



Horizon 2020
European Union Funding
for Research & Innovation

D6.10 Report on training activities

WP6

Lead Partner: FENIX TNT

Dissemination Level: Public

Deliverable due date: M56 Actual submission date: M57

Deliverable Version: V1

Project Acronym	EENSULATE
Project Title	Development of innovative lightweight and highly insulating energy efficient components and associated enabling materials for cost-effective retrofitting and new construction of curtain wall facades
Grant Agreement n°	723868
Funding Scheme	Innovation Action
Call	H2020- EEB-2016
Topic	EEB-01-2016 Highly efficient insulation materials with improved properties
Starting Date	1 st August 2016
Duration	58 Months

Executive Summary

The present document deliverable D6.10 “Report on training activities” describes a set of training activities performed within the framework of the EENSULATE project and its results. The report D6.10 is delivered in the context of the task T6.4 “Training activities” within the WP6 “Exploitation, Dissemination and Communication”. The objective of EENSULATE project is to develop innovative lightweight and highly insulating energy efficient components and associated enabling materials for cost-effective retrofitting and new construction of curtain wall facades.

Table of Contents

1	Introduction	4
2	Target audience and themes of interest.....	5
3	Training activities performed.....	6
3.1	Training manual – EENSULATE Best Practices booklet	6
3.2	Training videos	9
3.3	Public webinar organization and recording	11
3.4	EENSULATE Installation Guidelines.....	13
3.5	Project website implementation.....	15
4	Conclusion.....	16

List of Figures

Figure 1 Best Practice Booklet.....	8
Figure 2 Training video 1: Installation of the EENSULATE facade module.....	9
Figure 3 Training video 2: Public School Dzierzoniow	10
Figure 4 Training video 3: Muzeum Dzierzoniow	10
Figure 5 EENSULATE Webinar.....	11
Figure 6 Webinar recording on EENSULATE website and YouTube channel.....	12
Figure 7 EENSULATE Installation Guidelines Booklet	15

Abbreviations and Acronyms

D	Deliverable
M	Month
ESCO	Energy Service Company
WP	Work Package
VIG	Vacuum Insulated Glass

1 Introduction

The idea behind the EENSULATE project to bring existing curtain wall buildings to nearly zero energy standards is a result of challenge Europe is currently facing. Thousands of buildings in Europe were constructed in the recent decades using curtain walls. However, the curtain wall technology of this time is regarded as substandard today and contribute to energy inefficiency of said buildings. Consequently, in order to improve energy consumption in the existing curtain wall building stock, retrofitting solutions must be developed and implemented. The need for energy efficient curtain wall solutions is furthermore more enhanced by the fact that curtain wall technology has recently moved from office buildings to glazed residential towers.

As the EENSULATE project has developed several new technologies, tools and practices, training activities were important part of the WP6 towards the end of the EENSULATE project. These activities exploited processes and tools developed in the EENSULATE Project and further elaborated them to be available to a wider community of professionals, relevant for the production, design, application, installation and disassembly.

2 Target audience and themes of interest

The main goal of the training activities for the EENSULATE project was to train professionals and stakeholders involved in the insulation materials, energy efficiency and the construction sector in general as well as to disseminate the EENSULATE Best Practice.

In order to define the content of training materials and guidelines, different stakeholders have been identified together with their themes of interest. The target audience was identified as follows:

- Educators (academic staff, researchers, higher education, public administration in charge of energy and building, etc.).
- Technical Experts (architects, engineers, designers, construction industry, installers, etc.).
- Decision Makers (Investors and developers, local and regional authorities, etc.).
- Service providers (thermo-technical companies, construction companies, ESCOs).
- Standardization/certification bodies (technical chambers, National standard organizations).
- End users.

The themes of interest were identified as follows:

- EENSULATE technology development and its benefits.
- EENSULATE real-scale demonstration.
- Retrofit process application at the individual demonstration site interventions
- Final state of the demonstration interventions
- EENSULATE Best practice and recommendations.

