COST Action CA16114 RESTORE
***RE**thinking Sustainability **TO**wards a **R**egenerative **E**conomy*

TRAINING SCHOOL WG4

"Rethinking technologies for regenerative indoor environment"

Venice, 2nd - 5th December 2019

COST is supported by
the EU Framework Programme
Horizon 2020

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1. Introduction

The COST Action CA16114 RESTORE "REthinking Sustainability TOwards a Regenerative Economy", led by EURAC Research, affects a paradigm shift towards restorative sustainability for new and existing buildings across Europe, promoting forward thinking and multidisciplinary knowledge, leading to solutions that celebrate the richness of design creativity while enhancing users' experience, comfort, health, wellbeing and satisfaction inside and outside buildings, and in harmony with urban and natural ecosystems, reconnecting users to nature.

The RESTORE Action advocates, mentors and influences for a restorative built environment sustainability through working groups. In 2019, the activities of Working Group Four have been undertaken with the aim of defining the aspects that determine a regenerative indoor environment so that it would have been possible to define all the technologies and their characteristics that provide the "restorativeness".
Proper technology solution-sets can enable a regenerative indoor environment for building users and for the planet ensuring well-being and health.

Among the activities of WG4, a training school took place in Venice, Italy, during the first week of December. It was open to European professionals, researchers, PhD and master students with relevant skills in the thematic areas: products manufacturing, facility management, design, advisor.

In the training school, further than receive the frontal lectures, the 30 trainees were asked to work on a real case-study with the goal to redesign it in a regenerative building perspective by using principles and implementation strategies as presented in the mentioned lectures.

The solutions developed for the case studies analysed during the Training School, and authorized to be published, were then evaluated by a Commission. Now, they are available to be consulted on the RESTORE website.

2. Participants to the Training School & Case Study

Avella Francesca, Italy
Case Study: *Nursery school and kindergarten CASANOVA*

Francesca Avella was born in 1991 in a city near Bari in southern Italy. She is an Architect with a post-graduate master's degree in Environmental Technological Design. She currently works as a Researcher in the field of indoor air quality and ventilation in the Institute for Renewable Energy of Eurac Research in Bolzano.

Bessi Alessandra, Italy
Case Study: Prysmian HQ

Bessi Alessandra is currently Senior Consultant and Sustainability Team Leader at Manens-Tifs where she has been working since 2011. Alessandra is an experienced professional in green rating systems consultancy, passionate in sustainable and regenerative design. She joined the Prysmian HQ Project since the beginning within the LEED and Sustainability Team, working close to the Client and Design Team in order to achieve high level of sustainability performance.

Delli Paoli Marco, Italy
Case Study: *CopenHill*

Marco Delli Paoli is an architect and a PhD candidate in Environmental Technological Design at Sapienza University of Rome, Italy. Working as a BIM Specialist and during his studies He developed a deep interest in the issues of sustainability and Building Information Modeling, intended both as tools and as approaches to design, experimenting their application in many projects especially in his graduation thesis about the requalification of an industrial complex. He is going to focus his studies on these topics, developing them in his Phd thesis, in order to define new strategies about the restorative design.

Evola Gianpiero, Italy
Case Study: *Aulario IndUVA*

Gianpiero Evola is a Researcher of Building Physics at the University of Catania, where he also teaches disciplines regarding the Energy Performance of Buildings and Energy Systems. His main field of investigation is the energy performance of buildings, especially those located in warm Mediterranean countries, but he also works on adaptive thermal comfort and outdoor thermal comfort in urban areas. He wrote 40 papers published on peer-review journals, and more than 70 communications to International and National Conferences

Fernandes Jorge, Portugal
Case Study: *Solar XXI*

Jorge Fernandes is an architect, M.Sc. in Sustainable Construction and Rehabilitation and has been developing research work in sustainability principles of vernacular architecture and exploring new ways of integrating those principles into new sustainable buildings. He is currently a PhD candidate and has carried out several studies on Portuguese vernacular architecture, namely thermal performance, comfort and life cycle impacts assessments. He was a research fellow in the research project “reVer: Modeling the life-cycle performance of Portuguese vernacular buildings – contribution to the sustainability of buildings” (www.rever.pt). He is a Qualified Expert in the Sustainability Assessment System - SBToolPT and member of iiSBE Portugal (International Initiative for a Sustainable Building Environment).

Franzé Federica, Italy
Case Study: *VP22*

Federica Franzè is sustainability consultant and WELL AP, expert in (eco)logical strategies for smart and regenerative buildings at the nexus of health, energy and sustainability. She holds MSc degree in Building and Architectural Engineering from Politecnico di Milano and she collaborated with Alta Scuola Politecnica in research project for new strategies of healing environments in healthcare facilities. She is involved in the HORIZON 2020 European Project MiniStor in exploitation and dissemination activities.

Iuga Tudor, Romania
Case Study: *CERC Boldești-Scăeni*

Managing Sustainability Consultant @greengineers. Helping partners to design, build & certify better buildings, with minimum impact on one's health, budget and environment.

Jiménez-Pulido Cristina, Spain
Case Study: *Espacio itdUPM*

Cristina Jiménez-Pulido works as a researcher in the Sustainability in Construction and Industry Research Group at Universidad Politécnica de Madrid (giSCI-UPM), where she collaborates in other different activities related to research, teaching, and dissemination. She obtained a bachelor’s degree in Architecture from UPM in 2005 and a master’s degree in Advanced Architecture and City Project from the Universidad de Alcalá de Henares (UAH) in 2010. After working as Architect/Designer for over 12 years, she is currently a PhD candidate of innovation in building conservation and deep renovation management of building stock at UPM.

Kelmendi Sadije, Kosovo
Case Study: *Detached House*

Sadije Deliu Kelmendi is an architect/planner and researcher with 14 years of experience in practice (private sector, UN-Habitat, NGO, consultant) and 10 years in higher education as a lecturer of building physics, spatial planning and urban design at UBT in Pristina, Kosovo. She has authored and co-authored guidelines and scientific papers on Participatory Spatial Planning (2014-15), sustainable building design (2009-2017), and policy paper on Energy Efficient Obligation Measures (2020). She is also certified for Health and Safety and is a bureau member of ISoCaRP.

Krezlik Adrian, Poland
Case Study: *KAPSARC*

Architect, educator and creative entrepreneur dedicated to the application of contemporary science and technology into design processes. Founder of educational platform Architektura Parametryczna. Adrian is a PhD researcher at the University of Porto in the filed of vernacular mimicry and regenerative growth. He also teaches at the School of Form in Poznań. Before, he gained his professional experienced at Zaha Hadid Architects, FREE Fernando Romero and Rojkind Arquitectos.

Maffessanti Viola, Italy
Case Study: *70 Wilson*

Viola Maffessanti is an Italian architect based in London, UK. She graduated with her MArch in Architecture at the IUAV University of Venice in 2007, after studying in Venice and at the TU-Berlin, and since then she has been working in architectural practices in Barcelona, Venice and London.
Alongside her passion for design, her strongest values concern the respect for the environment and the acknowledgment of our responsibility as architects to do our part to preserve it. This focus and interest, especially developed in the last years, led her to undertake her MSc in Environmental Design and Engineering at UCL, London, completed in 2018.
Since 2012, she has been working at Astudio Architects in London, currently as an Associate, and she is part of the practice's Sustainability and R&D teams, bringing her skills within the studio, sharing knowledge on sustainability principles and performing environmental modelling on projects to test and constantly improve design.

Magurean Ancuta Maria, Romania
Case Study: *National Headquarters E.ON ROMANIA*

Ancuța M. Măgurean is Assistant Professor at Technical University of Cluj-Napoca, Romania, with a PhD degree in Civil Engineering and Building Services. She is Vice President of the Association of Energy Auditors for Buildings in Romania - Transylvania branch. Her scientific research is focused in the energy efficiency of buildings, including advanced hygrothermal simulations, based on numerical methods and Artificial Intelligence techniques, introduced and applied in the civil engineering field.

Martin Simon Sandra, Spain
Case Study: *Greenpeace Spain Headquarters*

Sandra is an architect, LFA ambassador and Circular Economy designer. She works towards a regenerative society through SmartinCircles (a social enterprise that designs circular strategies and creative actions in cities and other territories) and Cirklo, living systems (an architectural firm that creates circular and healthy solutions in the built environment).

Ontkoc Marian, Slovakia
Case Study: *Ca' Foscari, Palazzo*

Architect and PhD candidate focused on natural materials in architecture and design. Enthusiastic about straw and clay.

Orova Melinda, Hungary
Case Study: *Hungarian Nest +*

Melinda Orova is an architect working at ABUD Ltd., a sustainability consultancy company based in Budapest, Hungary. Her main expertise includes LEED and WELL certification management and R&D work on building and neighborhood level sustainable refurbishments

Perozzo Franesco, Italy
Case Study: *Bullit center*

Francesco Perozzo is a technical sales representative for Fassa srl, Venezia. Building materials. State of the art integrated solutions from small building work to large scale construction sites.

Petrova Veronika, Denmark
Case Study: *Rokko Shidare Observatory*

Petrovski Aleksandar, Republic of North Macedonia
Case Study: *B+A House*

Petrovski Aleksandar's research interest is in the development of Sustainable buildings and urban spaces by implementing sustainable and regenerative design concepts, principles and processes, methods and materials which reflect the needs of the society. By holistic approach in the research of the new architectural and urban tendencies, his work is oriented towards the unification of the social, economic and environmental aspects and utilizing multicriteria assessment systems, which will enable efficient and effective evaluation of a given building. The buildings design and performance are examined and improved by utilizing parametric design and tools as well as optimization of the buildings design.

Rouyet Nestor, Spain
Case Study: *Bullitt Center*

Nestor Rouyet is a Building Engineer, Master of Science in Building Systems, and PhD candidate in Building Technological Innovation at the Polytechnic University of Madrid, whose research focuses on residential environments and health. Faculty at the New York School of Interior Design, and Master Thesis Director at the International University of La Rioja. His international experience, in the USA and Europe, in architecture and construction, and his research-oriented work, have enabled him to lead a consulting firm focused on social sustainability.

Stella Anastasia, UK
Case Study: *Bullitt Center*

Stella Anastasia is a Sustainability Consultant focusing on LCA, embodied carbon and circular economy

Vian Silvia, Italy
Case Study: *Copenhagen Tower Buildings 405-406*

Silvia Vian has lived and worked across Italy, Germany and the UK, where she has been working at Foster+Partners, the award-winning integrated design firm since 2015. She is a charted Architect for the RIBA and ARB and has graduated with a Master of Science in Architecture at the IUAV - University of Venice in 2013. She is passionate and supportive, always open to new challenges and aiming for the best. She likes to sum up Architecture as a good compromise between Art and Reality.

Yıldırım Gürkan, Turkey
Case Study: *Villa Castelli*

Dr. Gürkan Yıldırım is a full-time Associate Professor of Construction Materials and Materials Science at the Civil Engineering Department of Kırıkkale University, Turkey. He holds a Ph.D. degree from Gazi University, Turkey on Construction Materials. He is an expert in the area of development of ductile cementitious composites characterized with the strain-hardening, self-healing, self-sensing and self-compacting capabilities for sustainable infrastructure.

3. Case studies

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Nursery school and kindergarten CASANOVA

http://www.interasrl.it/portfolio-item/scuola-materna-e-asilo-nido-bolzano/

LOCATION
Via Ortles, 44, 39100 Bolzano, BZ

CLIMATE ZONE
(according to KFICAT)
Dwa Monsoon-influenced hot-summer humid continental climate

BUILDING TYPOLOGY

- **R** **Residential**
- **O** Office
- **E** Education
- **L** Lodging
- **RS** Retail/Services

SUSTAINABILITY LEVEL

- **C** **Conventional** — ***Building as usual***
- **S** Sustainable — ***Limiting impact.*** *The balance point where we give back as much as we take*
- **RS** Restorative — *Restoring social and ecological systems* ***to a healthy state***
- **RG** Regenerative — *Enabling social and ecological systems to maintain a healthy state* ***and to evolve***

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CLIENT / OWNER / INVESTOR
Municipality of Bolzano

PROJECT TEAM
Arch. Antonio D'Alessandro
Arch. Giuseppe Caputo
Ing. Gianluca Gangemi
Arch. Ilaria Iovino
Arch. Francesca Mammucari
Arch. Riccardo Martignoni
Geom. Giuseppe Vetrano
Arch. Francesca Zummo
Ing. Giuseppe Fabiano
Ing. Santo Massimiliano Marceca

COMPLETION YEAR
2017

AWARDS
CasaClima A
CasaClima School

The Casanova kindergarten, located in Bolzano, is made up of the only functionally distinct building in the nursery school and kindergarten.
It consists of two parts made with different materials: the basement is in reinforced concrete isolated and protected by radon gas, while the above-ground part is in laminated wood insulated internally and externally.
Thanks to the technological solutions implemented and the materials used, the building allows a better quality standard for users and a building organism's ability to interact with the external environment by reducing its impact on the reference context.

TECHNICAL DATA

Gross area: 3.881 sqm

Key performance indicators (KPIs) *(Please tick ✓ the KPI's which are addressed in the case study)*

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	✓
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓ ✓
Occupants satisfaction - % satisfied people	
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	✓
Occupants satisfaction - % satisfied people	
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	✓
Occupants satisfaction - % satisfied people	
HUMAN VALUES	
External view and Right to light - % workstations with windows access	✓

REGENERATIVE TECHNOLOGY #1

CENTRALIZED MECHANICAL VENTILATION WITH HEAT RECOVERY AND CONTROL SENSORS OF CO2 , TEMPERATURE AND HUMIDITY

Classification of the technology: active

Effects/improvements on indoor environment of the case study
to improve indoor air quality, reduce heat loss and the energy saving

Sustainability level: Sustainable

Detailed description of technology: The ventilation system with heat recovery is associated with sensors and devices that regulate the

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system according to parameters such as ambient temperature, ambient humidity, CO_2 concentration, crowding of rooms, etc.
CO_2 sensors monitor the concentration of carbon dioxide in the environment (especially schools, classrooms, offices, meeting rooms or environments with many people) providing to operate air changes in order to increase the indoor air quality.
The humidity sensor measures the humidity of the environment in which it is installed. The sensors are typically low safety voltage and can be assimilated to a button or switch. To integrate them into an automation system, a binary input device, or in some cases analogue, is used. The signals sent by the sensors are used to control the binary output devices; these are connected to the cooling devices (fan-coils, etc.).

REGENERATIVE TECHNOLOGY #2

HIGH EFFICIENCY LIGHTING REALIZED WITH SCREENED LED TECHNOLOGY WITH CONTROL SENSORS

Classification of the technology: active

Effects/improvements on indoor environment of the case study
Energy saving, visual comfort

Detailed description of technology:
Lighting with LED technology associated with control systems able to compensate variations based on natural light and the presence of people.

REGENERATIVE TECHNOLOGY #3

ABOVE GROUND WOODEN STRUCTURE

Classification of the technology: sustainable

Effects/improvements on indoor environment of the case study
Reduction of construction times and environmental and economic impact of the construction site, reduction of CO_2 emissions, improvement of thermal and acoustic insulation, absorption of the environment humidity changes.

Detailed description of technology:
The external wall package consists of a wall in X-LAM composite panel in wooden material with an external insulating layer to which the zinc-titanium slats are spaced apart from the insulation. This creates an internal convective motion of air based on the criteria of the ventilated wall.

REGENERATIVE TECHNOLOGY #4

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EXTERIOR FRAMES EQUIPPED WITH SENSORS

Classification of the technology: active

Effects/improvements on indoor environment of the case study
To improve visual environment comfort, indoor air quality, indoor thermal comfort

Detailed description of technology:
Wood-aluminum window frames equipped with a dynamic visual climate control system that can be managed automatically or individually: the sunscreen actuator and wind sensors.
The sunscreen actuator is a device that allows the opening and closing of the sunscreen to which it is connected; it consists of an electric motor which is activated by a sensor (wind, temperature, twilight). In case of strong gusts of wind the sensor generates an impulse which is collected by the motor which closes the sunblind; the same mechanism is triggered in the case of high temperatures so it is necessary to protect yourself from solar radiation. Also in this case the temperature sensor sends a signal to the motor that causes the blind to close.
Wind sensors have low safety voltage and can be assimilated to a button or switch.
To integrate them into an automation system, a binary input device, or in some cases analogue, is used. The signals sent by the sensors are then used to control the binary output devices, for example to close the awnings.

ACKNOWLEDGEMENTS
Agenzia per l'Energia Alto Adige - CasaClima
Municipality of Bolzano

LINKS AND REFERENCES
Comune di Bolzano, FASCICOLO DELL'OPERA.
Brochure CasaClima 2017.
https://www.comune.bolzano.it/UploadDocs/20245_Progetto_Scuola_Materna_e_Asilo_Nido_Casanova.pdf

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Prysmian HQ

Maurizio Varratta Architetto

LOCATION
Via Chiese, 6, 20126 Milano MI

CLIMATE ZONE
(according to KFICAT)
(Cfa Humid Subtropical Climate)

BUILDING TYPOLOGY

- R Residential
- **O Office**
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL
LEED v3 BD+C New Construction – Platinum

- C Conventional — ***Building as usual***
- S Sustainable — ***Limiting impact.*** *The balance point where we give back as much as we take*
- **RS Restorative** — *Restoring social and ecological systems **to a healthy state***
- RG Regenerative — *Enabling social and ecological systems to maintain a healthy state **and to evolve***

Prysmian HQ is an office building located in Milan. The design dates back to 2001 and was aimed at holding onto its industrial past by maintaining and modernizing the building shell to recreate some new parts that were lacking and renovating the old structures by giving them a brand-new skin. It consists of four main buildings separated by two bioclimatic glasshouses: triple-height glazed spaces featuring plenty of landscaped areas, interaction places and horizontal/vertical linking systems connecting the various buildings serving as offices.

