Cracow University of Technology
Faculty of Civil Engineering

MEZeroE

Measuring Envelope products and systems contributing to next generation of healthy nearly Zero Energy buildings

MEZeroE implementation at the Faculty of Civil Engineering, Cracow University of Technology

Aneta Nowak-Michta

This project has received funding from the European Union's Horizon 2020 research and innovation programme under **grant agreement No 953157**

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MEZeroE

MEZeroE aims to create an EU distributed open innovation ecosystem for:

- developing nearly Zero Energy Building (nZEB) Enabler **Envelope Solutions**;
- transferring **knowledge**;
- **matching** testing **needs** with test **facilities**;
- providing **monitoring** in real **buildings** used as **living labs**;
- **standardizing** cutting-edge **solutions** coming from Small and Medium Enterprises (SMEs) and larger industries.

Single entry point (SEP) web-based multi-side virtual marketplace includes:

- 9 Pilot Measurement & Verification Lines (**PM&VL**)
- 3 Open Innovation Services (**OIS**)
- Access to real-buildings as living labs (**LL**)
- Additional resources and support including training, business model development, systematic IP and knowledge management, and more

MEZeroE will **fast-track prototypes to the market** as fully **characterized** and **exploited** (full potential unlocked) products

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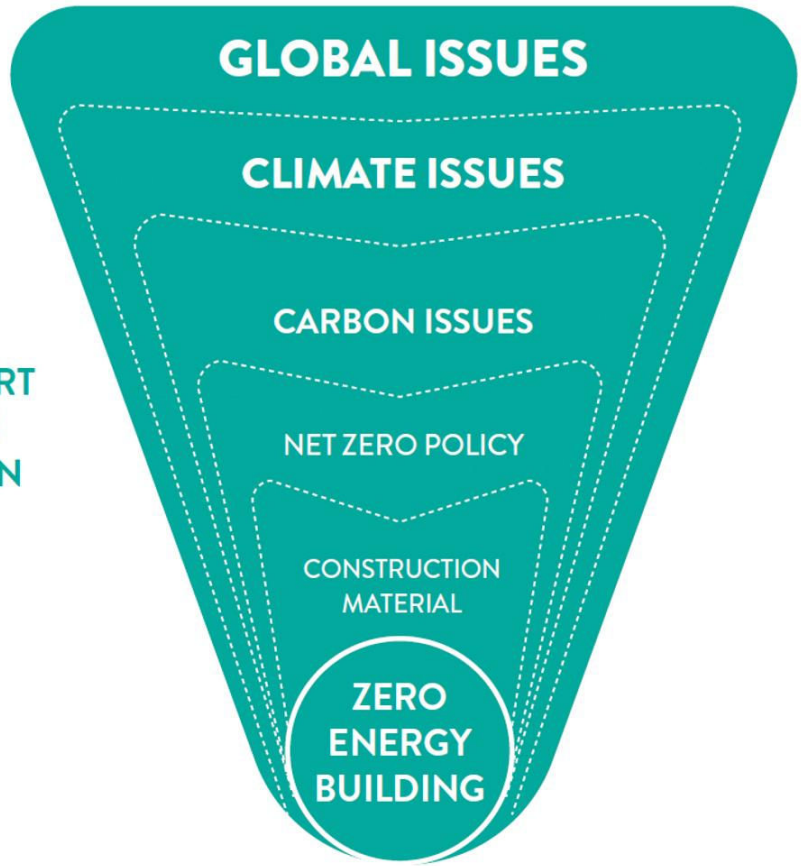
MEZEROE