3 Training activities performed

According to the themes of interests of each target audience group, different training materials have been prepared:

- Training manual – “EENSULATE Best Practice” booklet
- Training videos – Demonstration site installation process and finalisation
- Public webinar organization and the webinar recording
- EENSULATE installation guidelines
- Project website implementation

3.1 Training manual – EENSULATE Best Practices booklet

A 16 pages long booklet “BEST PRACTICE BOKLET” was created by FENIX in cooperation with technical partners. The Booklet is available on the EENSULATE project website and was intended for printing and distribution on physical events. The latter is not possible at the moment due to the coronavirus restrictions and the fact that physical events are being cancelled. Therefore, the EENSULATE project is putting more emphasis on the online dissemination of the material, social media profiles, press releases, newsletter, etc. The booklet is available on the project website, in the section “Training” (<http://www.eensulate.eu/documents/training>).

The main topics covered in the booklet:

- EENSULATE main technologies (Vacuum Insulated Glass – VIG), Foam, Sealant, Getter, Thermochromic coating.
- EENSULATE real-scale demonstration.
- Retrofit process application at the individual demonstration sites.

HIGH END MATERIAL FOR MODERN BUILDINGS

Development of lightweight and highly insulating energy efficient components and associated coating materials for cost-effective retrofitting and new construction of curtain wall facades.

EENSULATE

BEST PRACTICES BOOKLET

PROJECT PARTNERS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101019744.

MAIN TECHNOLOGIES

1. Lightweight and thermally transparent insulating glass (VIG) for transparent part of the facade curtain wall construction.
2. High insulating and fire resistant foam to be used for the insulation of non-panels, a two-component injection expansion foam (OCF) to be used in the curtain part and a one-component polyurethane foam (TCF) to be used as thermal insulator, both shaped with a vacuum.
3. EENSULATE Sucker
4. EENSULATE Sucker
5. Thermochromic coating

VACUUM INSULATED GLASS (VIG)

Vacuum Insulated Glass (VIG) manufactured by AGC with a patented manufacturing process implementing the innovative insulator and spacer design, to ensure the achievement of the target performance. The VIG is manufactured in two sizes:

- Small Scale VIG prototypes (300x300mm)
- Large scale VIG prototypes (1000x1000mm)

The assembly process for the small-scale VIG prototypes by AGC required a significant and sustained effort by two project partners, namely UICLER and SACS, contributing to the achievement of the project performance goals and the definition of suitable process protocol ready for technology transfer for large scale production.

Two approaches were investigated for the application of the polymer edge sealant:

1. Heads dispensing by semi-automated two-step generation based on robot arm for heat a compression edge VIG sealant.
2. Manual application of a water-based primed solid strip.

EENSULATE FOAMS

ONE-COMPONENT FOAM (OCF)

The OCF will be used as an effective thermal insulator between curtain wall and sub-structure, comprising a foaming agent that will prevent wall cavities and prevent moisture and dirt from entering and degrading the foam in the cavities. The polyurethane foam is packaged in a pre-foamed can and can be easily used in construction sites.

Why it is beneficial?
EENSULATE OCF has improved behavior thanks to the use of reticulated inorganic fillers and responsible right to obtain a high level of resistance. The experience from the component foam was transferred to increase the properties and improve the compound (eg. hydrophobic).

TWO-COMPONENT FOAM (TCF)

TCF is a high insulating polyurethane foam based on liquid material enhanced with in-situ formed urethane fillers, that contribute to meet energy performance requirements, environmental challenges and cost reduction without undue compromise of the overall building safety. The TCF is used to be injected working for the manufacturing of glazing replacing cast-in-place mineral wool panels.

Why it is beneficial?
The advantage of the TCF system during the production phase are the increased efficiency of its liquid and ease of the processing. The system with urethane fillers also provides a unique property because of the formation of a microvoid system (avoiding an effective barrier against heat and oxygen, prevent non-flammable gases, and at the same effectively aggregates smoke and gas during the combustion process).