TECHNICAL DATA

Gross area: 13200 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓ ✓
Occupants satisfaction - % satisfied people	✓
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	✓
Occupants satisfaction - % satisfied people	
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	✓
Occupants satisfaction - % satisfied people	
HUMAN VALUES	
External view and Right to light - % workstations with windows access	✓

REGENERATIVE TECHNOLOGY #1

Daylighting maximized

Classification of the technology: Passive

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Effects/improvements on indoor environment of the case study
Almost Eightyfive percent of workspaces can benefit of natural light increasing occupants wellbeing.

Sustainability level: Restorative

Detailed description of technology: Daylighting has been maximized by means of triple-height glasshouses connecting the office blocks with the roof pitches facing south provided with adjustable mechanically controlled shutters to keep out direct sunlight and any extra inflow.

STRENGTH MEASURE OF EFFECTS -

STRENGTH-WEAKNESS ANALYSIS OF THE TECHNOLOGY -

Possible providers of technology: -

REGENERATIVE TECHNOLOGY #2

Lighting controls

Classification of the technology: Control

Effects/improvements on indoor environment of the case study
Artificial lighting is used only when daylighting is not sufficient with the aim to maximize occupants wellbeing and reduce energy consumption.

Sustainability level: Sustainable

Detailed description of technology: Artificial lighting is provided by variable-intensity LED lighting fittins, automatically regulated by sensors based on natural light levels. These sensors also detect the presence of people and shut off lights in empty open spaces and vacant meeting rooms.

STRENGTH MEASURE OF EFFECTS Energy savings of more than 80% compared to the use of traditional bulbs and use artificial lighting with no lighting controls.

STRENGTH-WEAKNESS ANALYSIS OF THE TECHNOLOGY -

Possible providers of technology: -

ACKNOWLEDGEMENTS
Prysmian Group s.p.a.
Maurizio Varratta Architetto

LINKS AND REFERENCES

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CLIENT
(Prysmian Group spa

PROJECT TEAM
Architect: Maurizio Varratta Architetto

MEP Design; Lighting Design; Building Physics, Commissioning Authority; Energy and LEED AP-Design: Manens-Tifs s.p.a.

Structural Engineer: SCE Project SRL

Interior Designer: DEGW

Development Manager: SCE Project SRL, Tekne s.p.a.

Contractor: Italiana Costruzioni SpA

LEED AP-Construction: Lombardini 22

Sub contractor: Armofer s.r.l.

COMPLETION YEAR
2017

AWARDS
GBC Italia Award 2018 - Leadership&Design Performance

https://ongreening.com/en/Projects/prysmian-hq-1328#info

Please note that the document should not exceed 3 pages

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CopenHill

Photo credits: The New York Times

LOCATION
Copenhagen, DK
(55°41'04.5''N 12°37'12.7''E)

CLIMATE ZONE
(according to KFICAT)
Dfb-Humid continental climate

BUILDING TYPOLOGY

- R **Residential**
- O Office
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL

- C **Conventional** — *Building as usual*
- S Sustainable — ***Limiting impact.*** *The balance point where we give back as much as we take*
- RS Restorative — *Restoring social and ecological systems **to a healthy state***
- RG Regenerative — *Enabling social and ecological systems to maintain a healthy state **and to evolve***

In order to achieve the CPH 2025 goal to become the first carbon neutral city in the world, Copenhagen has built the cleanest power plant in the world able to transform waste to energy.
BIG Architects designed this building rethinking the role of a industrial settlement transforming it in a public space where enjoying of a beautiful views of the city and where to ski in a natural landscape.
The particular U-shaped building allows to maximize both the interior and the exterior spaces and the permeable surfaces, avoiding the air pollution, taking advantages for water management.
Using a curve shape with modular elements for cladding the building has a continue envelope able to change colors during the day and the seasons when light reflects on it.

TECHNICAL DATA

Gross area: 41,000 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	✓
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓
Occupants satisfaction - % satisfied people	
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	
Occupants satisfaction - % satisfied people	
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	
Occupants satisfaction - % satisfied people	
HUMAN VALUES	
External view and Right to light - % workstations with windows access	✓

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Green roof


Green roof with plants around


Interior work spaces


Exterior planters

REGENERATIVE TECHNOLOGY #1

Green Roof

Classification of the technology: Control

Effects/improvements on indoor environment of the case study
The sloped green roof allows to reduce the heat loss and to control the microclimatic conditions about humidity. With its different species planted it provides a new ecosystem for bees, flowers and birds, improving biodiversity. In order to avoid the air pollution it can remove harmful air particles and reduce the noises for acoustic properties, while minimizing stormwater runoff thanks to its permeable capacity, collecting it to reuse it inside the building.

Sustainability level: Regenerative

Detailed description of technology: The sloped green roof is placed along the edges to create a tilted hiking pathways around the rooftop. It provides different native species, improving benefits with their ecosystem services, able of withstanding the cold climate.

STRENGTH MEASURE OF EFFECTS

Integrating a green roof in a public building allows people to benefit from suggestive views of the city form the rooftop, in a natural environment.

STRENGTH-WEAKNESS ANALYSIS OF THE TECHNOLOGY

Using native species the device doesn't need a particular management, but it could provide some disadvantages because of allergens.

Possible providers of technology: SkanDek

REGENERATIVE TECHNOLOGY #2

Aluminium Bricks

Classification of the technology: Control

Effects/improvements on indoor environment of the case study
The aluminum bricks design the entire envelope through a modular framework, following the sloped roof, forming a particular mesh where voids represent the windows. In this way the interior spaces have natural lighting during the day, creating a diffuse lighting effect very comfortable for workers.

Sustainability level: Sustainable

Detailed description of technology: The envelope is composed by the stacked aluminium bricks and glazed windows. Every single brick has a stratigraphy consisting of soil, filtering, draining and waterproofing layer to which an irrigation system is connected. The

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Stacked aluminium bricks

CLIENT / OWNER / INVESTOR
Amager Ressourcecenter (ARC)

PROJECT TEAM
Bjarke Ingels Architects

COMPLETION YEAR
2017

AWARDS
Progressive Architecture Awards citation, 2015. Mipim Future Projects Awards Special Award, 2012.

cladding of each brick consists in Aluminium alloy EN-AW 5083 with hardness H22 and H11. The bricks drain from each other and down and at the top of the building the facade works as railing on the rooftop.

STRENGTH MEASURE OF EFFECTS

The use of aluminum bricks double as planters allows to avoid the glare inside the spaces, because of the vegetation able to filter the direct sunlight. Furthermore the green wall mitigates the air pollution, integrated with the benefits from the green roof.

STRENGTH-WEAKNESS ANALYSIS OF THE TECHNOLOGY

The vegetation inside the brick doesn't need so much water, but some pruning and management are required.

Possible providers of technology: Plootu19

LINKS AND REFERENCES

http://www.volund.dk/Waste_to_Energy/References/ARC_Amager_Bakke_Copenhagen
https://www.nytimes.com/2019/10/23/travel/copenhagen-ski-hill-powerplant.html

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Aulario IndUVA

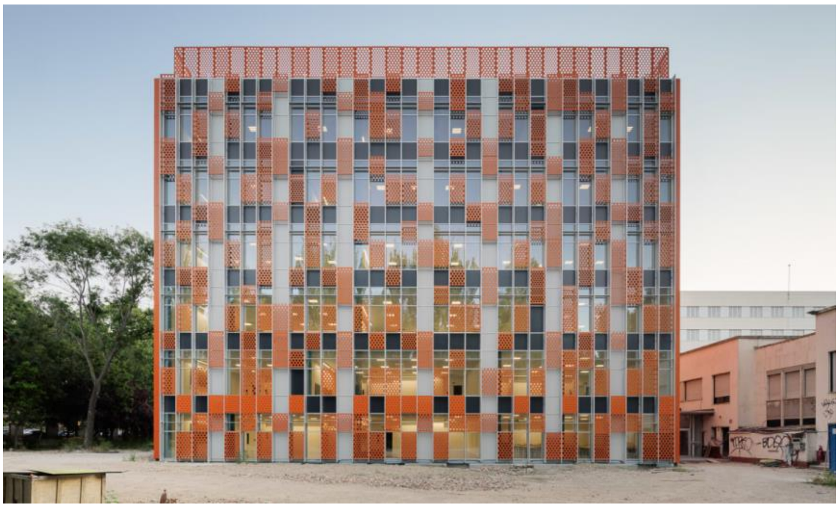

Photo available on: www.construction21.org/case-studies/es/aulario-induva.html#its

LOCATION
Paseo Prado de la Magdalena s/n
47011 Valladolid - SPAIN
(41°39'27"N, -4°42'50"W)

CLIMATE ZONE
CSb – Coastal Mediterranean

BUILDING TYPOLOGY

- R Residential
- O Office
- **E Education**
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL

- C Conventional — *Building as usual*
- S Sustainable — ***Limiting impact.*** *The balance point where we give back as much as we take*
- **RS Restorative** — *Restoring social and ecological systems **to a healthy state***
- RG Regenerative — *Enabling social and ecological systems to maintain a healthy state **and to evolve***

The Aulario for the School of Industrial Engineering of the University of Valladolid (IndUVA) is composed of 34 classrooms of different size, and a variable occupation schedule from 100 to around 2500 students over a net floor area of 5,539 square meters. It is located within the headquarters of Mergelina, a university area that hosts other buildings such as workshops, laboratories, residential centers, while also including gardens, recreation areas and parking.
It is connected to other buildings in the area by means of a glazed corridor that houses the communication hubs (staircase and two elevators on each of the six floors). Special attention has been paid to daylighting, biodiversity of green species, ventilation and energy savings. The building has been designed aiming at the n-ZEB label, and is going to be certified LEED Platinum and WELL by externally bodies.

TECHNICAL DATA

Gross area: 5,845 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	✔
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	–
Occupants satisfaction - % satisfied people	✔
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - SET	✔
Occupants satisfaction - % satisfied people	✔
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	✔
Occupants satisfaction - % satisfied people	✔
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	–
Occupants satisfaction - % satisfied people	–
HUMAN VALUES	
External view and Right to light (% workstations with windows access)	–

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OWNER / INVESTOR
Universidad de Valladolid

PROJECT TEAM
Designer:
Francisco Valbuena García

Thermal consultancy:
Cristina Gutiérrez Cid

Environmental consultancy:
Vega Ingeniería

Other consultancy:
María Jesús González Díaz
Ana Jiménez
María de la O García
Manuel Muñoz
José Luis Muñoz

COMPLETION YEAR
2018

AWARDS
Sustainable Construction Grand Prize winner - Green Solutions Awards 2018

REGENERATIVE TECHNOLOGY #1

CO2-controlled Variable Air Volume (VAV) ventilation

Classification of the technology: Active/Control

Effects/improvements on indoor environment of the case study
This technology has the aim of improving indoor air quality while also saving energy needed for ventilation and heating purposes. The estimated energy savings are by between 30% and 70%, also thanks to the electronically commutated fans installed in the entire building.

Sustainability level: Sustainable

Detailed description of technology: Ventilation in each classroom is controlled by a CO2 probe located in the room itself and linked to two Variable Air Volume (VAV) boxes for supply and return air. A minimum ventilation rate of 30% is maintained during the whole occupancy time, while for most of the time the ventilation rate fluctuates between 40% and 70%, thus substantially reducing the consumption for heating and ventilation.

STRENGTH MEASURE OF EFFECTS: Even if this technology does not directly control the indoor formaldehyde concentration, the dilution of the indoor pollutants ensured by the ventilation systems will reasonably address also this KPI. In any case, the designers have included a further requisite concerning the choice of indoor materials, which must not contain formaldehyde and must have only a minimum VOC content.

STRENGTH-WEAKNESS ANALYSIS OF THE TECHNOLOGY:
Unlike conventional ventilation technologies, CO2-controlled VAV modulates the ventilation rate as a function of the actual ventilation needs in the indoor spaces: indeed, ventilation is almost stopped when occupants are not in the rooms.

Possible providers of technology:
France Air (http://www.vmc-franceair.com/)
F.C.R. (https://www.fcr.it/)

REGENERATIVE TECHNOLOGY #2

Optic fibers for daylighting

Classification of the technology: Passive

Effects/improvements on indoor environment of the case study
This technology has the aim of enhancing indoor daylighting while also minimizing electricity consumption for artificial lighting. Thanks to this technology it is possible to ensure daylight availability also in internal areas without windows.

Sustainability level: Restorative

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Detailed description of technology: This technology implies the installation of a rotating receiver on the roof which, through a system of thin and flexible bundles of optic fibers within cables, transports sunlight in the indoor spaces whilst maintaining the whole spectrum of solar light. Natural light is then emitted through suitable luminaires.

STRENGTH MEASURE OF EFFECTS: This technology has multiple benefits. First, it addresses the KPIs concerning visual comfort: not only it does improve daylight fruition and uniformity in indoor spaces, but it also favors circadian rhythms, as measured through the *Equivalent Melanopic Lux* (EML) values. Moreover, the exploitation of daylight makes it possible to minimise the electricity consumption proportionally to the available natural light, which is already low thanks to the use of LED technology.

STRENGTH-WEAKNESS ANALYSIS OF THE TECHNOLOGY:
Optic fibers can show low transmission efficiency over distances above 20 m, which may in some cases hinder their use. Another problem is the coupling loss, which depends on the refraction index of the fiber material at the end of the fiber. Glass fibers have better transmission than plastic fibers, but the acceptance angle is very small.

Possible providers of technology:
PARANS (https://www.parans.com/)

LINKS AND REFERENCES

https://www.buildup.eu/en/practices/cases/aulario-induva-valladolid-spain

https://www.construction21.org/case-studies/es/aulario-induva.html#

https://www.construction21.org/data/sources/users/3474/full-paper-cambridge-20180127l.pdf

https://www.interempresas.net/Construccion/Articulos/247647-Aulario-IndUVa.html

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Solar XXI

Photo credits: LNEG

LOCATION
LNEG Campus, Lumiar, Lisbon
Lat: 38,7724; Lon: -9,1777

CLIMATE ZONE
(according to KFICAT)
Csb – Warm-summer Mediterranean climate

BUILDING TYPOLOGY

- R Residential
- **O Office**
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL

- C Conventional — ***Building as usual***
- **S Sustainable** — ***Limiting impact.*** *The balance point where we give back as much as we take*
- RS Restorative — *Restoring social and ecological systems* ***to a healthy state***
- RG Regenerative — *Enabling social and ecological systems to maintain a healthy state* ***and to evolve***

The Solar XXI building was designed to be mainly naturally ventilated and to make use of both passive and active solar technologies. It uses passive systems both for heating and cooling (ground cooling). The building is considered a high-efficient building and may be currently considered a nearly Zero Energy Building. It was designed as a multipurpose building containing three floors, both office and laboratory spaces. The office space, being permanently occupied, is situated on the south side of the building to take advantage of solar exposure. Spaces with intermittent use, such as laboratories and meeting rooms are located on the north side of the building.

TECHNICAL DATA

Gross area: 1500 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	
Occupants satisfaction - % satisfied people	✓
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓
Occupants satisfaction - % satisfied people	✓
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	
Occupants satisfaction - % satisfied people	✓
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	
Occupants satisfaction - % satisfied people	✓
HUMAN VALUES	
External view and Right to light - % workstations with windows access	✓

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CLIENT / OWNER / INVESTOR
Portuguese National Energy and Geology Laboratory (LNEG)

PROJECT TEAM
Project coordinator: Helder Gonçalves
Architecture: Pedro Cabrito and Isabel Diniz

COMPLETION YEAR
2006

AWARDS
EDP award – Electricity and Environment 2005: Office building category

REGENERATIVE TECHNOLOGY #1

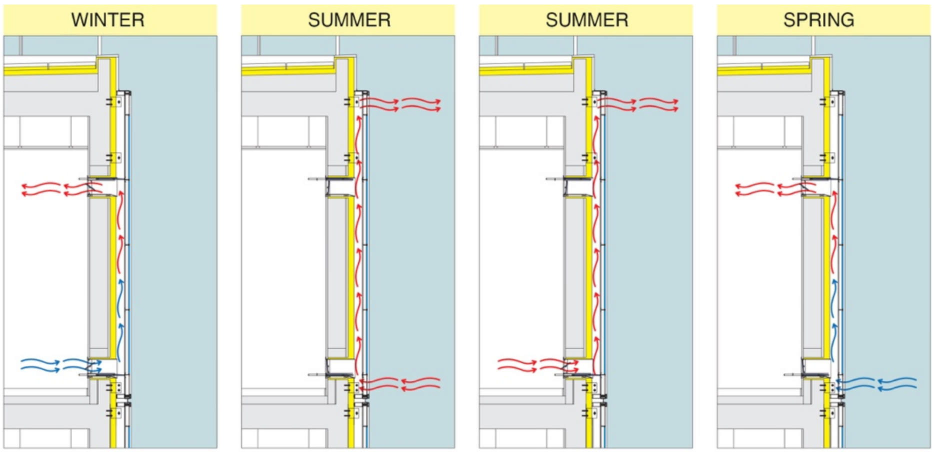
THERMAL BUILDING INTEGRATED PHOTOVOLTAIC (BIPV-T)

Classification of the technology: Passive and Active

Effects/improvements on indoor environment of the case study
This technology was chosen to energy saving and to improve indoor thermal environment during the heating season by reducing heat losses and through the recovery of the heat released in the process of converting solar radiation into power. As a heating strategy, in winter time during the days with high solar radiation, the temperature of the air heated by BIPV-T and insufflated into the offices can reach 30°C. The 100 m2 of photovoltaic panels mounted on the south façade and an additional array of panels located in the nearby car park, represent a total installed peak power of 18 kWp. The annual electricity use for the building is approximately 17 kWh/m2, of which 12 kWh/m2 is supplied by the PV system.