GLOBAL SOCIETY ISSUES

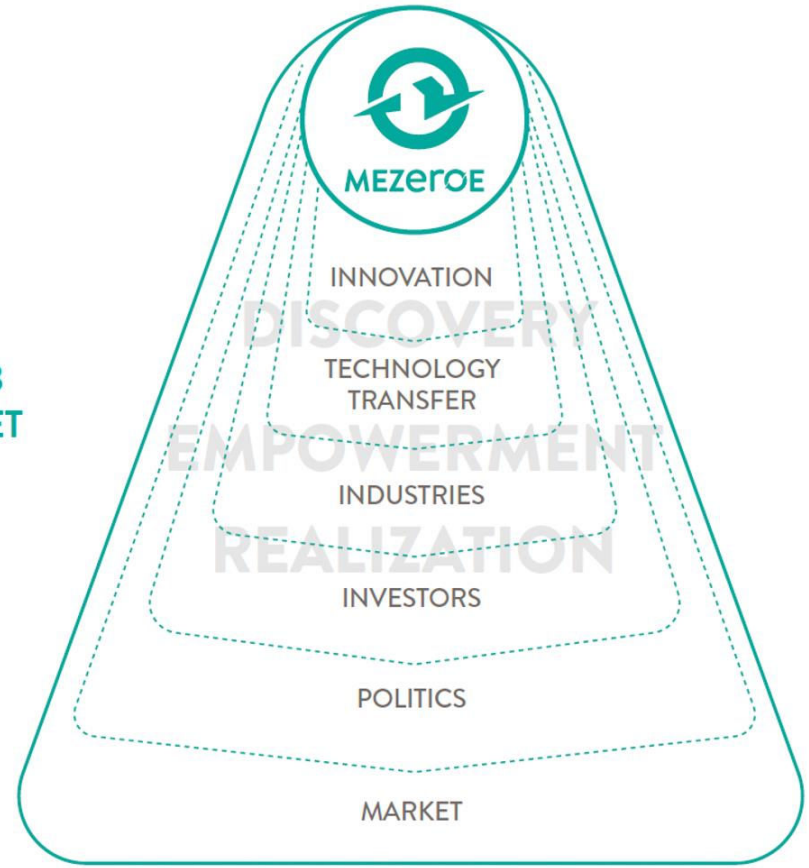
BEING PART OF THE SOLUTION



BUILDING ECOSYSTEM RESPONSE

NICHE AUDIENCE

FROM LAB TO MARKET



INNOVATE
Testing unique new construction materials
Testing lab

INDUSTRIALIZE
Monitor living labs; standardize cutting-edge solutions.
Validate

transfer knowledge; match test demand and offer
Empower industries

COMMERCIALIZE
Bring to industries new performent materials
Marketplace

Bring to market nZEB envelope solutions
Zero Energy Buildings

MASS AUDIENCE

Measuring Envelope products and systems contributing to next generation of healthy nearly Zero Energy buildings

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MEZeroE

RTD PARTNERS
- EURAC
- POLIMI
- LEITAT
- UIBK
- ZAG
- CUT
- ITEC
- DTU
- TECNALIA

IND PARTNERS
- FOCCHI
- VELUX
- WINDOWMASTER
- FLEXBRICK
- HELIATEK
- TECNAN
- FLEX&ROBUST
- ROTHOBLAAS
- RIKO
- INDRESMAT

M&V PARTNERS
- AIRBNCO
- NUVAP
- GREETEG

BIZ PARTNERS
- INCURVO
- COMPAZ
- R2M

RTD partners: providing testing facilities, research and innovation capacities and knowledge of standardisation and certification processes

IND partners: bringing innovative products or products needing standardise assessment methodologies

MEZeroE eco-system

M&V partners: providing advanced and comprehensive monitoring systems and data analytics shared environment

BIZ partners: providing capacity and practical tools to support innovation process, results exploitation and knowledge transfer

External participants: providing buildings to be used as living labs (see letter of support)

External participants: market players and early adopters (see letter of support)

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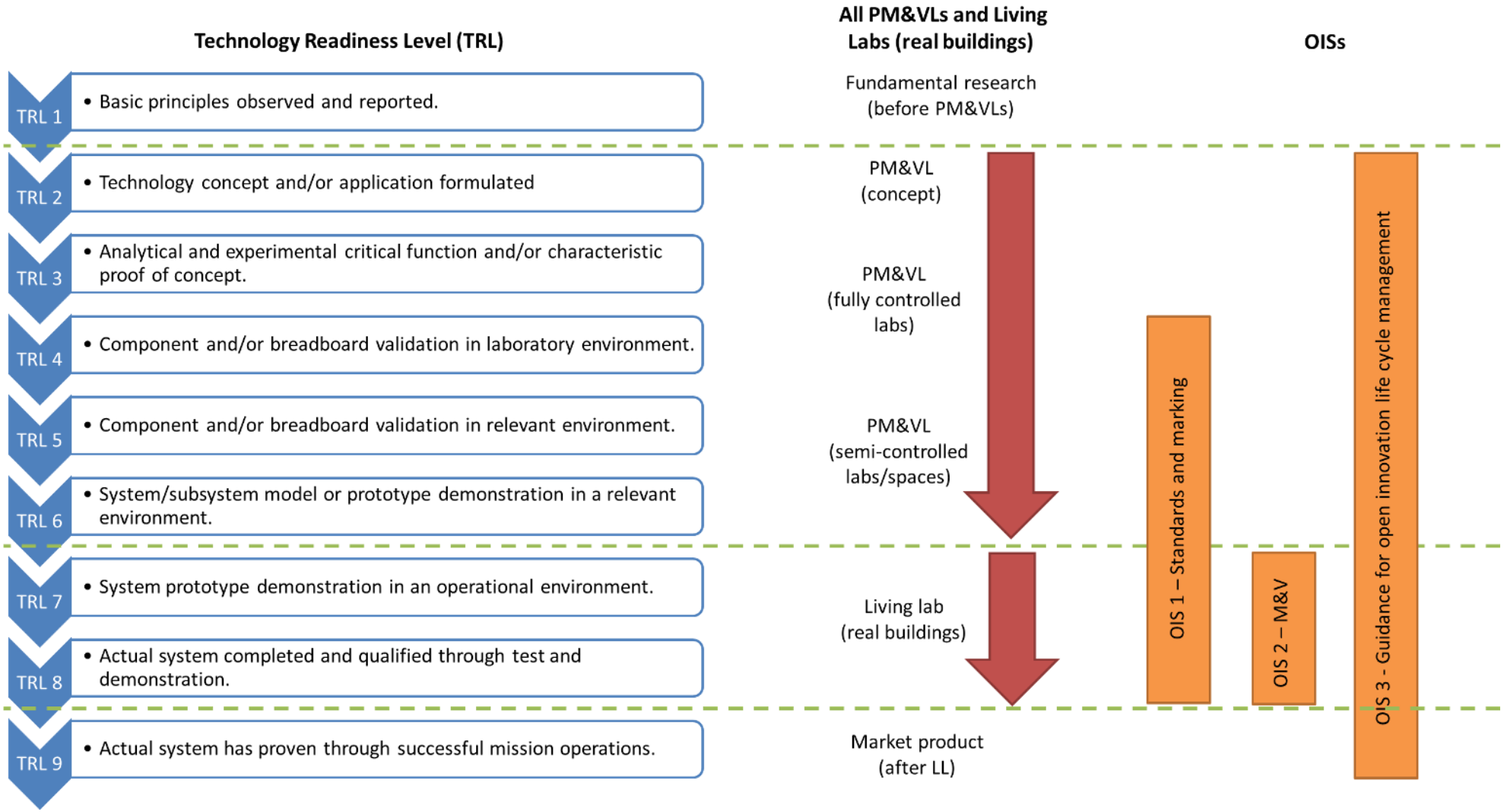

