. The research pathway is inspired by the principles of the *European Union's Circularity Plan*, selecting and applying five key strategies that guide the scientific working method: Cradle to Cradle, to promote a potentially infinite material lifecycle: **Design for Adaptability (DfA)**, which provides resilience and flexibility to structures over time; **Design for Disassembly and Deconstruction (DfD)**, to facilitate the disassembly and recovery of building components; **Design for Recycle (DfR)**, which optimises the reuse and valorisation of materials at the end of their life; and the concept of the built environment as a **Bank of Materials (BAMB)**, in which each architectural element is conceived as a resource for future use. These principles provide the methodological basis for developing carbon-neutral

buildings that combine advanced environmental performance, energy efficiency and long-term sustainability.

Focus 2. Product and Process Innovation in advanced materials (10R approach)

A specialised focus analyses the **Product and Process Innovation in advanced bio-based materials**, whose carbon footprint, embodied energy and environmental carrying capacity are analysed. This study is realised through the integration of Nature-Based Solutions, to reinforce decarbonisation goals and carbon sequestration, optimising bioclimatic, technological and energy aspects; carbon storage in building materials, with a focus on those with a high capacity to absorb and retain CO_2, such as cementitious materials (concrete, mortar and aggregates) and biogenic materials (thermal insulation and other natural products).

A particularly innovative area of research concerns the recycling of textile materials and their use in construction and advanced manufacturing. Through textile waste processing and valorisation processes, the group investigates the possibility of integrating recycled textile fibres into insulation panels, composite materials for cladding and energy-efficient solutions. The reuse of discarded textiles, with a view to the circular economy, not only reduces the amount of waste produced by the fashion industry, but also actively contributes to reducing the carbon footprint of the building and industrial sector. In parallel, the group experiments with Sustainable Technologies for Fashion Design, with a focus on smart and bio-based materials, innovations in eco-printing and high-performance fabrics. The research focuses on experimenting with fashion materials/products with reduced environmental impact, exploring the use of biodegradable fibres, low energy production processes and advanced upcycling techniques. This line of investigation, linked to biofabrication and additive manufacturing, opens up new perspectives for a truly sustainable fashion, capable of combining aesthetics, innovation and environmental responsibility.

Focus 3. Historical analysis and regeneration of historic buildings, urban contexts, and bio-cultural landscapes

In parallel, the Research Group conducts advanced studies on the **historical analysis and regeneration of historic buildings, urban contexts, and bio-cultural landscapes**, addressing the challenges of conservation and technological innovation through an integrated approach. The research focuses on the **Adaptive Reuse** of historic buildings, promoting strategies that preserve the cultural and identity value of heritage while optimizing environmental and energy performance. Another key area of study is the **Environmental Design** of sustainable mobility interventions in bio-cultural landscapes, aiming to enhance spatial accessibility while minimizing ecological impact. Additionally, the group explores the integration of **renewable energy sources** in historically and scenically significant contexts, applying the *Visual Impact Assessment* method to identify design solutions that balance energy production needs with landscape protection requirements. This approach ensures compliance with regulatory and technical standards while also meeting the expectations of local communities, fostering collective recognition and social acceptance of interventions.

The Research Group's activities, some conducted in collaboration with the innovative start-up DReAM-IT srl, linked to the SITdA Research Clusters: "Energy Climate Architecture" (Coord. Pietro Davoli), "Architectural Heritage" (Coord. Alessandra Battisti) and "Environmental Design" (Coord. Mario Losasso), which are joined by lecturers/researchers from 20 different Italian universities.

Relationships with other research groups of the University of Campania L. Vanvitelli during

the last three years:

- BIM technology and material innovation: from efficiency to environmental compatibility (coord. prof. R. Franchino/DADI)
- The Memory of Sites. History and Preservation for promoting the environmental and architectonical heritage (MemoS)
- Systemic design per l'innovazione circolare e consapevole nel Sistema Moda e Tessile del Made in Italy (Coord. Roberto Liberti)
- Small open spaces as techNOlogical DEviceS in the urban ecosystem_ NODES (Coord. Caterina Frettoloso)

Participation in research projects during the last three years:

Project Title: From Common Goods to Ecological Resources. Environmental Development Prospects for Areas Subject to Civic Use in Campania and Molise
Scientific Responsible: Elena Manzo
Announcement Title: PRIN PNRR 2022
Staff involved: M. D'Aprile, F. Fiorillo, M. Calabrò, S. Losco, F. Muzzillo, A. Violano.
Project status: in corso
Date of start/end of design: 01/12/2023 – 30/11/2025

Project title: Studies and research on the technological imprint of the textile product of sacred vestments and the related material and immaterial culture
Scientific Responsible: Antonella Violano
Announcement Title: Convention
Staff involved: L. Liberti, A. Maio, A. Violano
Project status: in progress
Date of submission/start/end of design: 22/10/2024 - 22/10/2025

Project title: DEVELOPMENT&RESEARCH ACTION ON MATERIALS INNOVATION TECHNOLOGIES. Activities of the innovative start-up DReAM-IT srl born from the academic spin-off of the University of Campania "Luigi Vanvitelli".
Scientific Director: Antonella Violano
Staff involved: M. Cannaviello, M. Merola, A. Violano
Project status: in progress
Dates of start/end of project: 01.06.2022/ 31/12/2100

Project title: MEDITERRANEAN UNIVERSITY AS CATALYST FOR ECO-SUSTAINABLE RENOVATION (MedEcoSuRe)
Scientific Responsible: Antonella Violano (for DADI)
Announcement title: ENI CBC MED Project - European Union
Staff involved: R. G. Aenoai, M. Cannaviello, M. Merola, Portella P., A. Violano
Partners: Mediterranean Renewable Energy Centre (MEDREC), Tunisia
University of Tunis El Manar (UTM), Tunisia
University of Florence - Department of Architecture (UNIFI-DIDA), Italy
University of Seville - Thermal Energy Engineering Department (TMT-US), Spain
An-Najah National University - Energy Research Centre (ERC), Palestine

Naples Agency for Energy and Environment- (ANEA), Italy
Spanish association for the internationalization and innovation of solar companies (SOLARTYS), Spain
University of Campania- Department of Architecture and Industrial Design (DADI), Italy
National Cluster of the Sectors of Home Automation, Smart Buildings and Smart Cities (DOMOTYS), Spain
University of Naples Federico II - Department of Industrial Engineering, Italy
Project status: funded, closed
Dates of start/end of project: 1.10.2019-31.08.2023

Project title: THERMAL HERITAGE FOR ECOSUSTAINABLE REGENERATION, MOBILITY AND ECONOMY (THERME)
Scientific Responsible: Monica Esposito
Announcement Title: Young researchers project DR 509/2022 VALERE
Staff involved: M. D'Aprile, C. De Biase, E. Manzo, D. Matricano, R. Serraglio, A. Violano, M. Cerro, F. Fiorillo, M. Merola, M. Perticarini.
Project status: Closed
Project submission/start/end dates: 17.10.2022-17.01.2024

Project Title: FASHION ALIVE
Scientific Responsible: Roberto Liberti
Titolo del bando: European Commission CREA-CULT 2021 Coop1
Personale coinvolto: Liberti R., Cannaviello M., Ottieri S., Palmieri A., Savarese G.
Stato del progetto: Concluso
Date di sottomissione/inizio/fine progetto: 01/07/2022-01/07/2024

Project Title: BIO-BASED REGENERATIVE MATERIALS
Scientific Responsible: Antonella Violano
Announcement Title: Industrial research project
Staff involved: M. Cannaviello
Project status: Closed
Project submission/start/end dates: 01.12.2021 – 30.11.2023

Project title: 3x3 ZERO ENERGY BUILDING (3x3ZEB)
Scientific Responsible: Antonella Violano
Announcement title: Industrial research project
Staff involved: M. Cannaviello, L. Capobianco, A.Violano
Partners: LSF Italia srl
Project status: Closed
Dates of start/end of project: 12.03.2019 – 12.03.2024

Scientific products of the last three years:
Scientific publications on Class A journals and/or indexed in the Scopus/WoS databases:

[1] Battisti A. Baiani S., ETHICS: Endorse Technologies for Heritage Innovation. Designing Environments. p. 209-226, Cham:Springer Nature, ISBN: 978-3-031-50120-3, doi: 10.1007/978-3-031-50121-0_13

[2] Franchino, Rossella, Frettoloso, Caterina (2024). Re-thinking Urban Open Space as a Tool for