Sustainability level: Restorative

Detailed description of technology: BIPV-T system integrated in the south façade, made of PV modules (multicrystalline silicon) in vertical position. The integration was made in order to allow the recovery of the heat during the winter season. The air layer between the PV panel and the wall is heated, fostering the natural convection effect (similar to the effect of a Trombe wall). The ventilation is regulated by the occupants.



Possible providers of technology: Manufacturer: not available; Executer: Obrecol S.A.

REGENERATIVE TECHNOLOGY #2

GROUND COOLING SYSTEM

Classification of the technology: Passive

Effects/improvements on indoor environment of the case study
This technology was chosen mainly to improve indoor thermal

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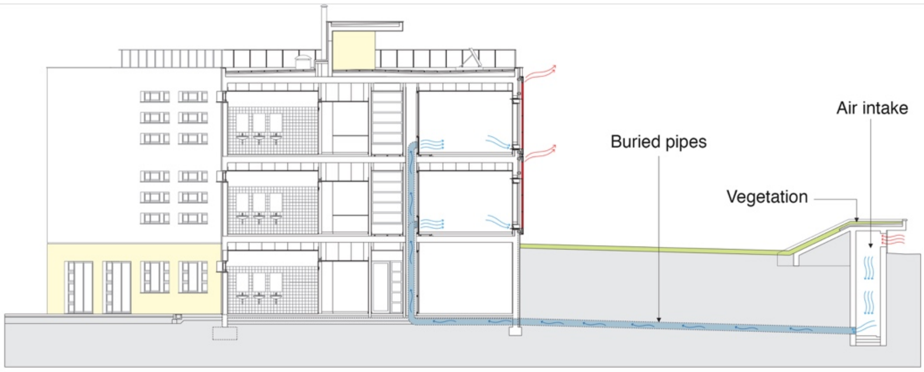
environment during the cooling season. The ground cooling system provides incoming pre-cooled air into the building using the earth as a cooling source. The ground temperature varies from 13 to 19°C throughout the year, so it represents an excellent cooling source during summer season. The air temperature injected in the office rooms ranges between 22–23°C, resulting in a decrease of the indoor air temperature between 2 and 3°C, when outdoor air temperature can reach 35 ºC. Each office room receives two ventilation tubes which the occupants can control the opening/closing.

Sustainability level: Regenerative

Detailed description of technology: The system consists of 32 tubes with 30 cm diameter, buried at 4.5 m depth. The air enters into the tubes array 15 m away from the building, cross the tubes circuit cooling to a temperature near the ground and is injected into the building office rooms by natural convection or forced convection using small fans. The system operates with great efficiency in the hot summer days, when the indoor temperature is significantly higher, by pushing the fresh air from the buried pipes.



Possible providers of technology: Manufacturer: not available; Executer: Obrecol S.A.

LINKS AND REFERENCES

Helder Gonçalves, Pedro Cabrito (2006) A Passive Solar Office Building in Portugal, PLEA 2006.

L. Aelenei et al, (2010). The Road Towards "Zero Energy" in Buildings: Lessons Learned from SOLAR XXI Building in Portugal, Proceedings of EuroSun 2010, Gratz, Austria.

Helder Gonçalves, Carlos Rodrigues & Laura Aelenei (2012). SOLAR XXI: A Portuguese Office Building towards Net Zero-Energy Building. REHVA Journal – March 2012. (https://www.rehva.eu/rehva-journal/chapter/solar-xxi-a-portuguese-office-building-towards-net-zero-energy-building)

https://www.buildup.eu/sites/default/files/content/B04_AdVENT_EdiffcioSolarXXILisbon%2CPortugal_WEB.pdf

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VP22

Photo credits Tectoo

LOCATION
(Via Vittor Pisani 22, Milan, Italy
45°28'38"28N; 09°10'53"40 E)

CLIMATE ZONE
(according to KFICAT)
(Cfa Humid Subtropical Climate)

BUILDING TYPOLOGY
- R Residential
- **O Office**
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL
- C Conventional — *Building as usual*
- S Sustainable — ***Limiting impact.*** *The balance point where we give back as much as we take*
- RS Restorative — *Restoring social and ecological systems **to a healthy state***
- **RG Regenerative** — *Enabling social and ecological systems to maintain a healthy state **and to evolve***

The "VP22" Project consists in the demolition and reconstruction of three buildings from the 1960s. Located in Via Vittor Pisani 22, in Milan financial district, between Central Station and Piazza della Repubblica, the new office complex is designed according to eco-sustainability and regenerative criteria and in order to maximize energy efficiency. The building will be completed by the end of 2021 and will be certificated LEED Platinum and WELL Gold.

TECHNICAL DATA

Gross area: 18000 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	✓
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	✓
Occupants satisfaction - % satisfied people	✓
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	
Occupants satisfaction - % satisfied people	
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	✓
Occupants satisfaction - % satisfied people	✓
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	
Occupants satisfaction - % satisfied people	
HUMAN VALUES	
External view and Right to light - % workstations with windows access	✓

REGENERATIVE TECHNOLOGY #1

Mechanical Ventilation with ISOcoarse pre-filters and particulate and molecular filters

Classification of the technology:

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CLIENT / OWNER / INVESTOR
(Antonello Manuli Holdings S.p.A.)

PROJECT TEAM

*(Molteni BEM
Tectoo
Milan Ingegneria
Ariatta
GAe
Carlotta Cocco)*

COMPLETION YEAR
(2021)

AWARDS
(LEED Platinum, WELL Gold)

Active

Effects/improvements on indoor environment of the case study

High efficient ISO coarse pre-filter and hybrid filter (particulate and molecular) are installed in the HVAC system to ensure an optimal mechanical ventilation in the indoor regular occupied spaces.
This technology with an efficiency of ePM_1 70% (comparable to MERV 13) permit to maintain the threshold of PM_{10} and $PM_{2.5}$ respectively lower than 50 and 15 µg/m_3 improving the quality of indoor air quality. The molecular technology permits to remove and/or reduce the volatile organic compounds such as formaldehyde with a level less than 27 ppb. Moreover, to ensure a correct and adequate ventilation rates in the regular occupied spaces, the project complies all the requirements set in the procedure in ASHRAE 62.1-2013, exceeding by 30% the ventilation rates recommended in order to maintain higher indoor quality.

Sustainability level:
Regenerative

Detailed description of technology:

The filters are installed inside the HVAC systems. The pre-filter ISOcoarse is installed in order to filter and remove first the coarse particulate matter with PM_{10} < 50%. Considering the limited space available inside the HVAC system, it has been considered to insert a single compact hybrid filter with rigid pockets able to decrease and control the concentrations of both particulates and gaseous contaminants. The molecular filter uses the adsorption technique, where the molecules adhere to materials with extremely large surfaces.

STRENGTH MEASURE OF EFFECTS

To increase the energy efficiency of the building and do not dissipate air changes in the regular occupied places are installed CO_2 sensors, which identifying the threshold of carbon dioxide fixed to 800 ppm activate the mechanical ventilation. This strategy improves the effects of the technology above described and ensure high indoor air quality.

Real-time displays of the indoor air environmental parameters (particle count, carbon dioxide and ozone) are made available and visible per 930 m^2 of regularly occupied spaces. The monitors are installed 1.1 – 1.7 meters above the floor and away from windows and entrances of 1 meter. As consequence, the occupants inside the building are aware and informed about the quality of air inside the spaces, increasing their satisfaction. This strategy increases the control of the mechanical ventilation performance.

Possible providers of technology:

The building project is actually under tender phase, no technical data sheets of manufacturers are available.

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REGENERATIVE TECHNOLOGY #2

Automated shading devices

Classification of the technology:
Active

Effects/improvements on indoor environment of the case study

The project provides internal shading devices that are automatically activated by light sensors when they detect glare condition in the inner spaces. All lighting except decorative and emergency fixtures has the capacity and is programmed to dim continuously in response to daylight. To guarantee healthy sunlight exposure, lighting simulations have been run in order to achieve the following conditions inside the regular occupied spaces:

- Spatial daylight autonomy (sDA 300,50%) achieved for at least 55%.
- Annual sunlight exposure (ASE 1000,250) achieved for no more than 10% of regularly occupied space. In other words, no more than 10% of the area can receive more than 1000 lux for 250 hours each year.

Sustainability level:
Regenerative

Detailed description of technology:

The external shading system is composed by fixed ceramic elements. In addition, internal automated blinds ensure glare avoidance and energy reduction. Furthermore, setting these features to automatically adjust can greatly contribute to comfort without disrupting occupants from other tasks.

STRENGTH MEASURE OF EFFECTS

Furthermore, to guarantee the right to light to the occupants, the 70% of all workstations are within 7,5 meters of an atrium or a window with views to the exterior. Moreover, the visible light transmittance of external windows is equal to 60% exceeding the 40% required. These strategies contribute to the shading device technology providing healthy sunlight exposure to the occupants.

Possible providers of technology:

The building project is actually under tender phase, no technical data sheets of manufacturers are available.

LINKS AND REFERENCES

http://www.VP22.it/
http://www.amholdings.com/immobiliare.html#pisani
https://blog.urbanfile.org/2019/05/24/milano-centrale-ecco-il-nuovo-vp22/
https://www.niiprogetti.it/un-bosco-nascosto-per-il-vp22-in-via-vittor-pisani-a-milano/

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CERC Boldești-Scăeni

Photo credits: Cosmin Dragomir, Laurian Ghinițoiu, Sorin Onișor

LOCATION
Strada Unirii, nr. 114B, Boldești-Scăeni, Romania

CLIMATE ZONE
(according to KFICAT)
Dfb

BUILDING TYPOLOGY

- R Residential
- O Office
- E **Education**
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL

- C **Conventional** — *Building as usual*
- S Sustainable — ***Limiting impact.*** *The balance point where we give back as much as we take*
- RS Restorative — *Restoring social and ecological systems **to a healthy state***
- RG **Regenerative** — *Enabling social and ecological systems to maintain a healthy state **and to evolve***

The Community Resource Center (CERC) Boldești-Scăeni is a building that serves an extensive program to support the disadvantaged community in Boldești-Scăeni, funded by OMV Petrom. The building was designed to support the local community not only functionally, but also through the values it promotes (using environmentally friendly, local, available and accessible materials for the community, along with innovative materials, local building techniques, resource saving, energy efficiency , the practice of permaculture, etc.) and through the construction process, in which people from the community actively engaged in the execution phase of the building participated.

Building designed according to the most rigorous sustainability standard, Living Building Challenge, has a closed water circuit (uses water from its own well, reuses rainwater and treats toilet water, turning it into decontaminated and composted water) and produces more energy than it consumes.

TECHNICAL DATA

Gross area: 225 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	✓
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	✓
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓
Occupants satisfaction - % satisfied people	
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	✓
Occupants satisfaction - % satisfied people	

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TOwards a Regenerative Economy

CLIENT / OWNER / INVESTOR

CERC Boldești Scăeni

Funding: OMV Petrom

PROJECT TEAM

ADP architecture
Inginerie creativa
DAS engineering & STC proiect
Habitat for Humanity Romania

COMPLETION YEAR
2015

AWARDS

2016 - Romanian Building Awards

2015 - Bienala de Arhitectură din Transilvania (BATRA)

ACOUSTIC ENVIRONMENT
Background noise level - Noise criteria (NC)
Occupants satisfaction - % satisfied people

HUMAN VALUES
External view and Right to light - % workstations with windows access ✓

REGENERATIVE TECHNOLOGY #1

PV system

Classification of the technology: Active

Effects/improvements on indoor environment of the case study
PV system specified to cover all the electricity needs of the building. Helps on reducing the NOx emissions in the area

Sustainability level: Regenerative

Detailed description of technology: Standard PV system, no battery/storrage.

Possible providers of technology: multiple

REGENERATIVE TECHNOLOGY #2

Strawbales & lime mortar

Classification of the technology: Passive

Effects/improvements on indoor environment of the case study
Reduced TVOC & formaldehyde emissions, good insulation.

Sustainability level: Regenerative

Detailed description of technology: standard strawbales flooring, walls and roof with wooden battens and finished with natural plaster

Possible providers of technology: multiple

LINKS AND REFERENCES

https://www.adp.ro/cercboldestiscaeni/
https://www.facebook.com/CERCBoldestiScaeni/

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Detached House


Photo credits: Kutia studio

LOCATION

Prishtina, Kosova (42°37'17.6"N 21°09'36.2"E)

CLIMATE ZONE

(according to KFICAT)
(Dfb/Dwb/Dsb: Warm summer continental or hemiboreal climates)

BUILDING TYPOLOGY

- **R** **Residential**
- O Office
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL

- C Conventional — ***Building as usual***
- S Sustainable — ***Limiting impact.*** *The balance point where we give back as much as we take*
- **RS** **Restorative** — *Restoring social and ecological systems* ***to a healthy state***
- RG Regenerative — *Enabling social and ecological systems to maintain a healthy state* ***and to evolve***

It is a detached house in the suburbs of Prishtina (Kosova). It is a newly built building consisting of a ground floor and first floor with a total area of 317 m2. The ground floor is a combination of a garage (unconditioned space), living room, kitchen and dining room (conditioned space), while the first floor revolves around 3 bedrooms, an office, sauna and laundry (conditioned). The building is insulated with 20cm EPS along with highly efficient windows. The south and west ventilated façade is used to cool down the walls from over-heating. The building is correctly opened towards south, with a living room having a gallery-like double floor, which enabled a passive solar gain. Heating is made through heat-pump combined with floor-heating and a reservoir. To ensure the high air quality, mechanical ventilation with heat-recovery unit is installed. All light bulbs are LED, and all equipment is of A category. Building provides a qualitative indoor environment with a low amount of active energy used.

TECHNICAL DATA

Gross area: 317 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	✓
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓
Occupants satisfaction - % satisfied people	✓
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	✓
Occupants satisfaction - % satisfied people	
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	
Occupants satisfaction - % satisfied people	
HUMAN VALUES	

COST EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY
COST is supported by the EU Framework Programme Horizon 2020
More information: http://www.eurestore.eu/

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External view and Right to light - % workstations with windows access ✓

REGENERATIVE TECHNOLOGY #1

DOUBLE FLOOR WINDOWS ON SOUTH FACADE

Classification of the technology: Passive

Effects/improvements on indoor environment of the case study
This technology was chosen to passively increase the indoor air temperature during winter and allow deeper light penetration while also enabling better external views. It is also used to improve the air quality through natural light acting as disinfectant. The living room measured temperature is 1-2 degrees higher than in the other rooms.

Sustainability level: Restorative

Detailed description of technology: The living room, has the height of 6m. The double set of windows are 4.5m wide and 2.2 high. They are formed of INOUTIC frame and low-e triple glazed glass. Electric blinds prevent over-heating during summer.

STRENGTH MEASURE OF EFFECTS *(optional if available)*
The penetrating high sunrays of east are reflected on the upper-floor office glass, increasing natural light quantity and increasing the dynamic feeling with light coming from different angles. This building is ready for certification system, probably as an NZEB.

Possible providers of technology: PROTEC and INOUTIC

REGENERATIVE TECHNOLOGY #2

HEAT RECOVERY UNIT WITH MECHANICAL VENTILATION

Classification of the technology: Active/passive

Effects/improvements on indoor environment of the case study
This technology was chosen to increase the ventilated air temperature during the winter while saving energy and by this increasing the comfort level.

Sustainability level: Restorative

Detailed description of technology: The ventilation system is spread in the whole building, except in the storage room. In winter, the temperature of exhausted air in kitchen and bathrooms, is transferred to the supplied air, warming the outdoor filtered air. In summer, the heat-exchange feature is turned off, so the outdoor air supplied during night with a temperature of 20-21°C cools down the indoor air, almost passively. It has the air flow range of 70-460m³/h, heat recovery rate of 87% and Specific electric power of 0.24 Wh/m³. The ISO ePM1 >55% (F7) filters helps to reduce fine pollen and carbon black particles in

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CLIENT / OWNER / INVESTOR
Building owner

PROJECT TEAM
Kutia Studio:
Tringa Ferri,
Rudina Qerimi

COMPLETION YEAR
2016

the supply air, however additional filtration such as NOx filters may be required. It is certified by Passive House Institute.

Possible providers of technology: Zehnder.

REGENERATIVE TECHNOLOGY #3

HEAT PUMP & HEAT ACCUMULATION RESERVOIR WITH FLOOR HEATING

Classification of the technology: Active

Effects/improvements on indoor environment of the case study
This technology was chosen to increase the ventilated air temperature during the winter while saving energy and by this increasing the comfort level. The floor heating system was firstly combined with a furnace that ran on pellet. By changing it to heat-pump in winter 2019, the costs were cut by 65%.

Sustainability level: Restorative

Detailed description of technology: The indoor temperature is 23-23.5°C during the winter season. The water temperature used for heating is 35°C. Only when higher flow temperatures are required, especially on cold winter days, does the existing gas or oil boiler need to be used to cover the additional demand. Because its operation can be reversed with an additional convection unit, it can and will also be used to cool living space on hot summer days, by cooling floors by 3-4°C. In this way, the heat/water pump ensures pleasant temperatures all year round.

Possible providers of technology: Viessmann, Rehau.