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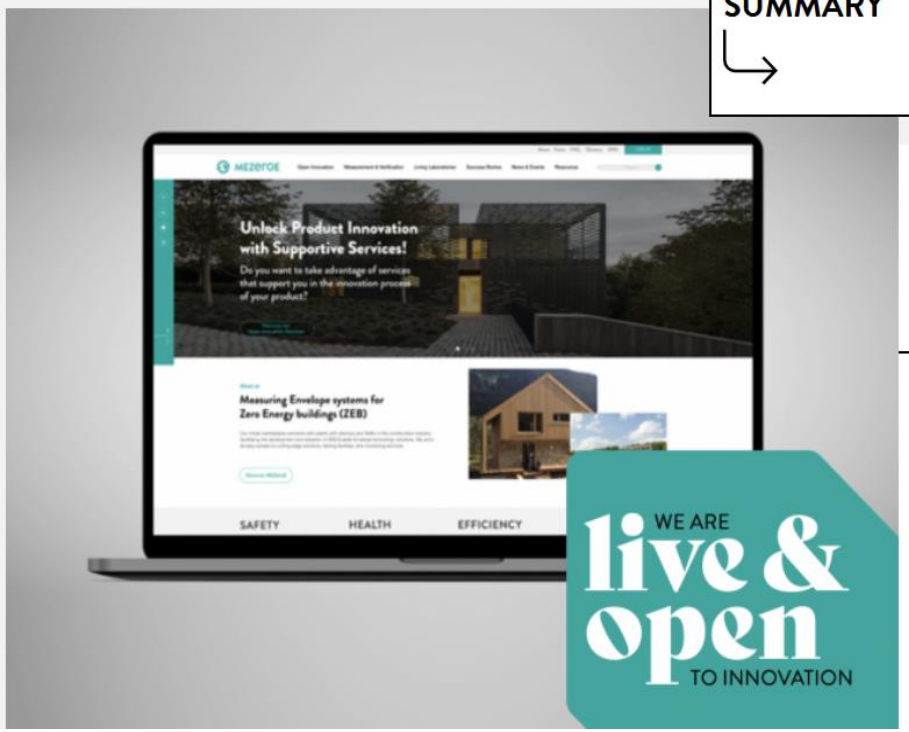
MEZEROE

https://www.mezeroe.eu

PROJECT SUMMARY | ECOSYSTEM | LIVING LAB | COMMUNITY | ACTIVITY



We are open to innovation

The MEZeroE Open Innovation Digital Platform for Zero Energy Building Ecosystem is live and online.

Join now the innovative and unique platform to accelerate the energy transition in the building sector by driving the advancement of low- impact, energy-efficient solutions from open innovation collaboration to the market.