EENSULATE SEALANT

Within the material development, a number of polymer materials have been analyzed. The most promising solution was represented by polyurethanes, typically with a permeability around 10⁻¹³ bar·cm. This, by means of a thorough material analysis of the polymer formulations and the optimization of the active and passive fillers, it was finally obtained a sealant formulation with 2.5-10⁻¹³ bar·cm of permeability. The final formulation also exhibited extremely high barrier performance for N₂ and O₂ (all two orders of magnitude better than commercial sealants for glazing glass). The sealant contains also an active filler for moisture absorption. The resin has high yield stress and adhesion strength to TSPs on glass surfaces. It can be processed in air and exposed to an accelerated system working with precise operation in the range of 50-80 °C and final curing at a temperature range of 150-170 °C.

EENSULATE GETTER

In the context of the distributed getter development, two getter families have been investigated: polymer-based and metallic organic coated films. Metallic organic coated films exhibited a higher ionization rate than the other two families. In particular, both S19T coated films and S122 based high porous thin films (S19T) may fulfil the selection criteria. However, coating films are hardly suitable to an industrial production while S19T products exceed the cost targets for VIG technology. Finally, the best getter solution was identified in laminated strips of a 2-μm-thick ZAF2O₃ alloy. This solution meets the application capacity requirements for VIG and OCF films and is superior than state of art solutions for VIG. It allows an industrial coating at a reasonable cost and can be easily handled for industrial use. The getter activation is performed by radio-frequency heating.

THERMOCROMIC COATING

To face the increasing request need to reduce the energy demands in buildings, EENSULATE proposes a glazed facade system based on VIG technology equipped with a thermochromic coated glass.

Thermochromic film has become a recognized potential solution for the reduction of the solar radiation entering into glazed systems due to its intrinsic ability of the glass as a function of its temperature. The "smallest" property of the thermochromic film distinguishes the transition rate of the device. From one part of the spectrum, the film has the same degree of insulation under the ambient temperature. On the contrary, the thermochromic window has a dynamic behavior as a filter or not the solar radiation entering through the glazed facade depending on the temperature reached by the thermochromic coating. In fact, below a certain temperature, called switching temperature, the coating allows solar radiation entering the building while above this temperature the solar radiation is reflected outside preventing indoor overheating.

Energy building simulation has been performed considering the effect of the first thermochromic system developed within the EENSULATE project on the energy saving against both clear glass systems and the VIG EENSULATE module. The simulation has to have the optical properties (solar and visible reflectance and transmittance) of the thermochromic glass provided by UICL and measured in the UNIROM laboratory. These properties have been considered as baseline from which the simulation starts. By changing the switching temperature and measuring the building energy consumption on the optimal thermochromic configuration has been released.

EXPERIMENTAL CHARACTERIZATION OF THERMOCROMIC COATED GLASS

- Substrate transmission and reflectance estimation
- Switching temperature evaluation

VIRTUAL TEST BENCH DEVELOPMENT APPLYING THE THERMOCROMIC GLASS CHARACTERIZATION

FUNCTIONAL TEMPERATURE OPTIMIZATION USING THE VIRTUAL TEST BENCH

At UICL, we applied a thermochromic VIG coating by using a sol-gel process and spin coating on glass. The coating is able to change the transmittance of glass as a function of the ambient temperature. At low temperatures the coating is highly transparent but as temperature rises it becomes more opaque particularly at the near infrared part of the spectrum. Our collaborators at Inceca have been involved by using building energy modeling software EnergyPlus: the performance of the thermochromic coating when applied in real buildings and have identified optimal conditions for different cities in Europe and types of buildings.