ACKNOWLEDGEMENTS
Contributors would like to acknowledge the building owners and Kutia studio for offering the information.

LINKS AND REFERENCES

Kutia studio official
https://www.instagram.com/p/BfxznifhURn/

Heat-pump features Viessmann Vitocal 200-s
https://www.heizungsdiscount24.de/waermepumpen/viessmann-vitocal-200-s-luftwasser-waermepumpe-147-kw-awb-e-ac-201d16-400.html

Heat-recovery unit features Zehnder ComfoCool Q600 ST
https://www.zehnder.co.uk/products-and-systems/comfortable-indoor-ventilation/system-extensionsystem-extensionsystem

Interview with owner and architect Rudina Qerimi

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TOwards a Regenerative Economy

KAPSARC

LOCATION
Airport Road, King Khalid International Airport, Riyadh 13416, Saudi Arabia

24.873130, 46.719361

CLIMATE ZONE
(according to KFICAT)
BWh

BUILDING TYPOLOGY

- R Residential
- O **Office**
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL

- C Conventional
- S **Sustainable**
- RS Restorative
- RG Regenerative

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TOwards a Regenerative Economy

KAPSARC (King Abdullah Petroleum Studies and Research Center) is a LEED platinum research center designed by Zaha Hadid Architects to accommodate a facility that researchers new sources of energy.

TECHNICAL DATA

Gross area: 70.000 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/airspeed - Standard Effective Temperature (SET)	✔
Occupants satisfaction - % satisfied people	
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	
Occupants satisfaction - % satisfied people	
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	✔
Occupants satisfaction - % satisfied people	
HUMAN VALUES	
External view and Right to light - % workstations with windows access	

REGENERATIVE TECHNOLOGY #1

Shape form-finding: The courtyard shape

Classification of the technology: Passive

Effects/improvements in the indoor environment of the case study
Due to severe weather conditions (during the hottest days the temperature above 40 degrees is observed) the shape (and morphology) of the building has to be adjusted. The C-shape patios and large canopies were designed the minimize radiation on the facade (heat gain). The initial studies provided by the engineer (ARUP) showed that up to 45% energy needed for air-conditioning could be saved in comparison to the non-optimized option.
Sustainability level: Sustainable

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TOwards a Regenerative Economy

A detailed description of technology: A 45% reduction in the energy performance (compared to the ASHRAE baseline standards) achieved via KAPSARC's building massing and orientation, façade optimization, system selection and the solar PV array located on the roof of the south-facing Conference Centre with a capacity of 5,000MWh/year.

Possible providers of technology: Seele - facade (PV panels embedded) provider

REGENERATIVE TECHNOLOGY #2

All KAPSARC's potable water is recycled and reused on-site and 100% of irrigation water is from non-potable sources.

CLIENT/OWNER/INVESTOR

Aramco (Saudi Arabian Oil Company)

PROJECT TEAM

Zaha Hadid, Patrik Schumacher, Lars Teichmann, Charles Walker, DaeWha Kang

Fabian Hecker, Michael Powers, Brian Dale / Henning Hansen, Fulvio Wirz, Elizabeth Bishop, Saleem A. Jalil / Maria Rodero, Lisamarie Ambia/Judith Wahle, Bozana Komljenovic, John Randle, John Szlachta

Adrian Krezlik, Alexander Palacio, Amdad Chowdhury, Amit Gupta, Andres Arias Madrid, Britta Knobel, Camiel Weijenberg, Carine Posner, Claire Cahill, Claudia Glas-Dorner, DaChun Lin, Daniel Fiser, Daniel Toumine, David Doody, David Seeland, Deniz Manisali, Elizabeth Keenan, Evan Erlebacher, Fernanda Mugnaini, Garin O'Aivazian, Giorgio Radojkovic, Inês Fontoura, Jaimie-Lee Haggerty, Jeremy Tymms, Julian Jones, Jwalant Mahadevwala, Lauren Barclay, Lauren Mishkind, Mariagrazia Lanza, Melike Altinisik, Michael Grau, Michael McNamara, Mimi Halova, MohammadAli Mirzaei, Mohammed Reshdan, Muriel Boselli, MyungHo Lee, Nahed Jawad, Natacha Viveiros, Navvab Taylor, Neil Vyas, Nicola McConnell, Pedro Sanchez, Prashanth Sridharan, Roxana Rakhshani, Saahil Parikh, Sara Saleh, Seda Zirek, Shaju Nanukuttan, Shaun Farrell, Sophie Davison, Sophie Le Bienvenu, Stefan Brabetz, Steve Rea, Suryansh Chandra, Talenia Phua Gajardo, Theodor Wender, Yu Du

Engineering: Arup
Interior Design: Woods Bagot
Landscape Design: GROSS.MAX
Lighting Design: OVI
Catering and Kitchen Design: Eastern Quay and GWP
Exhibition Design: Event
Artwork: International Art Consultants
Branding and Signage: Elmwood and Bright 3d

Library Consulting: Tribal
Cost Consulting and Design Project Management: Davis Langdon
Photography: ® Hufton+Crow

COMPLETION YEAR

2017

AWARDS

LEED Platinium (USGBC)
Archdaily Building of the Year
SMARTEST- Honeywell Smart Building Awards

FURTHER LINKS
https://www.usgbc.org/projects/kapsarc-iconic-energy-research-center

ADDITIONAL INFORMATION

40% of KAPSARC's construction materials have been sourced from within 500 miles, and 30% of materials made with recycled content.

98% of all wood certified by the Forest Stewardship Council (FSC).

4,000 tonnes of waste separated and diverted from landfills.

-

Also according to the LEED Report the following requirements regarding Indoor Environmental Quality were met:

EQc1	Outdoor air delivery monitoring
EQc2	Increased ventilation
EQc3.1	Construction IAQ management plan - during construction
EQc3.2	Construction IAQ management plan - before occupancy
EQc4.1	Low-emitting materials - adhesives and sealants
EQc4.2	Low-emitting materials - paints and coatings
EQc4.3	Low-emitting materials - carpet systems
EQc4.4	Low-emitting materials - composite wood and agrifiber products
EQc6.1	Controllability of systems - lighting
EQc6.2	Controllability of systems - thermal comfort
EQc7.1	Thermal comfort - design
EQc7.2	Thermal comfort - verification

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70 Wilson

BEFORE

AFTER

Photo credits: © Will Pryce

LOCATION

70 Wilson Street, London EC2A 2DB
United Kingdom
(51° 31' 18.49"N -0° 5' 3.62"W)

CLIMATE ZONE

(according to KFICAT)
(Cfb – Oceanic Climate)

BUILDING TYPOLOGY

- R Residential
- **O Office**
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL

- C Conventional — ***Building as usual***
- S Sustainable — ***Limiting impact.*** *The balance point where we give back as much as we take*
- **RS Restorative** — *Restoring social and ecological systems* ***to a healthy state***
- RG Regenerative — *Enabling social and ecological systems to maintain a healthy state* ***and to evolve***

This former 1980s office building, and an adjacent Grade II listed building were refurbished and extended in collaboration with Low Carbon Workplace (Columbia Threadneedle Investments, Stanhope and The Carbon Trust) to create a highly efficient, future-proof office space based on low carbon standards. To achieve such a striking result within budget, the net floor area was increased by 25% through rationalising the existing floor layouts and adding a two-storey steel-framed roof extension. The new envelope is designed to respond to the site's orientation and the adjacent building's massing; the patinated copper cladding makes the building a distinctive contemporary warehouse whilst keeping with the surrounding red brick buildings. The result is a building that performs as well as an equivalent new building.

TECHNICAL DATA

Gross area: 7091 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	✓
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓
Occupants satisfaction - % satisfied people	
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	✓
Occupants satisfaction - % satisfied people	
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	
Occupants satisfaction - % satisfied people	
HUMAN VALUES	
External view and Right to light - % workstations with windows access	✓

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CLIENT
Low Carbon Workplace: Stanhope, Threadneedle & The Carbon Trust

PROJECT TEAM
Architects: Astudio (Project team: Richard Hyams, Nick Gazanis, Lucia Da Villa, Emma Flynn, Sarah Ho, Christian Kerrigan, Max Rengifo, George Brennan, Gosia Cirko, Stavri Rousounidou, Ben Lee, Ronald Lammerts van Bueren, Lara Behmoaram de Toledo, Kate Millen)

Structural Engineers: Heyne Tillett Steel

Environmental / M&E Engineers: Thornton Reynolds

Quantity Surveyor / Cost Consultant: Gleeds

Facade Engineers: Eckersley O'Callaghan

Contractor: Willmott Dixon

COMPLETION YEAR
2016

REGENERATIVE TECHNOLOGY #1

CONDENSER LOOP

Classification of the technology: Passive/Active

Effects/improvements on indoor environment of the case study: This technology was chosen for energy saving and to improve the hygro-thermal environment, providing specific thermal conditions to different thermal zones ad occupants requirements.

Sustainability level: Restorative

Detailed description of technology: The building is heated and cooled via a common 'condenser loop' throughout the building that shares the heat rejection and heat absorption across condensers within the building. If the loop needs to reject heat, it does so through dry coolers on the roof, dissipating heat to the outside air. Should the loop need heating up, then boilers add heat to this loop. Condensers connected to this loop heat or cool areas within the building to suit the needs of that particular zone, through fan coil units blowing warm or cool air accordingly.

REGENERATIVE TECHNOLOGY #2

SOLAR CONTROL: GLAZING COATING AND SHADING

Classification of the technology: Passive

Effects/improvements on indoor environment of the case study: This technology was used to reduce unwanted solar heat gain, still allowing daylight and visual comfort.

Sustainability level: Sustainable

Detailed description of technology: Facade glazing was designed taking in consideration orientation and greater exposure to unwanted solar gain at higher height. In sunny areas, especially on the south and west-facing upper floors, solar control coating on glazing bounces heat off the building – preventing overheating, whilst letting light penetrate. Increased shading („intelligent blinds") on glazing further up the building prevent overheating. Shaded areas with low emissivity coating on the glazing act like a thermos and keep warmth inside.

REGENERATIVE TECHNOLOGY #3

LOW CARBON WORKPLACE with SENSORS MONITORING

Classification of the technology: Passive and Control

Effects/improvements on indoor environment of the case study: A comprehensive installation of energy sub-metering and thermal occupancy sensors allowed the Carbon Trust to provide detailed support to the occupants about their energy use and building utilisation and ensure that the building is operating at optimal efficiency in line with best practice emissions performance levels applied across the LCW portfolio. High efficiency lighting is installed throughout with daylight dimming and presence detection using PIR sensors, minimising energy

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AWARDS

Achieved:

- *BREEAM Excellent*
- *EPC: 30 (B)*

Won:

- *RIBA London Award 2018*

Shortlisted:

- *RICS Award*
- *BCO Award*

use and additional heat gains. Sensors also control and adapt temperature and ventilation when a space is not in use, for overall energy saving and improved occupants' wellbeing.

Sustainability level: Restorative

Detailed description of technology: From an early stage, design focused on working with the existing structure to minimise unnecessary work, reduce build costs and embodied carbon. Two additional floors required minimal strengthening works. Design supported a wide range of mostly passive and some active Low Carbon Workplace measures, metering and monitoring. Passive measures adopted are thermal mass, natural lighting and ventilation, insulation, façade glazing and solar shading. Active measures minimise emissions from mechanical and electrical systems and gather data to enable on-going performance management; intelligent heat recovery, energy-efficient HVAC and lighting, infrared sensors and controls, gas and electricity sub-meters to thermal imaging occupancy sensors.

STRENGTH MEASURE OF EFFECTS: **H**eyne Tillett Steel embodied carbon assessment for the structural design showed that demolitions and structural work equates to 66KGCO2/m2 of the development, 25% of that of a typical commercial development. EPC reached a B certificate from the previous E.

REGENERATIVE TECHNOLOGY #4

BIODIVERSITY, HUMAN COMFORT AND SOCIALITY

Classification of the technology: Passive

Effects/improvements on indoor environment of the case study: Measures were taken to support sustainable commuting, views out and human health, to enhance biodiversity, foster productivity, human wellbeing and sociality.

Sustainability level: Regenerative

Detailed description of technology: Car parking space were replaced with extensive bike storage and shower/changing areas to facilitate sustainable commuting and occupants health, green roofs and terraces incorporate native plant species to enhance biodiversity, and, with the internal café, also enhance productivity and wellbeing providing inspiring spaces to relax, meet or work and external views to approximately 80% of the indoor work space.

ACKNOWLEDGEMENTS

Contributors would like to acknowledge Astudio architects, Thornton Reynolds Environmental / M&E Engineers, and Heyne Tillett Steel structural engineers, the Carbon Trust and Jonathan Winston, Occupier Support Manager, for the information provided.

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National Headquarters E.ON ROMANIA

Photo credits: www.inmures.ro

LOCATION
44-46 Pandurilor Blvd, Tg. Mureș, Mureș County, Romania
Lat 46.5331931
Lon 24.5723319

CLIMATE ZONE
(according to KFICAT)
Humid continental climate – warm summer subtype

BUILDING TYPOLOGY

- R Residential
- **O Office**
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL

- **C Conventional** — *Building as usual*
- S Sustainable — *Limiting impact. The balance point where we give back as much as we take*
- RS Restorative — *Restoring social and ecological systems to a healthy state*
- RG Regenerative — *Enabling social and ecological systems to maintain a healthy state and to evolve*

The building serves the administrative offices for the company E.ON Romania, being located in Tg. Mureș. The building has a height above ground of 38 m, with a height regime of 12 levels (2 basements, ground floor, 8 floors and 1 withdrawn floor). The construction is provided with a 144-seat canteen.

TECHNICAL DATA

Gross area: 18270 sqm | Net area: 13051 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓
Occupants satisfaction - % satisfied people	
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	
Occupants satisfaction - % satisfied people	
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	
Occupants satisfaction - % satisfied people	
HUMAN VALUES	
External view and Right to light - % workstations with windows access	✓

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CLIENT / OWNER / INVESTOR
Client:
E.ON Romania
Investor:
RCB DEVELOPMENT & CONSULTING & ERSTE GROUP IMMORENT

PROJECT TEAM
WESTFOURTH ARCHITECTURE SRL – Architecture

POPP & ASOCIATII CONSULTING ENGINEERS – Structure

MC GENERAL CONSTRUCT SRL – Building services

BOG'ART – General Contractor

COMPLETION YEAR
2015

AWARDS
3RD PRIZE AICPS 2016 POPP & ASOCIATII CONSULTING ENGINEERS – (for structure)

REGENERATIVE TECHNOLOGY #1

MECHANICAL VENTILATION WITH HEAT RECOVERY / 7 AHU GEA CAIRplus + 3 AHU ATPicco GEA

Classification of the technology: ~~Passive~~/Active/Control

Effects/improvements on indoor environment of the case study
Considering the destination of the building, is was mandatory to provide mechanical ventilation, in order to ensure the physiological comfort of the occupants and to ensure a proper hygro-thermal environment. By using this type of solution and considering the heat recovery with which ventilation equipment are provided, the heat loss from ventilation is controlled and reduced, which it will take to thermal and electrical energy consumption reduction. The specific electrical energy consumption for mechanical ventilation for these 10 AHUs is 13.92 kWh/sqm year. The reduction of air flow due to the existence of heat recovery compared with the same equipment without heat recovery is of 51.39% during winter, respectively 51.89% during summer (air flow which actually the occupants of the building enjoy, without being consumed energy for it to be heated/cooled).

Sustainability level: ~~Regenerative~~/ ~~Restorative~~/ Sustainable/ ~~Conventional~~

Detailed description of technology:
The total air flow supply provided by the 10 AHU equipment is 97404 m^3/h and the exhaust air flow is 70361 m^3/h. The equipment is provided with heating coils and cooling coils, in order to pre-heat or pre-cool the outdoor air. The equipment is provided with heat recovery with a calculated yield for each AHU, in a range between 20% - 80% (with 80% and 70% for AHU1 and AHU2 which provide 51% of the total air flow supply) in the winter, respectively a range between 26% - 59% of the yield for the summer (with 59% and 51% for AHU 1 and AHU2, which provide 58% of the total exhaust air flow). Mechanical ventilation is connected to and controlled by a BMS.
AHU models: AHU1 - GEA CAIRplus SX160, 160AVBV; AHU2 - GEA CAIRplus SX188, 160IVBV; AHU3 - GEA CAIRplus SX096.096AVBV; AHU4 - GEA CAIRplus SX128.040IVBV; AHU5 - GEA CAIRplus SX096.128IVBV; AHU6 - GEA CAIRplus 096.096IVBV SX; AHU9 - GEA CAIRplus 096.128IVBV SX; AHU07, AHU08, AHU10 – ATPicco GEA.

STRENGTH MEASURE OF EFFECTS
A proper hygro-thermal environment is ensured due to this solution, which optimize the functioning of other systems (heating and cooling systems), by reducing heating / cooling demand.

STRENGTH-WEAKNESS ANALYSIS OF THE TECHNOLOGY
Unfortunately, not all AHU have a high value of the heat recovery efficiency, with direct effect in the energy consumption of the building. All AHUs of which yield is less than 70% cannot be considered high efficient equipment, being rather conventional technology.

Possible providers of technology: GEA

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REGENERATIVE TECHNOLOGY #2

CURTAIN WALLS WITH DIFFERENT LOW-EMISSIVITY VALUES / SAINT GOBAIN GLASS

Classification of the technology: Passive/~~Active~~/~~Control~~

Effects/improvements on indoor environment of the case study
The façades are mainly curtain walls, which ensures optimal natural lighting conditions. To reduce the thermal load of air conditioning system for the façades are used different low-emissivity coatings. The glazing packages used into the curtain walls have light transmission characteristics, thermal resistance and solar factor according to the requirements of an office building. Compared with another office building with traditional façade, it is ensured a higher number of workstations with windows access, offering increased comfort for occupants in terms of external view and right to light.