Access the platform

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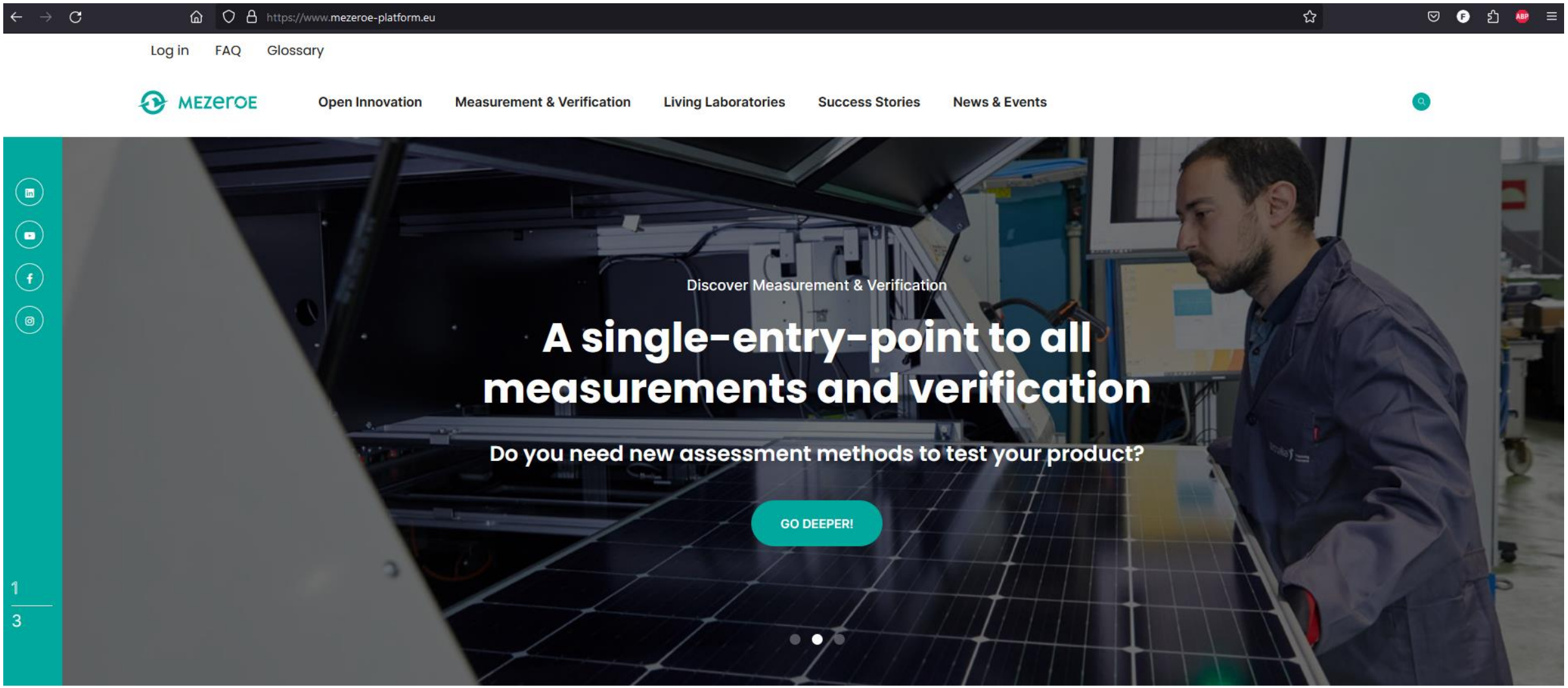

Measuring Envelope products and systems contributing to next generation of healthy nearly Zero Energy buildings

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Faculty of Civil Engineering

Coordinator CUT - Prof. Arkadiusz Kwiecien, Ph.D., D.Sc., Eng. L-08

Coordinator PM&VL7 - Aneta Nowak-Michta, Ph.D. L-11

7.1 Mechanical subline:
Prof. Arkadiusz Kwiecien, Ph.D., D.Sc., Eng. L-08
Łukasz Hojdys, Ph.D., Eng. L-01
Piotr Krajewski, Ph.D., Eng. L-01
Stanisław Kańka, Ph.D., Eng. L-12
Jarosław Górszczyk, Ph.D., Eng. L-05
Konrad Malicki, Ph.D., Eng. L-05
Piotr Stecz, Ph.D., Eng. L-15
Jarosław Chełmecki, MSc., Eng. L-15

7.2 Durability subline:
dr hab. inż. Teresa Stryszewska, Ph.D., D.Sc., Eng. prof. CUT L-02
Marta Dudek, Ph.D., Eng. L-02
Mateusz Sitarz, Ph.D., Eng. L-02

7.3 Vibroacustic subline:
Alicja Kowalska-Koczwara, Ph.D., D.Sc., Eng. prof. CUT L-08
Krzysztof Nering, Ph.D., Eng. L-04
Piotr Stecz, Ph.D., Eng. L-15
Jarosław Chełmecki, MSc., Eng. L-15

7.4 Termal subline:
Tomasz Kisilewicz, Ph.D., D.Sc., Eng. prof. CUT L-04
Małgorzata Fedorczak-Cisak L-13
Katarzyna Nowak, Ph.D., Eng. L-04