EENSULATE REAL-SCALE DEMONSTRATION

The performance of the Eensulate insulating solution will be assessed at full scale prototype demonstration buildings. We installed in three different climates (Italy and Poland). The focus will be placed on the thermo-optical behaviour of demo buildings and indoor comfort and different parameters will be monitored:

- Internal and external wall temperature
- Heat flux
- Indoor temperature and humidity
- Several transmission loss

POLISH SCHOOL - DZIERZONIOW, POLAND

The Polish school located in a historic wall building that the thermochromic technology would be used to enhance the facade performance. The renovation intervention consists of producing glazing curtain walls enhancing the building profile to save energy in the walls and external targets for public buildings. After the implementation of EENSULATE solution, the building will be a model case proving the project results to both national and international stakeholders, representing also the usage of thermochromic quality.

Intervention details

The renovation intervention consists of the full substitution of the system wall facade including thermal of the school building. The selected facade is one of the three facades of the overall building. The building area subject to the refurbishment is organized as an open space where students spend their free time during breaks. In order to compare the performance of the project developed solution, the two floors building facade is covered in part by EENSULATE module with VIG and the rest by the same module including standard VIG (Triple Glass UICL in the frame).

MUZEUM MIEJSKIE DZIERZONIOWA - DZIERZONIOW, POLAND

This museum, built in 1937, originally belonged to Hermann Gotha, a founder and one of the first mechanical weaving mill in Dzierzonow. The building has been carried out energy renovation and adaptation in order to improve the available space for museum purposes. Preserved elements of the modern structure include: former play thanks to the concrete work carried out. Today the museum hosts permanent exhibitions, including contemporary collections and documents concerning Dzierzonow and the surrounding area. A large collection of artifacts illustrates the development of the region since the last Renaissance to modern times.

Intervention details

The foremost intervention is the implementation of EENSULATE glass based on VIG (Vacuum Insulated Glass) technology in a selected number of museum windows, being an historic building, the restoration works, including the ones related to the windows, are subject to several and severe restrictions to preserve its artistic value. The first step, the implementation of VIG directly in the original window, increases the impact of the intervention increasing their insulation capacity with a consequent benefit for the people ready the room. This kind of operation is possible thanks to the small thickness of the VIG (122 mm) and the lightweight, perfectly adaptable to the original windows, increasing their performance without changing within the restrictions of the original one simply substituting the artistic aspect.

PUBLIC LIBRARY SAN GIOVANNI - PESARO, ITALY

Headed by the ancient monastery of the First Monks' Order, once annexed to the church of San Giovanni Battista long of Pesaro's most beautiful architectural works and planned by the Della Rovere family's architect Giovanni Battista, the library San Giovanni is an example where the historical site facade facing the access street and contemporary architectural elements coincide. These elements are a large windowed system for the lighting of the public space and a curtain wall facade to the building main entrance. The building acts as a case for testing EENSULATE glass in new contexts in the historical fabric. Although Pesaro municipality is not a project partner, they gave the availability of the building as demonstration site of EENSULATE project.

Intervention details

The foremost intervention is the implementation of EENSULATE glass based on VIG (Vacuum Insulated Glass) technology in a double window located in an area of the building organized as an open space building facade. The VIG will be installed directly in the original frame of the door window, ensuring the works to be carried out as well as the state of material. Nevertheless, the simple substitution of the glass part of the door window with high insulating VIG increases the thermal capacity of the window system with a consequent benefit for the people ready the room. The door window is composed by two parts, the above one is fixed, ensuring the possibility of opening and the bottom part is an emergency door with a conducting directly outside the building.

RETROFIT PROCESS APPLICATION AT THE INDIVIDUAL DEMONSTRATION SITES

POLISH SCHOOL - DZIERZONIOW, POLAND

The school building facade is a curtain wall and represents an ideal example to test and validate the applicability of the EENSULATE module.