Sustainability level: Regenerative/ ~~Restorative~~/ ~~Sustainable~~/ ~~Conventional~~

Detailed description of technology:
Types of glazing packages for curtain walls identified on-site:

- *Type 1* SG KN166 08+BA+8mm sec, 20 mm Argon 90%, Duplex 44.2, g = 0.38, U_g = 1.1 W/m²K;
- *Type 2* Cool Lite KN166 II 8mm,16 mm Argon 90%, Planiclear 55.2, g = 0.38, U_g = 1.0 W/ m²K;
- *Type 3* Planiclear 6mm, 20 mm Argon 90%, Planitherm XN low-e Duplex 44.2, g = 0.63, Ug = 1.1W/m²K;
- *Type 3 var* Planiclear 8mm, 20 mm Argon 90%, Planitherm XN low-e Duplex 44.2, g = 0.62, Ug = 1.1W/m²K;
- *Tip 4* Parsol Grey, 14 mm Argon 90%, PlanithermXN low-e Duplex 44.2, g = 0.29, Ug = 1.1W/m²K.

STRENGTH MEASURE OF EFFECTS
Such an approach allows to optimize solar heat gains in correlation with the orientation of the façade, with a direct effect in the heating/cooling demand and, subsequently, in the reduction of building energy consumption.

STRENGTH-WEAKNESS ANALYSIS OF THE TECHNOLOGY
It is noticed a lower thermal performance in terms of U –values, because of the actual limits of the technology compared with a traditional façade.

Possible providers of technology:
Saint Gobain

ACKNOWLEDGEMENTS
The results presented in this paper were obtained through the development of the energy performance certificate, commissioned by S.C. RCB DEVELOPMENT OFFICE S.A. – assigned energy auditor Ancuța Maria Măgurean.

LINKS AND REFERENCES – N/A.

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Greenpeace Spain Headquarters

Photo credits: Andrés Valentín-Gamazo

LOCATION
C/ Valores 1, 28007 Madrid (Spain)
(40º 24´51.9"N 3°40'04.0" W)

CLIMATE ZONE
***Csa**-Mediterranean hot summer climate*

BUILDING TYPOLOGY

- R Residential
- **O Office**
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL

- C Conventional — *Building as usual*
- S Sustainable — ***Limiting impact.*** *The balance point where we give back as much as we take*
- **RS Restorative** — *Restoring social and ecological systems to a healthy state*
- RG Regenerative — *Enabling social and ecological systems to maintain a healthy state **and to evolve***

This new headquarters sited in Madrid (Spain) reinforces Green Peace core values and It´s a nearly 1000 sq m2 mid-low budget fit-out, that hosts a 90 employees working-space (production area) and a flexible public area (action zone). The design project, won by a restricted competition, dealed with taking the maximum advantage of daylighting of a semi-basement space and two starting premises setting by the client: use of PVC-free materials and a chlorofluorinated refrigerant-free air conditioning system. The materials were subjected to a LCA and to an IAQ impact assessment. Carbon emissions resulting were offset through a reforestation project. A geo-environmental health analysis has been also conducted to propose measures that generate the best relationship between people and space.

TECHNICAL DATA

Gross area: 943 sqm
Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde 24ug/m3 monitored 2 months after the construction phase.	✓
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓
Occupants satisfaction - % satisfied people	
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	
Occupants satisfaction - % satisfied people	
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	
Occupants satisfaction - % satisfied people	
HUMAN VALUES	
External view and Right to light - % workstations with windows access	

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CLIENT / OWNER / INVESTOR
GREENPEACE SPAIN

PROJECT TEAM
sAtt Triple Balance

COMPLETION YEAR
2019

AWARDS
Sustainable Renovation Grand Prize of the 2019 Green Solutions Awards

REGENERATIVE TECHNOLOGY #1

DOUBLE-FLOW CONTROLLED MECHANICAL VENTILATION WITH HEAT RECOVERY

Classification of the technology: Active

Effects/improvements on indoor environment of the case study
This technology was chosen to improve indoor air quality, and therefore health and comfort of people. It also creates a more efficient ventilation system by reducing energy consumption and minimizing heat loss

Sustainability level: Restorative

Detailed description of technology: This technology has filtration units that clean the air of particles, guaranteeing the quality of the indoor air and supply the room with fresh filtered fresh air with a sufficient flow rate and proportionally adjustable. At the same time, this equipment aspirate an equivalent volume of stale air, loaded with CO_2, and eliminate it as evacuated air. This also effectively eliminates other harmful substances, such as odours, fine powders, moisture, etc. Heat recovery takes place by means of a corrosion-resistant rotary heat recuperator with heat recovery factors of up to 90% and moisture recovery factors of up to 90%, reducing considerably the primary energy costs of the heating installation

STRENGTH MEASURE OF EFFECTS

In this technology, the Joule effect is used, by means of electrical resistors coupled to the ventilation ducts. Despite not being in itself an efficient system (COP = 1), the Passive Building (envelope insulation and sun protection) + Joule Effect assembly is, providing a lower electrical consumption for heating than the existing installations based on a heat pump. The heat needs are minimized by taking into account the insulation, heat of equipment and people together with the heat recovered.

STRENGTH-WEAKNESS ANALYSIS OF THE TECHNOLOGY

Controlled mechanical ventilation is the most effective way to combat the accumulation of biological, chemical and radioactive contaminants. Double flow with heat recovery can help to keep “interior climate” at a constant level and to heat bills and carbon emissions by reclaiming and redistributing the heat into the property which would have been wasted if a traditional system had been used instead. (In some conditions, energy recovery wheels can reduce the energetic demand of conditioning incurrent air by up to 95% (Fischer 1998)).

Possible providers of technology: Wolf Ibérica (Md CRL 4800 iH. RWT rotary recuperator were used in this project)

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REGENERATIVE TECHNOLOGY #2

INDIRECT EVAPORATIVE COOLING SYSTEM

Classification of the technology: Active

Effects/improvements on indoor environment of the case study
This technology was chosen in first place to avoid the classic air conditioning systems that use chlorofluorinated gases with a high impact on climate change. In addition, this system maintains a good hygro-thermal comfort , generating 80% savings to conventional systems and a better air quality when filtered. (in synergy with technology #1)

Sustainability level: Sustainable

Detailed description of technology: The solution is based on indirect evaporative equipment (the direct equipment initially designed, finally was not installed) and It uses water evaporation to reduce the air temperature, without increasing the absolute humidity. In this case study, the efficiency of the cooling system (supported by 8 units located in a “cold” area) has been prioritized over heat production. In evaporative systems, the thermal efficiency is optimal since its electrical consumption corresponds to the fans of the equipment , estimated to an installed electrical power of less than 10 kw for the whole project. (The energy used is 100% renewable and own origin through a windmill installed in Catalonia)

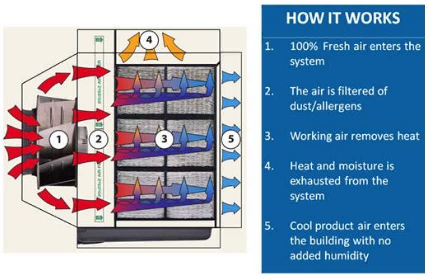

Photo credits: Coolerado

STRENGTH MEASURE OF EFFECTS
For the design of the air conditioning system, the context of climate change has been taken into account, estimating the rise in temperatures over the next 20 years. Therefore, the efficiency of cooling systems has been prioritized over heat production.
Working in synergy with technology #1 improves a better indoor air quality.

STRENGTH-WEAKNESS ANALYSIS OF THE TECHNOLOGY
The benefits and advantages of an evaporative cooler include inexpensive price and lower energy consumption (about one third of an conventional AC), an easier and /inexpensive installation and maintenance (compared to traditional air conditioners) and suitability for use in dry and arid climates, especially during hot and dry weather condition Evaporative coolers can be also retrofitted to existing air conditioning systems.
The disadvantages of an evaporative cooler centers primarily on the negative impacts of too much humidification if It´s not controlled.

Possible providers of technology: Wolf Ibérica (Mod Coolerado M50 used in this project)

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TOwards a Regenerative Economy

ACKNOWLEDGEMENTS

Contributors would like to acknowledge to Jesus Soto from Altertech Thermal consultancy agency, for providing information about the evaporative technology

LINKS AND REFERENCES

Suárez Pardo, P 2019. , *"Greenpeace Spain Headquarters", Construction21, accessed 17 January 2020.* *<https://www.construction21.org/case-studies/es/greenpeace-spain-headquarters.html>*

[Construction21]. (2019, Nov 4). *"Greenpeace Spain Headquarters- Green Solution Awards 2019"* [Video File]. Retrieved from *<https://www.youtube.com/watch?v=T9EVaFrswd8>*

C21 France la redaction, 2019. , *"Greenpeace Spain Headquarters- exemplary renovation, Spain-Green Solution Awards 2019 Winner", Construction21, accessed 17 January 2020.* *<https://www.construction21.org/articles/fr/greenpeace-spain-headquarters-exemplary-renovation-spain-green-solutions-awards-2019-winner.html>*

Babota , F 2014. , *"Mechanical ventilation systems with heat recovery for refurbishment projects and new building",* Bulletin of the Polytechnic Institute of Jassy, Constructions. Architecture Section. 60. 39-50.Accessed 19 January 2020 *<https://www.researchgate.net/publication/327941192_MECHANICAL_VENTILATION_SYSTEMS_WITH_HEAT_RECOVERY_FOR_REFURBISHMENT_PROJECTS_AND_NEW_BUILDINGS>*

Khayal, Osama. (2019)." *Uses , advantages and limitations of evaporative coolers". 10.13140/RG.2.2.19137.92004.* accessed 19 January 2020 *https://www.researchgate.net/publication/336550266_USES_ADVANTAGES_AND_LIMITATIONS_OF_EVAPORATIVE_COOLERS*

Comfort thermal wheel heat exchanger ventilation unit CRL-ID/IH for indoor installation, Wolf specifications: *<https://www.wolf.eu/en/air-handling-expert/products-systems/compact-units/crl/crl-idih/>*

Coolerado, M50 specifications: *https://www.seeleyinternational.com/us/artefact/coolerado_indirect-feac_2pp_m50_cl0002_1216_revb_us_final_web/*

Alonso I , Satt founder. Greenpeace Spain Headquarters talk , 18 Sept 2019, REBUILD2019, Advanced Architecture and Construction 4.0 Congress. Ifema , Madrid *https://www.rebuildexpo.com/rebuild/*

RESTORE

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LOCATION

Via Torino, 155, 30172 Venezia Italy
45°28'41.8"N 12°15'16.1"E

CLIMATE ZONE

(according to KFICAT)
Cfa

BUILDING TYPOLOGY

- **R** Residential
- **O** **Office**
- **E** Education
- **L** Lodging
- **RS** Retail/Services

SUSTAINABILITY LEVEL

- **Conventional** — ***Building as usual***
- Sustainable — ***Limiting impact.*** *The balance point where we give back as much as we take*
- Restorative — *Restoring social and ecological systems* ***to a healthy state***
- Regenerative — *Enabling social and ecological systems to maintain a healthy state* ***and to evolve***

Ca' Foscari - Palazzo Alfa

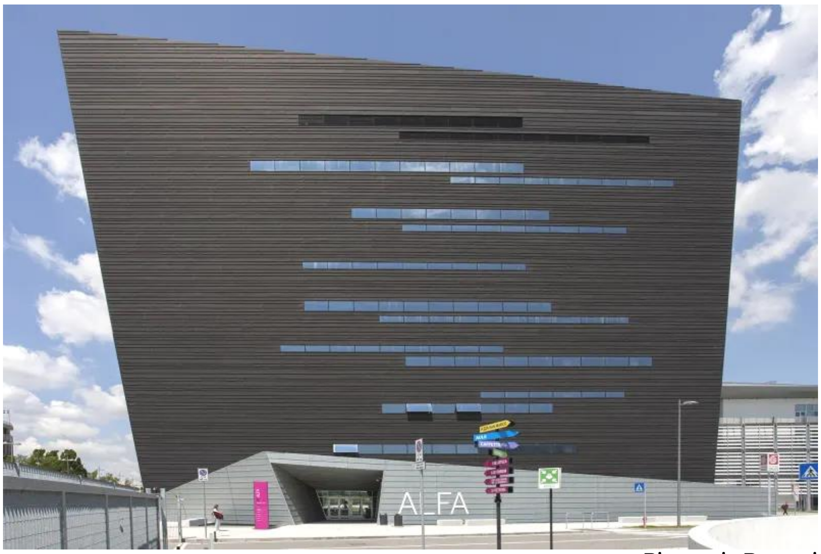

Photo credits: Piermario Ruggeri

Building consists from 2 solids: narrow higher solid with all technical facilities (stairs, hallway, elevators...) covered with black metal façade on south side, small stripes of windows and cubic solid with offices behind, glazed with horizontal aluminum shading lamellas. Library is distributed from the basement to the second floor. On rest of the floors are scientific departments.

TECHNICAL DATA

Gross area: 8000 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	✓
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓
Occupants satisfaction - % satisfied people	
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	✓
Occupants satisfaction - % satisfied people	
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	✓
Occupants satisfaction - % satisfied people	
HUMAN VALUES	
External view and Right to light - % workstations with windows access	✓

REGENERATIVE TECHNOLOGY #1

PAINT METAL FAÇADE WITH TiO_2 PAINT (SRI > 29)

Classification of the technology: Passive

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CLIENT / OWNER / INVESTOR
Università Ca' Foscari Venezia

PROJECT TEAM
yellow

COMPLETION YEAR
2014

AWARDS

Effects/improvements on indoor environment of the case study: Cleaner and less warm air as an input to building's ventilation system and direct air exchange.

Sustainability level: Regenerative

Detailed description of technology: Paint contained TiO_2 with SRI > 29 decrease heat island effect around and can remove nitrogen oxides in the air through photocatalysis - rapid conversion of NO_x into harmless soluble nitrate salts which are removed from a building's surface by rainfall. NO_x levels can be reduced by between 15 and 38%

POSSIBLE PROVIDERS OF TECHNOLOGY:
https://tdma.info/the-buildings-that-clean-our-air/

REGENERATIVE TECHNOLOGY #2

IMPROVE INTERIOR WALL SURFACES (clay plaster, cocciopesto, plywood 2mm, green walls...)

Classification of the technology: Passive

Effects/improvements on indoor environment of the case study: Better regulation of humidity inside, connection to nature, better acoustics, traditional material.

Sustainability level: Regenerative

Detailed description of technology: The earth materials passively controlled moisture in the building, generally to below levels known to be a major cause of asthma and mould related disease. Natural colour of wood, clay and plants create biofilic effect. They can be used mainly in staircases improving echo effect and promote people to take stairs instead of lifts.

POSSIBLE PROVIDERS OF TECHNOLOGY:
https://heresitalia.com/prodotti/materie-prime/cocciopesto-naturale/

REGENERATIVE TECHNOLOGY #3

DESIGN MANUAL OF BUILDING

Classification of the technology: Active/Control

Effects/improvements on indoor environment of the case study: By clear labeling of building and showing users energy consumption, users will be include to be part of building and better orientation.

Sustainability level: Restorative

Detailed description of technology: Design manual will unite labeling on floors including lifts, stairs, lobby, signs, marks on door etc. Visual compelling way will show energy actual demand on each floors (f.e. colored moving bubbles sized according to data), showing weather conditions, level of dust...

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Hungarian Nest +

http://sde2019.hu/hungarian_nestplus_en.html

LOCATION
2000 Szentendre, Dózsa György út 26.
Hungary

CLIMATE ZONE
(according to KFICAT)
Dfb

BUILDING TYPOLOGY
(color and highlight the correct one)

- **R Residential**
- O Office
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL
(Optional - Please give your opinion about the sustainability level)

- C Conventional — *Building as usual*
- **S Sustainable** — ***Limiting impact.*** *The balance point where we give back as much as we take*
- RS Restorative — *Restoring social and ecological systems **to a healthy state***
- RG Regenerative — *Enabling social and ecological systems to maintain a healthy state **and to evolve***

The prototype building has been constructed for the Solar Decathlon 2019 in Szentendre, Hungary. The 2019 year's contest addresses a very current social problem for the Hungarian contestants: 800.000 outdated, physically amortised "Cube Houses" are waiting to make them meet the challenges of the 21st century. Solar Decathlon Europe 2019 is an exciting opportunity to demonstrate a quality-oriented direction for the sustainable development of the inherited architectural environment, and define new architecture directions. For this experiment, the simple consistent ideas of vernacular Hungarian architecture, the self-confidence of environmentally conscious thinking and high-tech applications of energy design must be combined. In addition to the development of the prototype, the project puts particular emphasis on green environmental integration and social integration. The Team has worked on a variety of solutions and technological innovations for this unique blend that allows different versions of the Hungarian Nest + to deliver a realistic solution for a sustainable, energy-conscious living, without ecological footprint.