BIM:
Krzysztof Zima, Ph.D., D.Sc., Eng. prof. CUT L-07
Damian Wieczorek, Ph.D., Eng. L-07

Coordinator Living Lab - Katarzyna Nowak-Dzieszko, MSc., Eng. L-04

PMVL7: MECHANICAL AND DURABILITY TESTS OF CONNECTORS AND THEIR INFLUENCE ON VIBROACOUSTIC, THERMAL, AND MICROCLIMATE COMFORT

Cracow University of Technology
Faculty of Civil Engineering

MEZeroE

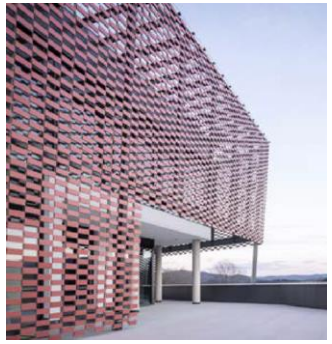
PM&VL7 research line tests

As part of the task of testing the research line using the equipment purchased under the project, research programs for construction products of four European industrial partners were implemented:

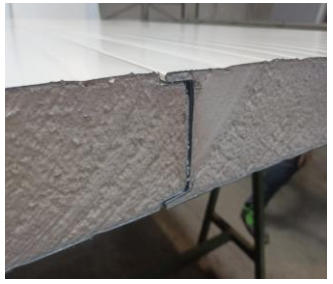
- Membranes, tapes and membrane-tape-membrane connections from ROTHOBLAAS,
- Curtain and facade brackets from FLEXBRICK,
- Window frames and sandwich panels from INDRESMAT,
- Composites, injections and layers from FLEX&ROBUST.

The public version of the research results are posters, two examples of which are presented on the following slides.

Flexbrick dressing architecture

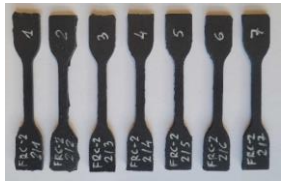


INDRESMAT® INDUSTRIAL RESINS & MATERIALS



rothoblaas

FLEX AND ROBUST SYSTEMS



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Mechanical tests and Durability to UV and heat of Rothoblaas membranes

MEZEROE
Measuring Envelope systems for Zero Energy buildings

Rothoblaas

Product: Membrane

Rothoblaas is an Italian multinational company from the Alpine region, leader in the development and supply of high-tech solutions for the areas of beam and post and Mass Timber construction systems, energy efficiency, zero emissions and other building best practices.

Membrane TRASPIR EVO UV 115

Pilot Measurement & Verification Line 7

Managed by: CUT

PM&VL7

Mechanical, durability, vibroacoustic, thermal, and microclimate comfort tests of envelope products and their connectors. Mechanical, vibroacoustic, thermal, and structural (scanning and optical microscope, spectrometer) tests are used for ageing diagnosis.

SAFETY

EFFICIENCY

Which is the need covered by this service?

The implemented program of mechanical and durability tests was based on certification requirements for membranes with appropriate modifications taking into account more intense UV exposure than those provided for in the standard. The obtained results set the path for further research and product development as well as making the construction products comparable.

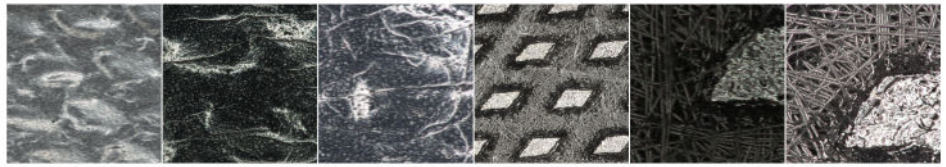
Design of Experiments

- Mechanical properties
- Structural properties
  - Observation in optical microscope (OM)
  - Observation in scanning electron microscope (SEM)
  - Spectrometric analysis (FTIR)
- Durability to UV and heat
  - STAGE 1: Structural properties before ageing
  - STAGE 2: Exposure to UV according to Annex C EN 13859-1 with modification to 5000h; FTIR after 1000, 2000, 3000, 4000 h
  - STAGE 3: Structural properties after UV ageing
  - STAGE 4: Exposure to heat according to Annex C EN 13859-1
  - STAGE 5: Structural properties after UV and heat ageing

Tensile properties according to EN 13859-1 EN 12311-1

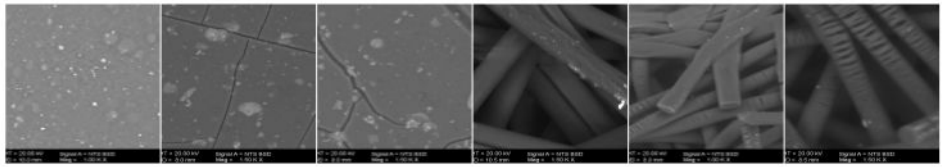
Resistance to tearing according to EN 13859-1 EN 12310-1