"Normality". In: A.A.V.V.. (a cura di): E. Manahasa F. Naselli A. Yunitsyna, COVID-19 (Forced) Innovations Pandemic Impacts on Architecture and Urbanism. THE URBAN BOOK SERIES, p. 39-47, Springer, ISBN: 9783031566066, ISSN: 2365-757X, doi: 10.1007/978-3-031-56607-3_4

[3] D'Ambrosio, V., Violano, A. (2022). Re-inhabiting the building stock: technical policies and design innovations. TECHNE, p. 15-19, ISSN: 2239-0243, doi: 10.36253/techne-13437

[4] Maio A., Violano A., (2024). The Regeneration of Architectural Heritage to Manage the Reversibility of Adaptive Reuse Technology Design: Two Italian Case Studies. In: AA.VV.. (a cura di): Battisti A. Baiani S., ETHICS: Endorse Technologies for Heritage Innovation. Designing Environments. p. 209-226, Cham: Springer Nature, ISBN: 978-3-031-50120-3, doi: 10.1007/978-3-031-50121-0_13

[5] Palmieri A. (2023). Midjourney experimentation: representing Nature on a macro scale. In: SCIRES-IT - SCIentific RESearch and Information Technology, vol. 13, issue 1, pp. 181-188, ISSN: 2239-4303

[6] Olivieri, C., Adriaenssens S., C., Cennamo (2023), A novel graphical assessment approach for compressed curved structures under vertical loading, International Journal of Space Structures, 2023, 38(2), pp. 141-155

[7] Manzo E., De Biase C. (2024), Patrimonio culturale in aree vulnerabili. Conoscenza, rigenerazione ecosostenibile e valorizzazione dei percorsi termali in territori plurali. In "Storia dell'Urbanistica", a cura di G. Belli, E. Manzo, V. Pagnini, n. 3, numero speciale monografico Architettura e paesaggio per la cura e il benessere, 2024, pp. 170-188. doi: 10.17401/su.s3.cdb-em13

[8] Salima Zerari, Rossella Franchino, Nicola Pisacane, Carmen Llatas, Bernardette Soust-Verdaguer (2024). Addressing the Difficulties and Opportunities to Bridge the Integration Gaps of Bio-Based Insulation Materials in the European Construction Sector: A Systematic Literature Review. SUSTAINABILITY, ISSN: 2071-1050, doi: 10.3390/su16198711

[9] Violano A., Cannaviello M. (2022). Design process innovation through flexible and circular technological solutions. VITRUVIO, vol. 7(2), p. 60-73, ISSN: 2444-9091, doi: 10.4995/vitruvio-ijats.2022.18715

[10] Violano A., Cannaviello M. (2023). The Carbon Footprint of Thermal Insulation: The Added Value of Circular Models Using Recycled Textile Waste. ENERGIES, vol. 16, p. 1-24, ISSN: 1996-1073, doi: 10.3390/en16196768

Additional scientific products:

[11] Capobianco L. (2023) Rigenerazione urbana: oltre l'architettura una sfida culturale e sociale. In: Aveta A., Castagnaro A. (a cura di), "Patrimonio culturale e naturale della Campania. rigenerazione urbana", VOL. 9, PP. 23-24, Editori Paparo, Roma, 2023; ISBN 979-12-813890-5-2

[12] Manzo E., Esposito M. (a cura di) (2024), Un modello di rigenerazione del patrimonio termale e delle infrastrutture per la mobilità sostenibile. FrancoAngeli, Milano

[13] Palmero Iglesias L., Bernardo G., Aenoai R. G., Violano A. (2023) The performed based regeneration of Author Social Housing Districts In: Zerlenga O., Jacazzi D., CorniellоL.(ed by) Climate Change and Cultural Heritage. Proceedings del IV International Forum on Architecture and Urbanism IFAU 2023, 22 - 23 June 2023, p. 91, DADI Press, ISBN: 9788885556270

[14] Violano A., Barbato N., Cannaviello M., Ferchichi S., Ibrik I., Khalifa I., Molina J. L., Trombadore A. (2022). Digital-green transition of knowledge buildings. In: (a cura di): Gambardella Claudio, BEYOND ALL LIMITS International Conference on Sustainability in

Architecture, Planning, and Design. p. 211-215, Aversa (CE):DADI Press, ISBN: 978-88-85556-23-2