TECHNICAL DATA

Gross area: 150 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	✓
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓
Occupants satisfaction - % satisfied people	
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	
Occupants satisfaction - % satisfied people	
ACOUSTIC ENVIRONMENT	

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CLIENT / OWNER / INVESTOR
Solar Decathlon Europe 2019

PROJECT TEAM
University of Miskolc, University of Pécs (Hungary) and Saad Dahlad University of Blida (Algeria)

COMPLETION YEAR
2019

AWARDS

Background noise level - Noise criteria (NC)
Occupants satisfaction - % satisfied people

HUMAN VALUES

External view and Right to light - % workstations with windows access

REGENERATIVE TECHNOLOGY #1

VENTURI TOWER

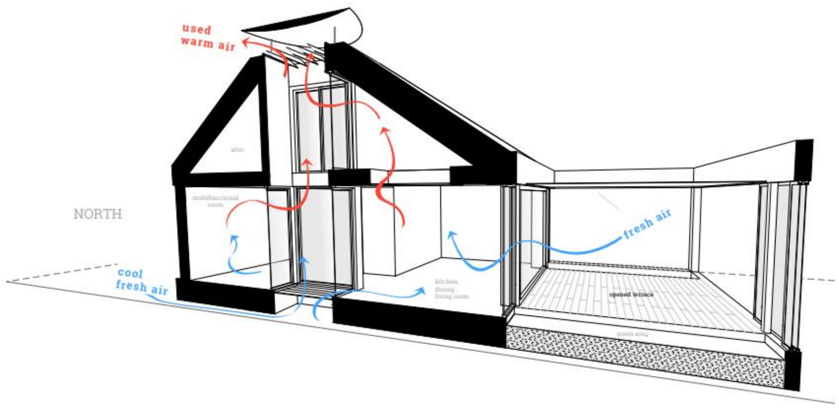
Classification of the technology: Passive

Effects/improvements on indoor environment of the case study
The technology were chosen to improve indoor air quality and thermal comfort by passive ventilation.

Sustainability level: Restorative

Detailed description of technology:

The solution consists of an underground air inlet and a solar atrium with a Venturi plate on top. This helps passive ventilation in summer, while in winter it makes internal sun exposure possible from the roof by the integrated mirrors.



REGENERATIVE TECHNOLOGY #2

INTERIOR ADOBE PLASTER
Classification of the technology: Passive

Effects/improvements on indoor environment of the case study
The natural material was chosen for interior passive humidity control and no VOC content to improve IAQ.

Sustainability level: Restorative

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Detailed description of technology:

The adobe plaster is capable to comply with the same technical specifications as a typical lime-cement based plaster. However, the adobe plaster is its 100% recyclable, easily maintained and capable of interior humidity control.

Possible providers of technology: Biokay

LINKS AND REFERENCES

http://sde2019.hu/hungarian_nestplus_en.html
http://www.someshineproject.hu/

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Bullit center

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More information: http://www.eurestore.eu/

LOCATION

Seattle, USA

1501 East Madison Street
Seattle, WA 98122

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CLIMATE ZONE

(according to KEIGAT)

Cfb

BUILDING TYPOLOGY

- R Residential
- **O Office**
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL

One of the most sustainable commercial building in the world

- C Conventional — *Building as usual*
- S Sustainable — ***Limiting impact.*** *The balance point where we give back as much as we take*
- RS Restorative — *Restoring social and ecological systems **to a healthy state***
- **RG Regenerative** — *Enabling social and ecological systems to maintain a healthy state and to evolve*

The Bullitt Center is a six-story commercial office building in the Central Area of Seattle, WA. The Center is home to a number of commercial office tenants who are successfully operating their businesses, while working in a net-positive energy environment. The Bullitt Center aims to advance the awareness and adoption of high-performance building through ongoing educational efforts, and by demonstrating that performance-based design works in a market-rate commercial project.

TECHNICAL DATA

Gross area: 4800 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	✓
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	✓
Occupants satisfaction - % satisfied people	✓
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓
Occupants satisfaction - % satisfied people	✓
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	
Occupants satisfaction - % satisfied people	✓
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	✓
Occupants satisfaction - % satisfied people	✓
HUMAN VALUES	
External view and Right to light - % workstations with windows access	✓

REGENERATIVE TECHNOLOGY #1

244 kW Photovoltaic Array

Classification of the technology: Active

Effects/improvements on indoor environment of the case study

It produes 152,877 kWh / year.
575 solar panels generate more energy than the building uses in a year.One energy-meter measures energy sold to electric utility, one measures energy purchased as the grid “stores” the extra energy produed during summer.

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CLIENT / OWNER / INVESTOR
Bullitt Foundation

PROJECT TEAM
Miller Hull

COMPLETION YEAR
2013

AWARDS
Living Building Certification; Net Zero Energy; Net Zero Water.

Sustainability level: Regenerative

Detailed description of technology: the designers realized that in Seattle, most of the sun is received in the summer, and the shallow-angled winter sun would not provide much benefit behind the blanket of clouds that shrouds our fair city during winter. The decision was made to optimize for summer, using the electrical grid as a battery to store power in the summer, and draw power from in the winter. The Bullitt Center energy budget shows how the summer surplus can offset a winter deficit.

STRENGTH MEASURE OF EFFECTS
In USA a typical office building operates at 92 EUI (Energy Use Intensity, which is comparable to American miles per gallon in a car). If the Bullitt Center had an EUI of 92, it would have needed an 18 sqm solar array on the roof to generate all of its energy from the sun. Instead, with the integration of energy saving systems, such as passive ventilation, ground source heat pump, and natural daylighting, along with the help of tenant energy budgets, the Bullitt Center is able to operate at an EUI of 16. With such a small EUI, the existing rooftop array is able to provide for all the electrical needs of the building.

STRENGTH-WEAKNESS ANALYSIS OF THE TECHNOLOGY
It's the synergy between passive active and control measure that realize the effectivness of this measure. It's not easy to do the same in every project, especially in residential because the initial investments cost.

Possible providers of technology: Viessmann, Tesla.

REGENERATIVE TECHNOLOGY #2

COMPOSTING TOILETS

Classification of the technology: Active/Passive

Effects/improvements on indoor environment of the case study
It uses 96% less water than flush toilets
Sustainability level: Regenerative

Detailed description of technology: Beside greywater and wastewater cutting edge technology, this multi storey buildings uses toilets that are a specially designed as waterless vessel that feeds into the basement composters through nearly completely vertical pipes. Once the cargo makes it all the way down, it begins a long aerobic process of decomposition in one of ten Phoenix Composting Systems, each about the size of a Volkswagen Beetle. The liquid and solid matter is mixed with wood chips and fluffed regularly using tines, or comb-like structures that can be turned using a special socket wrench.

STRENGTH-WEAKNESS ANALYSIS OF THE TECHNOLOGY
This solutions requires speific design, available law-makers and local authorities, with also investors understanding the potentials.

https://millerhull.com/project/bullitt-center/
http://www.bullittcenter.org/

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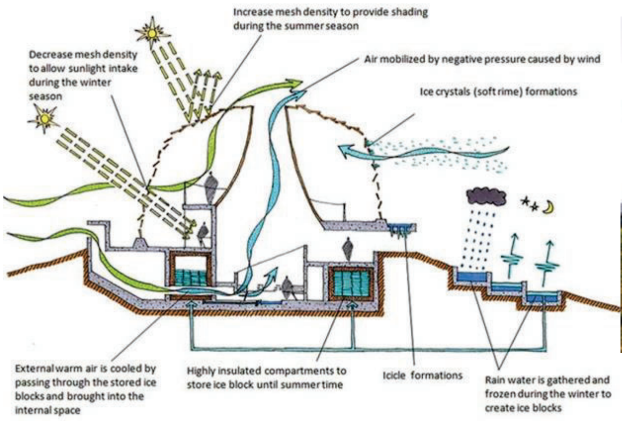
Rokko Shidare Observatory

Experiencing nature of Rokko Mountains



Left: Sambuichi architects © --- Right: Artyukh Igor ©

LOCATION

Kobe, Hyogo 657-0101, Japan
34°45'51.9"N 135°14'47.5"E

CLIMATE ZONE

(according to KFICAT)
Cfa

BUILDING TYPOLOGY

R Residential
O Office
E Education
L Lodging
RS Retail/Services

SUSTAINABILITY LEVEL

(Optional - Please give your opinion about the sustainability level)

C Conventional
Building as usual

S Sustainable
Limiting impact. *The balance point where we give back as much as we take*

RS Restorative
*Restoring social and ecological systems **to a healthy state***

RG Regenerative
*Enabling social and ecological systems to maintain a healthy state **and to evolve***

Rokko Observatory, 2010, conceived by architect Hiroshi Sambuichi, is built almost entirely from hinoki wood and operates on solar and wind power alone. The dome, comprised of numerous reciprocal structure hexagons, was designed to attract frost in the winter and to pull in the wind through an opening in the ceiling in summer, regulating its temperature using natural phenomena. It is designed to naturally and passively super cool in the hottest days. With priority and focus on existing natural resources (wind, water and sun) in his architecture, Sambuichi uses on-site data-collection, experimentation, and testing of prototypes to understand the notion and affects of natural elements. Sambuichi consistently seeks to discover how architecture can create an intimate connection between people and nature.
He spends up to two years thoroughly researching the terrain, climate and history of the site, before deciding on the architectural suitable. His primary concern is to utilize wind, water and sun, which he believes not only helps minimize the environmental impact of his work, but also ensures that it will withstand the test of time.
In this project, by learning how to capture ice from the air in the winter to then be stored and used in the summer, and using timber from local forests, Sambuichi achieves a regenerative architecture that goes beyond sustainable design.

TECHNICAL DATA

Gross are: ~205 m^2

Diameter of dome: 16 m^2

Visitors per year: 100,000

Key performance indicators (KPIs)

HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed – Standard Effective Temperature (SET)	✓
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF) Occupants satisfaction - % satisfied people	✓

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ICE LACE ROOF

Classification of the technology: Passive

Soft rime forms on the interlocking steel-pipe reciprocal structure roof, which provides partial shelter against the weather. In the winter, the woven self-supporting structure mesh transforms into a spectacular myriad of delicate ice crystals, for which Rokko is famous. These ice crystals and icicle formations melt and gather at the base of the dome to be stored as an ice block until summertime.

Sustainability level: Regenerative

Soft rime is an interesting natural phenomenon in which light fog freezes and crystallizes on the windward side of tree branches. Tree branches naturally vibrate in air, and this resonance coupled with a high atmospheric altitude is very particular for the occurrence of this phenomenon. To capture ice crystals in the same way as branches, Sambuichi built a temporary apparatus that mimicked the composition, thickness and resonance of tree branches; The building would sit on Rokko Mountaint in Kobe at the height of 1000m. 10 different mockups were installed in the winter on site where density of pattern, pattern variation, type of wood, and thickness of members, was set up to see which pattern was optimal to accumulate the ice. Sambuichi pursued his research, making adjustments until the exact specifications for reproducing this natural effect were determined.

Providers: ARUP

In this project, Arup provided geometric and structural engineering, as well as environmental design services to bring the ice lace roof into reality. Arup broke down the complex geometry of the interlocked-steel-pipe roof and developed a computer solver program 'Shift Frame Geometry', that had the capacity to incrementally shift all elements simultaneously, to manipulate and accurately find the geometrical member sizes. To construct the dome, Arup exported the geometrical data of individual members and connection locations directly to the fabricator, along with three-dimensional models indicating the precise locations of each individual member. Although irregular in pattern, the dome is built from a regular single-unit. The main structural arrangement is a reciprocal frame made of 50 mm welded steel tubes between 1 and 2 m long, in-filled with 15–20 mm thick wooden (Japanese cypress) patterns of varying density. The pattern is also interrupted with bamboo tubes which when channeling the wind, create a tune.

Designed to mimic the performance of tree branches in winter, this innovation and technology is set to perform regardless of the changes in air and temperature, and as a passive strategy, is an effective and beautiful piece of design able to provide resourceful cooling.

ARCHITECTS/STUDIO
Sambuichi

COMPLETION YEAR
2010

AWARDS
3rd Kobe City Urban Design Award

Rokko Observatory, detail of surrounding water pond (Hyogo / 2010) (photo © Sambuichi Architects)

Ice lace detail (photo © Maya)

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ICE BLOCK TANK

Classification of the technology: Passive

Surrounding the observatory, are pools of water, utilized to harvest rainwater for ice block formation. The rainwater is gathered and frozen during the winter to create ice blocks. The harvested ice blocks are stored in highly insulated compartments in the observatory basement until the summer when they become a resource for passive cooling of the whole building. The act of storing ice for the summer is traditional in the local region of Japan and this simple technology reflects the nature and culture of the people and users, who may find other unfamiliar more-high-tech technologies a disturbance.

Sustainability level: Regenerative

In the summer months, external warm air is induced into the basement of the building. It passes through the stored ice blocks and continues through in the internal space, cooled. The air is channeled out through the top of the roof, where air is mobilized by negative pressure caused by the wind. This technology is passive and withstands the hot days of the summer when cooling is needed most.

Detail of the welded connection and tied wooden timber battens (photo © Olga Popovic Larsen)

WATER POOLS

Classification of the technology: Passive

The rain collection water pools cool down the observatory as warm summer breezes pass over them into the structure. Airflow is cooled further through the ice block compartment.

RECIPROCAL ROOF PATTERN & DENSITY

Classification of the technology: Passive

The overall shape of the roof is the result of having to facilitating natural ventilation by passively inducing air movement. The patterns and density vary so that more shading (more density) is provided in the south side, and there is air flow in the direction of prevailing wind. The structure needed to be within budget constraints and be relatively easy to construct.

In the summer, increased mesh density provides shading, where the pattern is dense enough to block the rays and the rubes reflect the rays back. Decreased mesh density at lower elevation permit the solar rays access into the building in the winter season. The set patterns work in a passive way to enable comfort throughout the year.

Mount Shidare closeup of roof structure (photo © Olga Popovic Larsen)

LINKS AND REFERENCES

arup.com/projects/rokko-shidare-observatory
japantimes.co.jp/life/2016/09/24/style/hiroshi-sambuichi-nature-architecture
iconeye.com/architecture/features/item/10603-future-50-hiroshi-sambuichi
dnp.co.jp/artscape/eng/focus/1605_01.html
indesignlive.hk/articles/people/hiroshi-sambuichis-innate-connection-with-earth

Anon (2013). *Models are real*. Japan Architect 91.
Anon (2011). *Sambuichi*. Japan Architect 81.
Popovic Larsen, O (2014). *Reciprocal Frame (RF) Structures: Real and Exploratory*. Nexus Netw J 16.
Hummel Lee, A (2017). *Sambuichi, Kaze Mizu Taiyo*.

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B+A House

Photo credits: MDC Architectonica (architect; Dr. Aleksandar Petrovski)

LOCATION
Skopje, R. Macedonia, 41.8, 21.5

CLIMATE ZONE
(according to KFICAT)
Cfa: Mediterranean warm/cool summer climates

BUILDING TYPOLOGY

- **R Residential**
- O Office
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL

- C Conventional — ***Building as usual***
- S Sustainable — ***Limiting impact.*** *The balance point where we give back as much as we take*
- RS Restorative — *Restoring social and ecological systems* ***to a healthy state***
- **RG Regenerative** — *Enabling social and ecological systems to maintain a healthy state* ***and to evolve***

This single-family residential building is located in a natural setting on the outskirts of the city of Skopje. The buildings` design is governed by the passive solar, sustainability and regenerative principles, in which the spatial arrangement develops in two levels. The living and sleeping spaces have a south orientation, protected with canopies with a double height living room. The energy performance simulations show that it performs as a passive building, i.e. class A+. The design principles used, such as buildings` shape and orientation, optimization of the windows` size, green roof, thermal storage, rainwater capturing and composting, altogether with the prefabricated façade walls, recyclable and low-emitting materials and construction systems, heat pumps and PVs`, constribute towards the preservation of the natural resources, support the circular economy, stimulate the thrive of the natural habitat and biodiversity in a regenerative manner and provide a comfortable indoor environment for the occupants.

TECHNICAL DATA

Gross area: 340 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	✓
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	✓
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓
Occupants satisfaction - % satisfied people	
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	✓
Occupants satisfaction - % satisfied people	
ACOUSTIC ENVIRONMENT	

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Background noise level - Noise criteria (NC)	✓
Occupants satisfaction - % satisfied people	
HUMAN VALUES	
External view and Right to light - % workstations with windows access	✓

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CLIENT / OWNER / INVESTOR
Buildings` owner

PROJECT TEAM
architectural office:
MDC Architectonica

architects:
Dr. Aleksandar Petrovski
MSc Lepa Petrovska-Hristovska

COMPLETION YEAR
in construction (2020/2021)

REGENERATIVE TECHNOLOGY #1

GREEN ROOF WITH RAINWATER CAPTURING SYSTEM

Classification of the technology: Passive

Effects/improvements on indoor environment of the case study
The green roof contributes towards the regulation of the interior temperatures, stimulates the biodiversity and regenerates the natural habitat. The materials used are recyclable and with the superinsulation there is heating and cooling demand reduction towards low-energy consumption, equal to the passive house standard.

Sustainability level: Regenerative

Detailed description of technology: The green roof serves several purposes in the delivery of regenerative building. It contributes to the decrease of the energy demand by 23%, it helps retaining the rainwater stored partially in the roof system for stimulating the biodiversity on the roof and another part in water tanks for watering the garden. In the future it is intended the system to be upgraded and to filter the rainwater and use it in the toilets for showering and toilets. Thus it contributes towards lower consumption of water from the public system.

Possible providers of technology: BIM Sveti Nikole, Macedonia

REGENERATIVE TECHNOLOGY #2

SUSTAINABLE WALL AND FAÇADE

Classification of the technology: Passive

Effects/improvements on indoor environment of the case study
The superinsulation in the façade walls and the high performance glazing system contribute to a very-low heating and cooling energy demand and to the delivery of passive building. This contributes towards comfortable and healthy indoor environment.