Results – structural properties



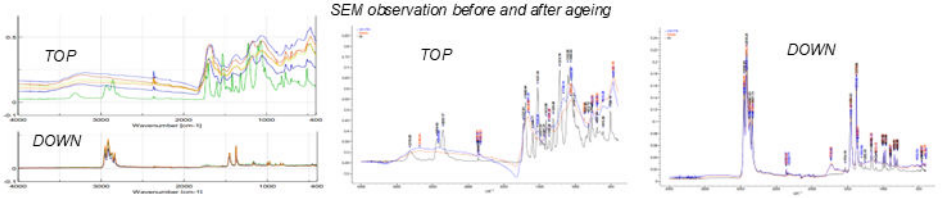
TOP reference | *TOP after UV* | *TOP after UV+heat* | *DOWN reference* | *DOWN after UV* | *DOWN after UV+heat*

OM observation before and after ageing



TOP reference | *TOP after UV* | *TOP after UV+heat* | *DOWN reference* | *DOWN after UV* | *DOWN after UV+heat*

SEM observation before and after ageing



FTIR analysis before, during and after UV, and after UV + heat ageing

Open Innovation outcomes

The standard ageing time under UV rays was significantly modified from 336 to 5000 hours to better reflect real exposure conditions and enhance the credibility of product performance information. In addition, the scope of diagnostics before and after ageing was extended to include the observation of microstructure in an optical and scanning microscope as well as FTIR analyses before, during and after ageing.

Conclusions

Exposure to 5000h UV of membrane causes their degradation (the both side) visible changes include microcracks and defragmentation of fibers PP.

IR spectra after exposure to UV for 1000, 2000 3000, 4000 and 5000 hours allow to monitor changes and determine the beginning of degradation.

IR spectra and SEM images show that exposure to heat intensifies the degradation process. No additional changes were observed.

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Research partner: Cracow University of Technology Faculty of Civil Engineering

Industrial partner: rothoblaas

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Want to know more?
- Follow us on LinkedIn
- Write us to contact@mezeroe.eu
- Visit our marketplace www.mezeroe-platform.eu

Mechanical, Durability, Acoustic tests and Thermal simulations of Indresmat window frame

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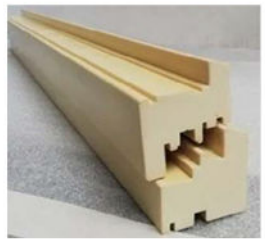
Measuring Envelope systems for Zero Energy buildings

INDRESMAT

Product: KLIMA-PUR window frame

INDRESMAT is a company founded in 2017 and located in Barcelona (Spain) & Geleen (The Netherlands) that is redefining the thermal envelope of buildings with materials such as biobased Polyurethane window frames and insulation foams.



Pilot Measurement & Verification Line 7

Managed by: CUT

PM&VL7

Mechanical, durability, vibroacoustic, thermal, and microclimate comfort tests of envelope products and their connectors. Mechanical, vibroacoustic, thermal, and structural (scanning and optical microscope, spectrometer) tests are used for ageing diagnosis.

SAFETY HEALTH EFFICIENCY INTERACTION

Which is the need covered by this service?

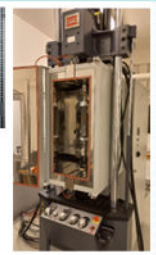
The completed program of mechanical, durability and vibroacoustic tests as well as thermal simulations were based on the certification requirements for window frames with appropriate modifications taking into account the biopolyurethane raw material used to produce the frames and the designed solutions for their connections. The obtained results indicate a path for further research and product development and may also be used during product certification.

Design of Experiments

1. Low temperature cracking according to EN 12697-46 with modifications.
2. Durability:
   - Resistance to artificial ageing by exposure to freeze-thaw according to EN 13165 with modification.
   - Resistance to accelerated ageing by exposure to temperature in accordance with the requirements of EN 13165.

   Diagnostics of durability due to ageing included features not defined in the standard:
   Mechanical test before and after artificial ageing - Strength of corners according to EN 514.
3. Direction-averaged junction velocity level difference for connector or for connection model according to our own procedure based on EN ISO 12354-1 and EN ISO 12354-2.
4. Internal surface temperature according to EN ISO 13788.