[15] Violano A., Cannaviello M. (2022). Bio-based thinking: ricerca e innovazione sui materiali carbon-zero per la circular economy. In: AA. VV. (a cura di): Tiziana Ferrante Fabrizio Tucci, BASES - Benessere, Ambiente, Sostenibilità, Energia, Salute. Programmare e progettare nella transizione. p. 387-395, MIlano:Franco Angeli, ISBN: 9788835138310

[16] Violano A., Ottieri S., Liberti R., Cannaviello M., Savarese G. (2024). MANIFESTO OUTFITS: CREATIVE AND COMMUNICATIVE TOOLS, GREEN TECHNOLOGIES AND MATERIALS. In: (a cura di): Luis Gómez Chova Chelo González Martínez Joanna Lees, INTED2024 Proceedings. 18th International Technology, Education and Development Conference. INTED PROCEEDINGS, p. 3210-3219, Valencia:IATED Academy, ISBN: 978-84-09-59215-9, ISSN: 2340-1079, Valencia, Spain, March 4th-6th, 2024, doi: 10.21125/inted.2024.0863

[17] Violano, A., Harputlugil, T. (2024). Water and Carbon Neutral Buildings: systemic approaches and hybrid strategies. In: (a cura di): J. Gaspari L. Felicioni L. Marchi E. Antonini, Challenges for the Next Generation Built Environment. IOP CONFERENCE SERIES. EARTH AND ENVIRONMENTAL SCIENCE, vol. 1402, p. 1-12, BRISTOL:IOP Publishing, ISSN: 1755-1307, Bologna, 9-10 May 2024, doi: 10.1088/1755-1315/1402/1/012053

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

since 2023 - Scientific collaboration with the Universitat Politècnica de Timisoara (Romania)

since 2022 - Scientific collaboration with the Department of Architecture, Faculty of Architecture of Çankaya Üniversitesi (Turkey)

since 2022 - Scientific collaboration with the Escola Tècnica Superior d'Enginyeria d'Edificació of the Universitat Politècnica de València (ES)

2022 - Scientific collaboration with the Museo Diffuso Diamare Sessa Aurunca (MUDISE)

since 2019 - Scientific collaboration with Service Biotech srl for the design, analysis and prototyping of innovative biobased materials

since 2017 - Scientific collaboration with Escuela Técnica Superior de Edificación" of the "Universidad Politécnica de Madrid (ES)

since 2011 - Participation in the Network RehabiMed Barcelona (ES) Mediterranean interdisciplinary network aimed at sustainable rehabilitation, heritage restoration and urban regeneration.

since 2011 - Scientific collaboration with the School of Architecture of the National Technical University of Athens - (GR)

since 2007 - Inter-University Centre for Bio-ecological Architecture and Technological Innovation for the Environment ABITA - Consortium members: University of Florence (DIDA), University of Campania 'L. Vanvitelli' (DADI), Polytechnic of Milan (DAStU), Polytechnic of Turin (DAD), University of Genoa (DAD), La Sapienza University of Rome (PDTA), University of Naples 'Federico II' (DiARCH), Mediterranean University of Reggio Calabria (dArTe)

Collaborations with Consortia, Scarl or other Institutions participated by the University of Campania L. Vanvitelli during the last three years:
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ISI Web of Science Subject Categories:

Architecture; Engineering, Civil; Rehabilitation; Green & Sustainable Science & Technology; Environmental Studies; Materials Science, Biomaterials.

Scientific-Disciplinary Sectors:

08/CEAR-06/A (ex ICAR/08)
08/CEAR-08/A (ex ICAR/10)
08/CEAR-08/C (ex ICAR/12)
08/CEAR-08/D (ex ICAR/13)
08/CEAR-09/A (ex ICAR/14)
08/CEAR-10/A (ex ICAR/17)

Keywords:

Decarbonization
LEVEL(s) framework
10R approach
Buildings as Materials Banks
Whole Life Carbon
Carbon Footprint
Regenerative Design
Life Cycle Impact Analysis
Adaptive Reuse
Renewable Energy Sources

ERC Categories:

PE8_3 Civil engineering, architecture, offshore construction, lightweight construction, geotechnics
PE8_11 Environmental engineering, e.g. sustainable design, waste and water treatment, recycling, regeneration of recovery of compounds, carbon capture & storage
SH7_5 Sustainability sciences, environment and resources
SH8_6 Architecture, design, craft, creative industries