Sustainability level: Regenerative

Detailed description of technology:
The wall structure is designed as a light-timber frame system filled with recycled rock wool between the studs. Additional insulation is placed on the outer layer as well as in the interior leaf, which is finished with gypsum boards and the ones on the ceiling have catalyzing properties.

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STRENGTH MEASURE OF EFFECTS

The calculations have shown that the energy class of the building is A+ with 12 kWh/m2.a energy consumption for heating and cooling. All of the materials have EPD declarations and are recyclable/reusable. Due to the catalyzing gypsum boards the indoor air quality is improved and which needs to be measured in the occupancy phase.

Possible providers of technology: Knauf Radika, Knauf insulation.

REGENERATIVE TECHNOLOGY #3

PCM HEAT STORAGE IN RADIANT FLOOR

Classification of the technology: Passive/Active

Effects/improvements on indoor environment of the case study

This technology contributes towards the indoor comfort by catching, storing and releasing solar radiation in a controlled manner by using parrafin. It provides optimal mean radiant temperature of the floor and of the indoor air.

Sustainability level: Sustainable

Detailed description of technology:

The phase changing materials (PCM) storage is made out of paraffin in plastic containers 30 mm thick, which are placed in wet floor construction, positioned under the dining and living floor area and exposed to the sun. The PCM absorbs the winter solar radiation and stores it, which is released into the space when needed thus improving the indoor comfort and reducing the heating energy demand. During the summer period, the excess heat during the day is stored and released during the night to the outside.

STRENGTH MEASURE OF EFFECTS

The calculations have shown that the combined effects of all of the sustainable design principles applied contribute towards achieving A+ energy class, i.e. a passive building, while also improving the comfort levels in the building by providing optimal and comfortable mean-radiant temperature of the spaces` surfaces. The radiant floor contributes with 11% decrease of the yearly energy consumption.

ACKNOWLEDGEMENTS

The author would like to acknowledge MDC Architectonica for sharing the projects` information.

LINKS AND REFERENCES

www.arh.com.mk

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LOCATION

Av. Complutense s/n. Ciudad Universitaria. 28040 Madrid (España) (Lat Lon: 40.442220, -3.729160)

CLIMATE ZONE

(according to KFICAT)

Mediterranean

BUILDING TYPOLOGY

(color and highlight the correct one)

- R Residential
- **O Office**
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL

(Optional - Please give your opinion about the sustainability level)

- C Conventional — *Building as usual*
- S Sustainable — ***Limiting impact.** The balance point where we give back as much as we take*
- **RS Restorative** — *Restoring social and ecological systems **to a healthy state***
- RG Regenerative — *Enabling social and ecological systems to maintain a healthy state **and to evolve***

Espacio itdUPM

Photo credits: Ángela Pons

The Innovation and Technology for Development Centre (itdUPM) is an interdisciplinary centre of the Polytechnic University of Madrid (UPM). The project involved the retrofit of an existing building, the ETSIA Maintenance Building, sited at the International Excellence Campus Moncloa. The project consisted of providing a place to conduct research activities, by addressing complex problems related to sustainability while co-creating practical solutions. The build took place in 2016 and since when it has become an icon of technologic innovation for UPM.

TECHNICAL DATA

Gross area: 399.80 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓ ✓
Occupants satisfaction - % satisfied people	
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	
Occupants satisfaction - % satisfied people	
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	✓
Occupants satisfaction - % satisfied people	
HUMAN VALUES	
External view and Right to light - % workstations with windows access	

REGENERATIVE TECHNOLOGY #1

INNOVATIVE FAÇADE SOLUTION INCLUDING VEGETATION

RESTORE

REthinking Sustainability
TOwards a Regenerative Economy

Classification of the technology: Passive

Effects/improvements on indoor environment of the case study
One of the activities carried out at itdUPM is the analysis of air pollution, where the building is working as a lab according to biodiversity concepts. The green wall can reduce the heat loss of the building, contributing to energy saving to ensure interior thermal comfort. The green wall is working as a test bench for research about the use of heating sources for experimental crops, the grey water recycling, the use of rainwater, etc. Plants are also being used in the interior walls to improve the quality of space.

Sustainability level: Sustainable

Detailed description of technology: The green wall is part of an advanced building enveloped. The bioclimatic system consists on a sub-structure attached to the building east, west and south façades. It was designed to incorporate different elements and materials, being the vegetation one of them. The structure is a modular grid to ensure the flexibility of the system.

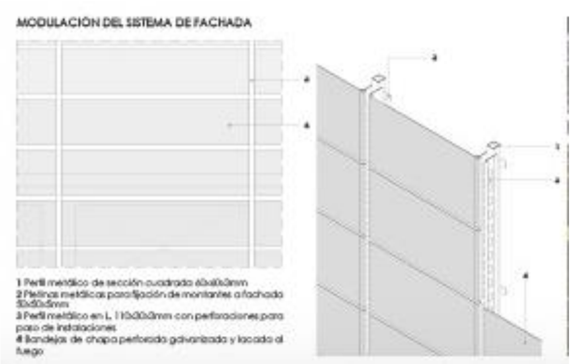

Photo credits: "Sicilia y Asociados" Architects *Ángela Pons*

STRENGTH MEASURE OF EFFECTS

A study of the effects of the exterior green wall on the building and its impact on the urban microclimate has been conducted. There is also an on-line platform where some data of the building are available: http://monitoring.robolabo.etsit.upm.es/itd/monitoring.php?tab=therm

STRENGTH-WEAKNESS ANALYSIS OF THE TECHNOLOGY
The system designed achieves the integration between natural and artificial components, improving the public space of the Campus and becoming a gathering place.

Possible providers of technology: "Sicilia y Asociados" Architects (experts in bioclimate buildings), agronomists (experts in urban agriculture), engineers (experts in solar energy and water), and students worked together to develop the technology. The assembly was also carried out in a collaborative way between the students and the professors involved.

REGENERATIVE TECHNOLOGY #2

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INTERIOR GREEN WALL

Classification of the technology: Passive

Effects/improvements on indoor environment of the case study
A collection of solutions to improve the acoustics where incorporated in the renovated interior of the building. A total of 17 solutions were analysed before selecting the most relevant to be installed. A green wall was installed in front of the main entrance to the building, together with other technical solutions (e.g. placing acoustic conditioning panels).

Sustainability level: Regenerative
Detailed description of technology: The green wall is s composed of modules where the different plant species are cultivated. The module configuration within the green wall seek to maximise the capacity to decontaminate that the plants have. It is because every module provides a large surface area contact with the rhizosphere of the plants and the contaminated indoor air. The result is a very profitable symbiosis between both, becoming a balanced system. The water circulates in vertical and horizontal direction, ensuring the system humidity is stable.

Photo credits: Ángela Pons *Cristina Jiménez-Pulido*

STRENGTH MEASURE OF EFFECTS
The vegetation can improve the CO2 concentration and while exploiting potential positive impacts of the biophilia.

STRENGTH-WEAKNESS ANALYSIS OF THE TECHNOLOGY
There is not measured the occupants' satisfaction after the technology implemented.

Possible providers of technology: Vertiarte

LINKS AND REFERENCES

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Building website: http://www.itd.upm.es/espacio/
Architects (project designers) website: http://www.siciliayasociados.com/
Providers of the green wall technology website: http://vertiarte.com/

Mataix, C., Romero, S., Mazorra, J., Moreno, J., Ramil, X., Carrasco, J., ... & Lumbreras, J. (2017). Working for Sustainability Transformation in an Academic Environment: The Case of itdUPM. In *Handbook of Theory and Practice of Sustainable Development in Higher Education* (pp. 217-234). Springer, Cham.

Segovia Cardozo, D. A., Rodríguez Sinobas, L., & Zubelzu Mínguez, S. (2018). ESTUDIO DE COEFICIENTES DE CULTIVO EN JARDINES VERTICALES.

CLIENT / OWNER / INVESTOR
Universidad Politécnica de Madrid

PROJECT TEAM
"Sicilia y Asociados" Architects

COMPLETION YEAR
2016

AWARDS
Awarded at the World Green Infrastructure Congress 2016, Bogotá (Colombia).
The design and construction process were acknowledged 'good practice' by the International Sustainable Campus Network and include in the "Educating for Sustainability. Best Practice Report".

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Bullitt Center

Photo credits: Nic Lehoux

Six-story commercial office building in the Central Area of Seattle, WA, USA, awarded the Certified Living (Living Building Challenge). The building incorporates renewable energy sources, photovolotaic and geothermal, a high performance envelope, and heating recovery ventilation system.

LOCATION

1501 East Madison Street
Seattle, WA 98122, USA

CLIMATE ZONE

(according to KFICAT)
Csb

BUILDING TYPOLOGY

- R Residential
- **O Office**
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL

- C Conventional — ***Building as usual***
- S Sustainable — ***Limiting impact.*** *The balance point where we give back as much as we take*
- RS Restorative — *Restoring social and ecological systems* ***to a healthy state***
- **RG Regenerative** — *Enabling social and ecological systems to maintain a healthy state* ***and to evolve***

TECHNICAL DATA

Gross area: 4.800 m²

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	✓
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	✓
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓ ✓
Occupants satisfaction - % satisfied people	
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	✓
Occupants satisfaction - % satisfied people	
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	
Occupants satisfaction - % satisfied people	
HUMAN VALUES	
External view and Right to light - % workstations with windows access	✓

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More information: http://www.eurestore.eu/

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CLIENT / OWNER / INVESTOR
Point 32

PROJECT TEAM
Miller Hull Partnership
PAE Consulting Engineers
DCI Engineers
2020 Engineering
Luma Lighting Design
Berger Partnership
Solar Design Associates
Foushee & Schuchart

COMPLETION YEAR
2013

AWARDS
Certified Living (Living Building Challenge)

Honor Award: 2014 Sustainable Building Industry Council Beyond Green Awards, Category A: High-Performance Building

REGENERATIVE TECHNOLOGY #1

Renewable Energy / Photovoltaic

Classification of the technology: Passive

Effects/improvements on indoor environment of the case study
The photovoltaic panels were selected to satisfy all the electrical demand of the building, generating a surplus of 90.793 kWh during the summer season.

Sustainability level: Regenerative

Detailed description of technology:
244 kW photovoltaic array; 575 panels, 1.300 m^2
Simulated / Actual annual energy use: 231,000 / 152,877 kWh/year

STRENGTH MEASURE OF EFFECTS
The electrical surplus is pushed back onto Seattle´s grid. In terms of Energy Use Intensity (EUI), a typical office building operates at 92 EUI. The Bullitt Center operates at 10 EUI due to the integration of additional systems, such as passive ventilation, geothermal energy, and natural daylighting.

Possible providers of technology: NW Wind & Solar

REGENERATIVE TECHNOLOGY #2

High performance envelope

Classification of the technology: Active / Passive

Effects/improvements on indoor environment of the case study
The well-insulated envelope eliminates thermal bridging and minimizes air infiltration. Thermal mass, orientation, and triple-glazed curtain walls with automated blinds were designed to control heat gain and loss, while improving daylighting, glare control, and external views.

Sustainability level: Regenerative

Detailed description of technology:
Deployable exterior shades.
Operable automated windows to maximize ventilation

STRENGTH MEASURE OF EFFECTS
In the summer, the shades deploy to scatter direct rays before they hit the glass. In the winter, the shades are designed to maximize natural daylight in the office spaces, while still protecting against direct glare on workstations.

Possible providers of technology: Shuco

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REGENERATIVE TECHNOLOGY #3

Heat recovery ventilation system

Classification of the technology: Active

Effects/improvements on indoor environment of the case study
Warmth is recovered from the interior air before it is exhausted from the building. Then, this recovered heat is used to increase the temperature of the incoming air.

Sustainability level: Regenerative

Detailed description of technology:
The tempered outgoing air transfers its heat to the incoming air through a honeycombed rotating drum that turns slowly to maximize heat transfer. Aproximately 65% of the air heat is transferred.

STRENGTH MEASURE OF EFFECTS
The HVAC system improves its efficiency as the air is already pre-heat. The drum is also equiped with and advanced filtration system to remove air pollutants, improving indoor air quality.

Possible providers of technology: Zehnder; Baluberg.

LINKS AND REFERENCES

https://living-future.org/lbc/case-studies/bullitt-center/#overview

http://www.bullittcenter.org/

https://www.wbdg.org/additional-resources/case-studies/bullitt-center

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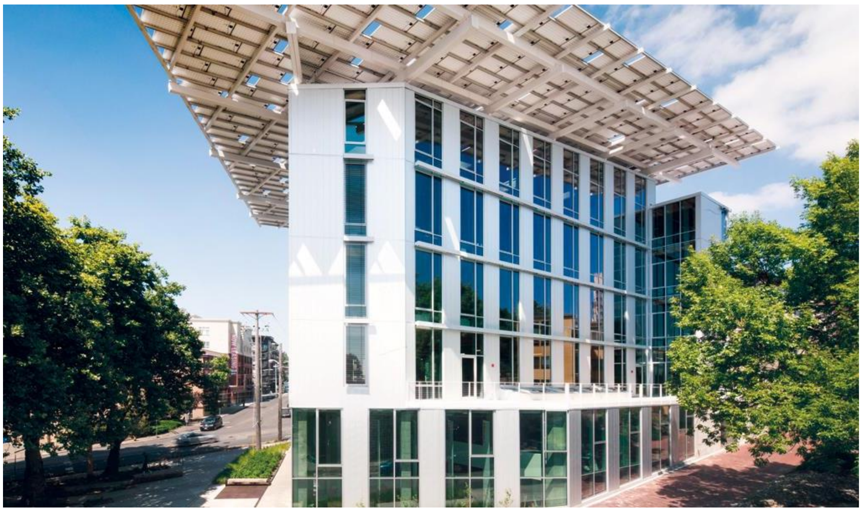
Bullitt Center



LOCATION
1501 East Madison Street, Seattle, WA 98122 (47.614582, -122.311987)

CLIMATE ZONE
(according to KFICAT)
Csb- Mediterranean warm/cool summer climate

BUILDING TYPOLOGY

- R Residential
- **O Office**
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL

- C Conventional — *Building as usual*
- S Sustainable — ***Limiting impact.*** *The balance point where we give back as much as we take*
- RS Restorative — *Restoring social and ecological systems to a healthy state*
- **RG Regenerative** — *Enabling social and ecological systems to maintain a healthy state **and to evolve***

The Bullitt Center is a six-story commercial office building in the Central Area of Seattle, WA. The building officially opened in 2013 and was designed to be the greenest commercial building in the world. It is certified as a Living Building by the Living Building Challenge 2.0 (LBC). The Bullitt Center is a high-performance, net-zero energy and net-zero water urban office building.

TECHNICAL DATA

Gross area: 4,800 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	✓
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓
Occupants satisfaction - % satisfied people	✓
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	✓
Occupants satisfaction - % satisfied people	
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	✓
Occupants satisfaction - % satisfied people	
HUMAN VALUES	
External view and Right to light - % workstations with windows access	✓

REGENERATIVE TECHNOLOGY #1

Windows and Exterior Shades/ Schüco Curtainwall System

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Classification of the technology: Passive/ Control

Effects/improvements on indoor environment of the case study
Schüco Curtainwall System was chosen due to its high thermal, daylight, and ventilation performance, airtightness, including water penetration resistance. Bullitt Center's operable windows capitalize on natural ventilation coupled with a heat-recovery system and weather-responsive shading system. Additionally, the window system's spacer maximizes condensation resistance and enhancess acoustic performance for quiet interiors.

Detailed description of technology: Vertical fenestration systems are triple glazed assemblies with 1 or 2 low-E coatings, argon filled, with warm edge spacers for a maximum center-of-glass U-value 0.17 BTU/hr.ft2.°F and condensation cating of 86. The Bullitt Center's Warema exterior automated venetian blinds have 100 mm (4") aluminum slats with a reflectance of approximately 50%. Blind deployment and slat angles are controlled by a combination of an astronomical time clock that locates the sun's altitude and azimuth, and a sensor to signal whether it's clear or cloudy.

Automated external shades

STRENGTH MEASURE OF EFFECTS: While the glazing with the lowest SHGC performed the best in terms of reducing the cooling load in the summer (Solarban 70), this was more than offset by the reduction in beneficial solar heat gain in the winter. The winning combination was to use an assembly with a higher SHGC (Sungate 500, SHGC 0.59), in combination with exterior automated venetian blinds.

Possible providers of technology: Schüco

REGENERATIVE TECHNOLOGY #2

Radient Heat

Classification of the technology: Active

Effects/improvements on indoor environment of the case study
The Bullitt Center has a radiant system which heats the building through hydronic radiant tubing that coils beneath the concrete overlay of each floor. In the winter, the system removes heat from the ground, while in the summer, the system can be run in reverse, restoring this heat back into the ground. The system was chosen due to its energy efficiency, in combination with the selected systems for cooling and HVAC. According to the thermal comfort feedback 63% of the occupants of Bullitt Center reported that they were satisfied, 4% reported that they were neither satisfied nor dissatisfied and 34% reported that they were dissatisfied.