Strength of corner

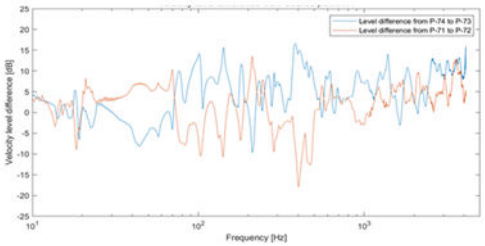


Low temperature cracking

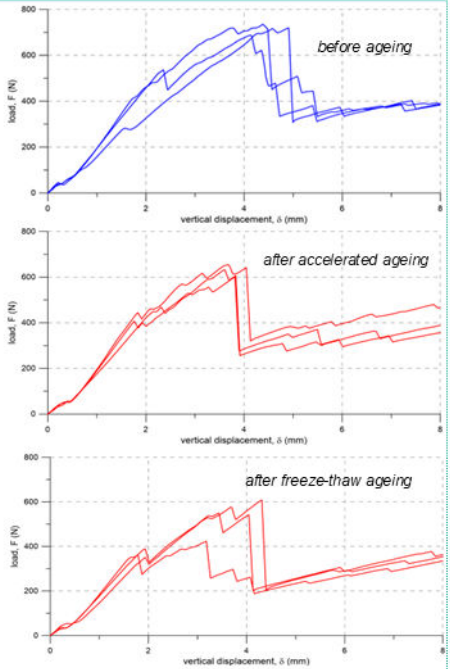
Velocity level difference

Results

1. Strength of the tested window frame corners is 3.3 N/mm², 2.5 N/mm² and 2.9 N/mm² for reference specimens, specimens after freeze-thaw ageing and specimens after accelerated ageing, respectively. Relationships between load and vertical displacement of corners before and after ageing.
2. In the low temperature cracking test, the average value of maximum cryogenic stress was equal to 1.36 MPa.
3. Foamed (bio)polyurethane frame connections found to be acoustically stiff. Average transmission of vibration velocity in frequency domain is below 6 dB.

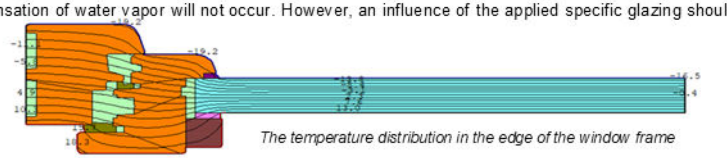


Velocity level difference from source point W1



Relationships between load and vertical displacement of corners

4. The purpose of the test was to check whether condensation and mold may occur on the inner surface of the window frame. The temperature distribution in the edge and middle element of the window frame was calculated as a 2D task. As a result of the analysis, it was found that in typical residential and office spaces with a moderate level of relative air humidity, condensation of water vapor will not occur. However, an influence of the applied specific glazing should also be checked.



The temperature distribution in the edge of the window frame

Conclusions

Both types of the used ageing procedure caused reduction in strength of the tested window frame corners.
In the low temperature cracking test, the specimens met the required evaluation criterion.
Biopolyurethane frame connections found to be acoustically stiff.

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Research partner: Cracow University of Technology, Faculty of Civil Engineering
Industrial partner: INDRESMAT®
Main author:
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- Visit our marketplace www.mezeroe-platform.eu

Cracow University of Technology
Faculty of Civil Engineering

MEZeroE

Interdisciplinary, Inter-Unit Research Team created at the Faculty of Civil Engineering.

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Cracow University of Technology
Faculty of Civil Engineering

MEZeroE

Faculty of Civil Engineering of Cracow University of Technology is the beneficiary of a 5.5% grant - EUR 817,375:

- purchased equipment,
- new research positions were built,
- 32 new research procedures were launched and tested.

Hydraulic cylinder Hydropuls PL 250 N as an extension to ISTS

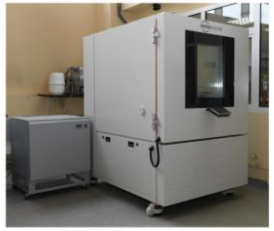
Lens for Optical microscope

Spektrometer FTIR + Set of libraries

Watertightness Tester WSP 3600 V4

Ageing chamber QUVsprayRP

Ageing chamber Xe



Climatic chamber

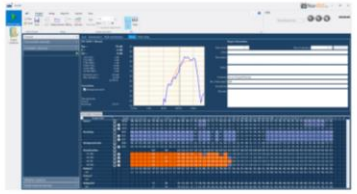
Dodecahedron loudspeaker Nor276 with Power Amplifier Nor280

Microphone boom turntable basic unit Nor265

Sound analyzer Nor150

Tapping Machine Nor277

Sound Calibrator Nor1256



Dedicated software for NOR850

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MEZeroE

Cooperation with scientists from foreign units:

- ACCADEMIA EUROPEA DI BOLZANO (EURAC),
- POLITECNICO DI MILANO (POLIMI),
- ACONDICIONAMIENTO TARRASENSE ASSOCIACION (LEITAT),
- UNIVERSITAET INNSBRUCK (UIBK),
- ZAVOD ZA GRADBENISTVO SLOVENIJE (ZAG),
- INSTITUT DE TECNOLOGIA DE LA CONSTRUCCION DE CATALUNYA (ITEC),
- DANMARKS TEKNISKE UNIVERSITET (DTU),
- FUNDACION TECNALIA RESEARCH & INNOVATION (TECNALIA).