Boundary conditions: Architectural and normative requirements

Some boundary conditions emerged during the design phase. On the base of activities about EENSULATE system design conducted within the project, some key elements became evident and are being addressed through the following actions for the restoration:

- **Load bearing structure** - out of scope of the project is to work on structural components of the existing building, therefore the EENSULATE facade must be able to be installed on the existing load bearing structure of the building. With this purpose, the existing curtain wall facade is a brick system installed on the front of the side and the installation of EENSULATE module replicates the bearing structure. Once removed the existing facade, new brackets will be installed to support the EENSULATE modules.
- **Facade interfaces with existing elements** - the interfaces between EENSULATE module and building elements (walls, ceiling, roof) are other crucial parts to be designed. The concept to maintain the facade of the EENSULATE module is to guarantee a "fit to be installed" solution. With this purpose as much as possible details need to be designed and solved off-site, reducing at maximum the installation on-site. The Figure 2, the Figure 3 and the Figure 4 show some pictures of the facade to be designed.

Facade colors - specific request of the municipality is to preserve the aesthetic consistency of the restored facade in relation to the other existing facade not subject of renovation. For this reason, the application of public treatments has similar colors to those already present in the building have been considered.

Adam Mickiewicz School study with EENSULATE system
Adam Mickiewicz School study with EENSULATE system

Retrofitting design
On the basis of above-mentioned considerations and thanks to the building school survey conducted on-site by BOSTEC, POLCOOR carried out the EENSULATE system retrofitting design.

Structure section with facade
Facade design

Monitoring design for validation phase
The school will be equipped to monitor the EENSULATE system performance in a real situation in comparison to common low energy triple glass (IGU). In order to perform the system characterization, both systems will be monitored with thermal and irradiance sensors. A picture of the Polish School facade can be seen on the image below, with the EENSULATE system highlighted in red and in yellow the standard glass installed in a frame close to the EENSULATE one.

The main physical quantities to be monitored are:

- Internal and external glass surface temperature
- Indoor and outdoor air temperature
- Heat flux through the glass
- Multiple external and internal radiation
- Solar external and internal radiation

From these data the thermal and optical transmittance of the glass can be calculated for the entire period of the monitoring activity.

Polish Primary School facade

Intervention

Before intervention
After intervention

Installation of EENSULATE system on Adam Mickiewicz Public School

MUZEUM MIEJSKIE DZIERZONIOWA - DZIERZONIOW, POLAND

Boundary conditions: Architectural and normative requirements
Being a historical building, the Museum has its restrictions in regard with modification of elements of its construction. It is expected that the new windows approach visually the same as the ones of the already existing facade.

Thanks to the EENSULATE project we can preserve the possibility of substitution of window pane performing obligations with high thermal figures including double IGU keeping the same construction of the window. Thanks to the thickness and lightweight of the new glass. In case of replacing for new windows it is usually a very challenging and costly to obtain the same details of window construction as shape and hardware.

Web-EENSULATE solution the process and analysis of facade highlighting terms of obtaining special permissions. According to the construction law, works on the monument require a building permit and the content of the monument conservation that is not easy to be obtained due to several requirements to be respected to allow the renovation in this specific field.

Retrofitting design
In case of the Polish Museum, the scope of activities within EENSULATE project focuses on renovation of a selected number of windows in one room on the ground floor. It is important that the intervention does not change visual aspect of the building.

Polish Museum - San Giovanni

Existing windows are old box windows with double sash covering to the inside filled with a single glass. As whole window construction is deteriorated and needs renovation, frame and sash will be repaired by sanding, painting, changing gaskets and performing all necessary works required for a proper functioning in order of the replacement of the pane low frame on site.

Old single glass will be replaced with EENSULATE WG of thickness 12,2 mm in 100x100 mm and weight 18kg/m² by dismounting the window sash.

Window sash will be removed carefully in order to perform renovation works. It will be sealed and painted. Hardware will be repaired and new gaskets will be attached. Then single glass will be replaced by IGU. The same sash will be installed in renovated, existing frame. During the intervention, the window opening will be protected against dusting and weather conditions. Thanks to the thorough assessment of necessary works on the base of assessment will be carried out continuously.