Radiant heating

Sustainability level: Regenerative

Detailed description of technology: The thermal production and delivery system at the Bullitt Center has both a source side and a supply side. The source side consists of a pair of pumps that circulate a solution of water and glycol (anti-freeze), through one of twenty-six, 400' deep

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CLIENT / OWNER / INVESTOR
Bullitt Foundation

PROJECT TEAM
PAE Consulting Engineers (Director), Miller Hull Partnership (Architect)

COMPLETION YEAR
2013

AWARDS
American Society of Landscape Architecture – Washington Chapter Award of Excellence for McGilvra Place, AIA Seattle Energy in Design, AIA Committee on the Environment (COTE) Top Ten, Highest Honor Award – Sustainable Building Industry Council "Beyond Green" Awards, Category A: High Performance Building, Green Lease Leader Award, Architizer A+ Awards, Architecture & Sustainability – Special Mention, Canadian Wood Council North American Wood Design Award – Citation, Woodworks US Wood Design Award – Multi-Story Wood Design, Pacific Region 'Best Green Project', National 'Best Green Project', National Best Construction Project in any Category in 2013, World Architecture News, "Sustainable Building of the Year" etc.

wells, drilled directly under the building. Each hole is about 5-1/2" in diameter and contains a loop of 1" diameter plastic pipe that extends to the bottom of the well and back up again. Because the ground maintains a temperature of around 55° F year around, cold fluid sent down the well returns about 10° F warmer, depending on the heating load. Additionally, the system is powered by electricity produced by the building's photovoltaic ("PV") system, or purchased from Seattle City Light with credits from surplus PV production during the summer months.

STRENGTH MEASURE OF EFFECTS: The radiant system is not solely the driver of good energy performance; however, it can be an important part of an integrated approach from design and technology selection through to occupancy and operations.

REGENERATIVE TECHNOLOGY #3

Heat Recovery Ventilation

Classification of the technology: Passive

Effects/improvements on indoor environment of the case study: The primary ventilation air for the building is supplied by a dedicated outside air handling unit located on the roof. This system is equipped with a heat recovery wheel located in the rooftop air-handling unit. This energy recovery ventilator (ERV) is approximately 65% effective at recovering heat from the exhaust air and transferring it to the ventilation air. This system was chosen due to the goal of net-zero energy use.

Detailed description of technology: Fresh air is supplied by the system whenever CO2sensors indicate the need for additional fresh air. Variable speed drive fans regulate airflow based on CO2 readings. Multiple CO2 sensors located on each floor and in the exhaust air ducts communicate with the building management system to regulate the delivery of fresh air to maintain the building's CO2level at less than 500 PPM above the outside CO2 levels.

LINKS AND REFERENCES

https://aamanet.org/blog/case-study-seattle-s-bullitt-center-earns-top-green-certification
http://www.bullittcenter.org/building/building-features/
http://www.bullittcenter.org/wp-content/uploads/2015/08/living-proof-bullitt-center-case-study.pdf
https://living-future.org/lbc/case-studies/bullitt-center/
https://www.wbdg.org/additional-resources/case-studies/bullitt-center
https://newbuildings.org/wp-content/uploads/2017/09/Radiant_Bullit.pdf

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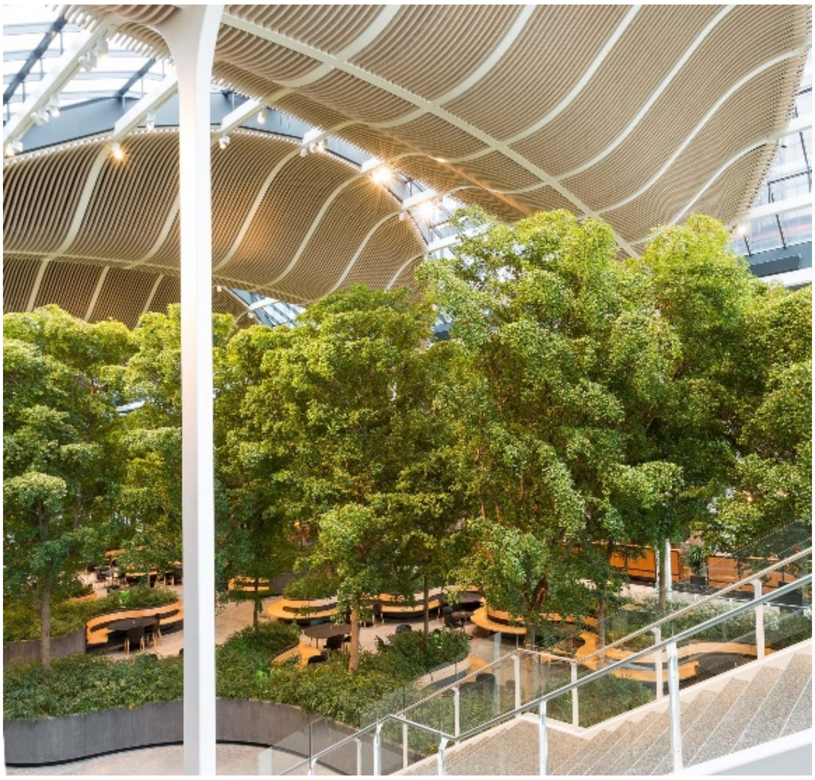
Copenhagen Tower Buildings 405-406



Foster+Partners_Copenhagen Tower

LOCATION
Copenhagen Towers,
Ørestads Blvd. 114 - 118,
2300 København, Denmark

CLIMATE ZONE: Cfb
(according to KFICAT)

BUILDING TYPOLOGY

- R Residential
- **O Office**
- E Education
- L Lodging
- RS Retail/Services

SUSTAINABILITY LEVEL

- C Conventional — ***Building as usual***
- **S Sustainable** — ***Limiting impact.*** *The balance point where we give back as much as we take*
- RS Restorative — *Restoring social and ecological systems **to a healthy state***
- RG Regenerative — *Enabling social and ecological systems to maintain a healthy state **and to evolve***

Designed to LEED Platinum standard, Copenhagen Towers is a major contribution to the new development area of Ørestad in Denmark.
The sustainable complex, featuring a 22-storey office tower and low-rise building joined together by an atrium, is conceived as a progressive, creative workplace that also embraces the strictest environmental criteria.
The result is a flexible, collaborative setting that combines the latest workplace trends with an environmentally responsible approach to building. Thanks to the groundwater-based heating and cooling system, along with a renewable energy system of solar panels, the energy consumption is almost the half compared to a conventional design. Furthermore in response to the extreme cold weather the buildings incorporate triple glazing and extra thick thermal insulation.

"The hotel's new solar array consists of 2,500 custom-made solar modules in 38 different designs. The array covers a total area of 1,700 square metres and will generate around 170,000 kWh per year representing approximately 10 percent of the building's annual energy consumption. The remainder will be supplied by wind turbines from DONG Energy." Source: www.renewableenergymagazine.com

Gross area: 18,348m²

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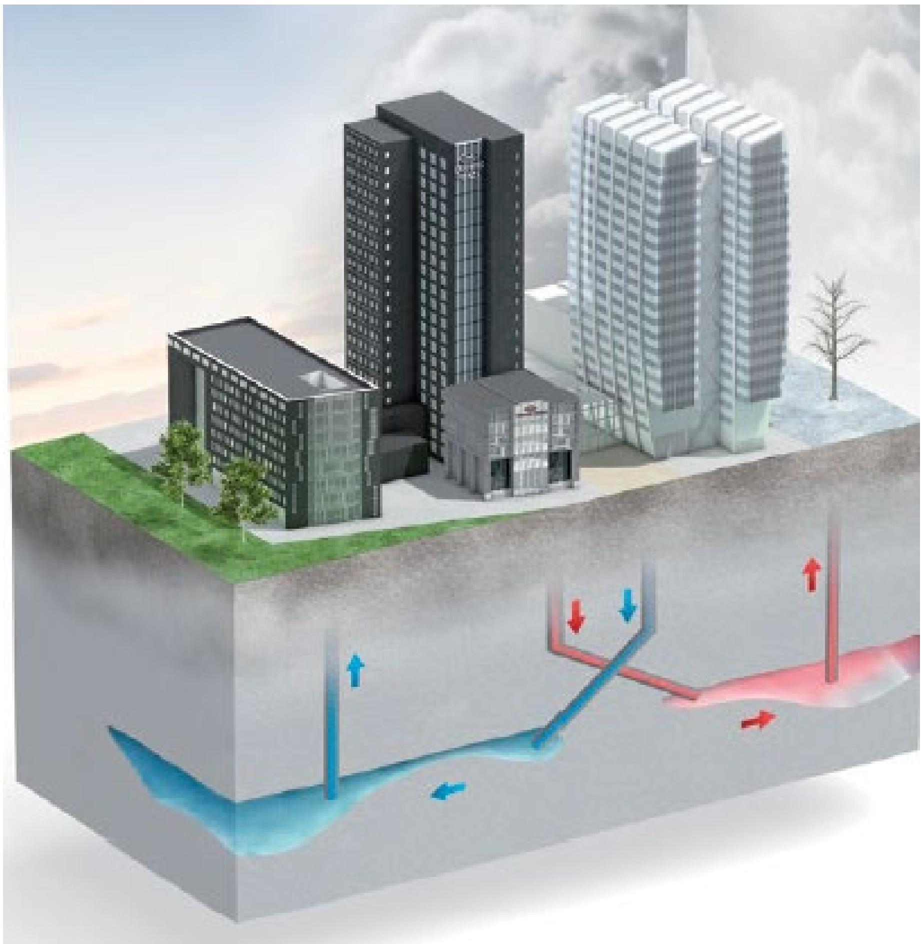
REGENERATIVE TECHNOLOGY #1

GROUND WATER – COOLING & HEATING

Classification of the technology: active

Beneath the complex, a groundwater-based heating and cooling system has been installed at a depth of 110 meters. This system is saving up to 90 percent of the building's heating and air conditioning consumption.

During the summer, 9˚C water will be pumped from the ground to the basement plantroom where it will be sent through a heat exchanger and back down to a heat reservoir where the heat will be accumulated and stored until winter comes. The cooled water from the heat exchanger will be circulated in the building to cool rooms without the need for any active refrigeration.
In the winter, the water from the reservoir will be pumped back through the heat exchanger and down to the wells to be sent through two heat pumps which will raise the temperature to 55˚C. This will be used to heat hotel rooms and offices.



Environmental Engineer: Midconsult A/S

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REGENERATIVE TECHNOLOGY #2

GREEN ATRIUM – BIOPHILIC DESIGN

60 Black Olive trees and 4500 plants and a continuous curve of wooden benches specifically design for this project welcome the visitors entering the 1400 sqm glass-roof atrium.
The 'green'heart of the complex allows direct views of the treetops from the adjacent spaces operating as an informal space for meetings, catching up over lunch during the day, or an exclusive dining destination in the evenings.
Open to the public during the day and connected by metro to the centre of Ørestad, the atrium is the perfect space for different small businesses to meet and interact in a natural environment.
The steel structure of the atrium roof is combined with curved wooden profiles that enhance the natural ambiance of the space and provide acoustic absorption.

Landscape Architect Schnoherr

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REGENERATIVE TECHNOLOGY #3

UPCYCLED INTERIOR FINISHES – RECYCLED MATERIALS

Working with Danish upcycling specialists Lendager Group, the innovative interiors of the building make use of a number of local materials such as reused timber wall cladding and concrete flooring from local building debris, providing warm interior finishes and furthering the sustainable credentials of the development.
A significant architectural feature is the use of up-cycled material in the construction process, such as the PET plastic felt ceiling which provides excellent acoustic absorption panelling in both office and public spaces.

Circular Economy Business Group Lendager UP

Acoustic Ceiling - https://lendager.com/en/upcycle-en/upcycle-acoustic-ceiling-panel/
Wall Cladding - https://lendager.com/en/upcycle-en/upcycle-wood-panel/
Concrete Flooring - https://lendager.com/en/upcycle-en/upcycle-concrete/

INVESTOR
Solstra Capital Partners

PROJECT TEAM
Foster + Partners

COMPLETION YEAR
2015

AWARDS

LEED BD+C: Core and Shell v3 2009 - Platinum

National ENERGY GLOBE Award Denmark 2019

EU Green Building certification

BUILDING MARKETS Danish Design Award

LINKS AND REFERENCES
https://www.fosterandpartners.com/projects/copenhagen-towers/
https://www.wiconafinder.com/en/references/denmark/copenhagen-towers/
https://www.energyglobe.info/denmark2019?cl=en&id=337465
https://dbdh.dk/2014/02/27/solar-biogas-and-groundwater-based-heating-cooling-at-copenhagen-hotel-crowne-plaza/
https://www.renewableenergymagazine.com/energy_saving/copenhagen-crown-plaza-towers-is-one-of-20140226
https://sustainability-leaders.com/crowne-plaza-copenhagen-towers-sustainable-hotel-example-denmark/
https://www.focusondrives.com/smart-hvac-reaches-new-heights/

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Villa Castelli - Italy

Photo credits: Valentina Carì

LOCATION
Via Loreti 4 23822 Bellano (LC), Italy
Lat: 46° 02’ 39‘ 12 N; Lon: 09° 18’ 25’’ 92 E; ALT: 202 m

CLIMATE ZONE
(according to KFICAT)
Cfb – Oceoanic Climate

BUILDING TYPOLOGY
(color and highlight the correct one)

- **R — Residential**
- O — Office
- E — Education
- L — Lodging
- RS — Retail/Services

SUSTAINABILITY LEVEL
(Optional - Please give your opinion about the sustainability level)

- C — Conventional — ***Building as usual***
- S — Sustainable — ***Limiting impact.*** *The balance point where we give back as much as we take*
- **RS — Restorative** — *Restoring social and ecological systems* ***to a healthy state***
- RG — Regenerative — *Enabling social and ecological systems to maintain a healthy state* ***and to evolve***

Villa Castelli is a listed residential building from the 19th century located at the riverside of Lake Como, Italy. It is a building worth preserving and situated in a protected area. It was renovated in 1939 and 2013 and is currently occupied by 4 occupants. It is a detached house with three floors. It is construction is based on stone masonry walls with rendered external finish, hard plastered internal finish and pitched roof.

TECHNICAL DATA

Gross area: 680 sqm

Key performance indicators (KPIs)

INDOOR AIR QUALITY	
Contaminants – % of Formaldehyde	
Outdoor/Indoor - Particulate matter: PM10 / PM2.5	
Occupants satisfaction - % satisfied people	
HYGRO-THERMAL ENVIRONMENT	
Temperature/humidity/air speed - Standard Effective Temperature (SET)	✓
Occupants satisfaction - % satisfied people	
VISUAL ENVIRONMENT	
Daylight - Daylight factor (DF)	
Occupants satisfaction - % satisfied people	
ACOUSTIC ENVIRONMENT	
Background noise level - Noise criteria (NC)	
Occupants satisfaction - % satisfied people	
HUMAN VALUES	
External view and Right to light - % workstations with windows access	

REGENERATIVE TECHNOLOGY #1

EXTERNAL WALLS (PERLITE and AEROGEL INSULATION)

Classification of the technology: Passive

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CLIENT / OWNER / INVESTOR
Arch. Valentina Carì
Via Loreti 4, 23822
Bellano (LC), Italy

PROJECT TEAM
Architect, Valentina Carì
Via Loreti 4, 23822
Bellano (LC), Italy

Energy Consultant, Oscar Stuffer "Solarraum - architecture, energy, mobility" Via Goethe 3, 39100 Bolzano (BZ), Italy

Structural Engineer, Vincenzo Buizza "Studio di Ingegneria Tecnica" Corso Martiri della Liberazione, 6 23900 Lecco LC

COMPLETION YEAR
2015

Effects/improvements on indoor environment of the case study
Utilization of perlite and aerogel insulation was decided in order to reduce heat loss.

EXTERIOR WALL IN NATURAL STONES + PERLITE INSULATION:
U-value (pre-intervention) [W/m^2K]: $1.33 W/m^2K$
U-value (post-intervention) [W/m^2K]: $0.19 W/m^2K$

CONCRETE WALL + AEROGEL INSULATION:
U-value (pre-intervention) [W/m^2K]: $2.47 W/m^2K$
U-value (post-intervention) [W/m^2K]: $0.18 W/m^2K$

WALL IN SOLID BRICK + PERLITE INSULATION:
U-value (pre-intervention) [W/m^2K]: 1.4
U-value (post-intervention) [W/m^2K]: 0.19

Sustainability level: Restorative

Detailed description of technology: The exterior wall in local natural stone masonry with lime mortar was insulated from inside with 20 cm perlite, applying on the existing lime plaster layer another layer of lime plaster as leveling layer, the glue, the perlite insulation panel and the interior plaster. Where it was geometrically not possible to install the 20 cm thick perlite layer, 8 cm of Aerogel were applied as internal insulation. The internal insulation of the exterior walls has followed the criteria to standardize the thicknesses of the insulation layers.

Possible providers of technology: Dicalite Group, Proctor Group

REGENERATIVE TECHNOLOGY #2

PHOTOVOLTAICS

Classification of the technology: Active

Effects/improvements on indoor environment of the case study
In order to cover the remaining energy demand locally and in a renewable way.

Sustainability level: Regenerative

Detailed description of technology: Electrical energy is produced with a mono-crystaline PV-system, integrated in the roofing and not visible from outside. Before the heritage authorities approved the PV system, several prototypes were developed for a roof-integrated and preferably invisible installation. The heritage authorities opted for the double-curled aluminum sheet covering of the roof - which is quite common for buildings of this age in a similar way - with integrated mono-crystalline PV modules, folded plates with integrated photovoltaic cells, of about 11 kWp. A sailboat outfitter supplied the extra-thin PV modules.

Possible providers of technology: Greenmatch UK

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LINKS AND REFERENCES

[1]https://www.hiberatlas.com/smartedit/projects/23/EURAC_Paper%20DenkmalUndEnergie_Troi_1.pdf
[2]https://www.hiberatlas.com/smartedit/projects/23/2017%20IBPSA%20Italy_Villa%20Castelli.pdf
[3]https://www.hiberatlas.com/smartedit/projects/23/2015%20International%20Passive%20House_Leipzig_Conference_Villa%20Castelli.pdf