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Workshops with representatives of the Spanish company Flexbrick

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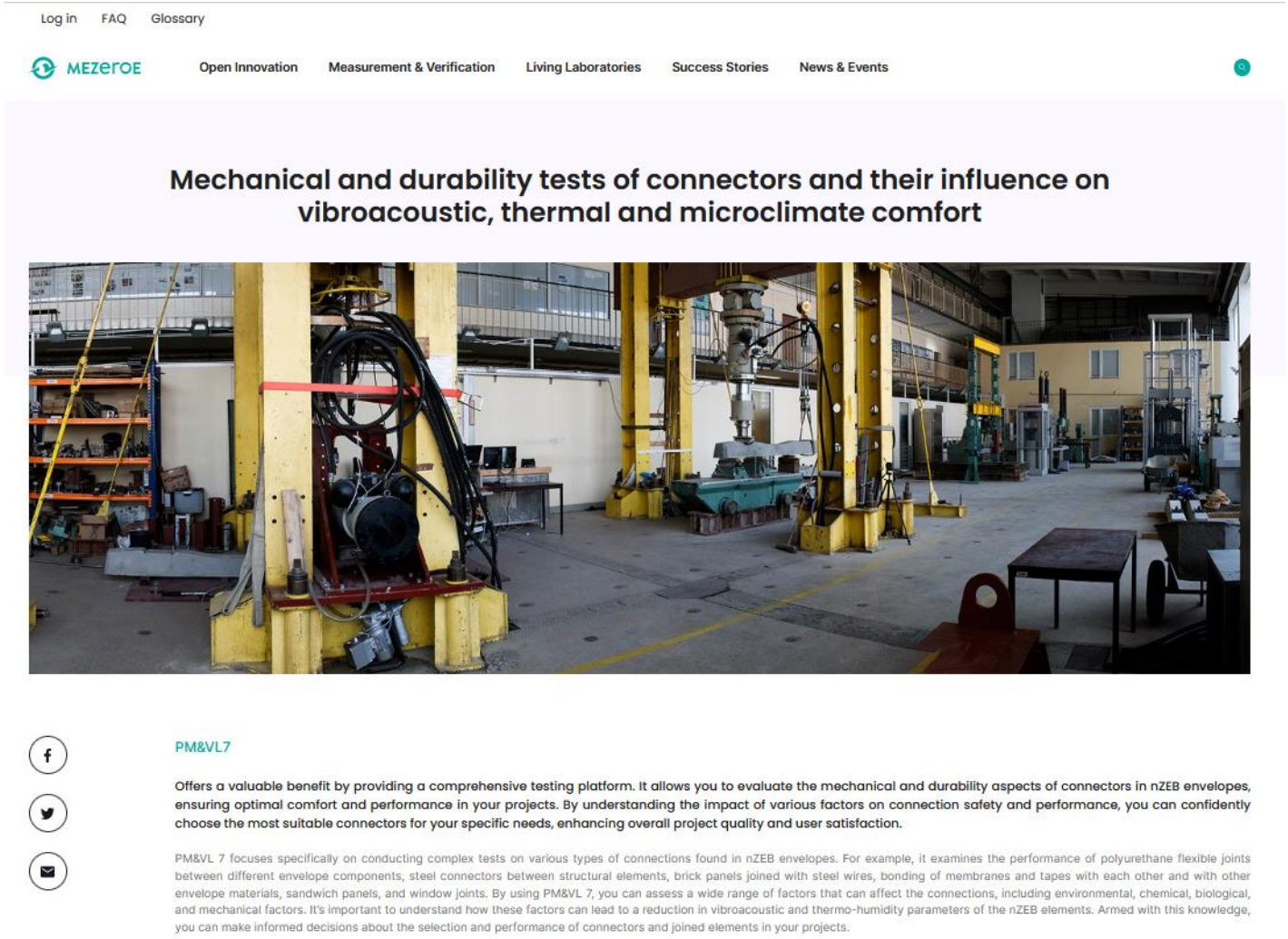
MEZeroE

PM&VL7, as one of 9 research lines, presents services on the newly launched MEZeroE digital service platform.



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Cracow University of Technology
Faculty of Civil Engineering

MEZeroE

Living Lab on the campus of Cracow University of Technology before renovation

Continuous monitoring of indoor air quality and thermal comfort.

Measuring Envelope products and systems contributing to next generation of healthy nearly Zero Energy buildings

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Cracow University of Technology
Faculty of Civil Engineering

MEZeroE

Living Lab on the campus of Cracow University of Technology after renovation

Scope of renovation works:

- Structure reinforcement using Flex&Robust flexible polyurethane joints,
- Replacement of window frames - Indresmat,
- Shading systems – Pelini,
- Insulation and acoustic protection of the building.

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Thank you for your attention

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