Polish Museum - intervention with renovation
Polish Museum - finished work with new public double frame

Monitoring design for validation phase
The Polish Museum will be monitored to estimate relative glass transmittance performance, therefore two glass systems will be monitored. The one that includes the EENSULATE system (shown red line in the image below) and the second one is installed by the standard glass (shown yellow line in the image below). The Polish Museum, the thermal comfort will be monitored. To this aim the following quantities will be measured:

- room mean radiant temperature
- relative humidity
- velocity of the air in the room

Polish Museum facade with sensors for monitoring performance

SAN GIOVANNI PUBLIC LIBRARY - PESARO, ITALY

Boundary conditions: Architectural and normative requirements
San Giovanni Public Library is a complex building managed by the San Marino public, protected by the regional protection of Architectural Superintendence. Therefore, the possible intervention for the application of EENSULATE solutions have been evaluated to respect with the existing and historical configuration of the building and decrease the approval process needed and without compromise of success. For this reason, the design has been considered not suitable to substitute the existing window with the EENSULATE module. The intervention has been conducted on a door window replacing the existing IGU with the WG. Along the main corridor of the library there is a large window with double sash and wooden frame and IGU in the center. The intervention will include the EENSULATE WG alternative replacing the existing IGU, not affecting the aesthetic of the building. The EENSULATE WG application on the new subject of substituting in this case.

Retrofitting design
The aim of the above-mentioned selection process to generate the overall window frame and replace only the IGU (120 mm) with the 100 mm WG. The intervention will be conducted choosing the internal aluminum frame which includes the IGU. Keeping the size from the existing window, placing the WG, setting the edge to consider air and water tightness performance and respecting the shut-off system in their initial position.

San Giovanni Public Library interior view
San Giovanni Public Library exterior view

San Giovanni Public Library
EENSULATE WG application

Monitoring design for validation phase
The San Giovanni Public Library will be monitored in terms of glass transmittance and room comfort as for the Polish Museum. In addition, in this historical building, the wall transmittance is measured as well for reason of a heat flux in the wall. Thermographic control on the internal and external surface of the wall will be the same quantity as for the Polish Museum. The wall transmittance will be measured with an external; the control will be measured with a camera fixed on the wall. The monitoring has been started in October 2019 for analyzing the transmittance of the glass quantity installed and the indoor comfort. The data required will be used for comparing the glass performance in more conditions in the case of comparison or for assessing the improvement that will be obtained with the replacement of the window with the EENSULATE system.

San Giovanni Public Library facade view
San Giovanni Public Library interior view

San Giovanni Public Library facade view
San Giovanni Public Library interior view

Intervention

Polish Museum - The facade view

CONCLUSION

The range of EENSULATE solutions for retrofitting scenarios demonstrates the wide applicability of EENSULATE components in different building types of retrofitting projects. Their capability and applicability to some application conditions can be defined regarding the retrofitting market with EENSULATE components, in conceptual manner.

Retrofitting of Certain Wall Facade

- Facade replacement** - EENSULATE WG is a solution which needs to be applicable for the replacement of existing Certain Wall Facade. The chosen building, indeed, the EENSULATE module is lightweight and can be installed on the existing structure of the building but also it is possible to use the existing structure. The main issue of the EENSULATE module can be considered the weight of the window pane.
- Existing glass replacement** - EENSULATE WG is a solution which is applicable for the replacement of the glass elements in Certain Wall Facade. The chosen building, indeed, the EENSULATE WG is applicable with more changes in Certain Wall Facade and will be the adoption of a second profile to add another window. Using the EENSULATE WG, the main issue of the EENSULATE WG is the weight of the window pane. The EENSULATE WG is a solution which is applicable for the replacement of the glass elements in Certain Wall Facade. The chosen building, indeed, the EENSULATE WG is applicable with more changes in Certain Wall Facade and will be the adoption of a second profile to add another window. Using the EENSULATE WG, the main issue of the EENSULATE WG is the weight of the window pane.

Retrofitting of Windows

- Historical window** - EENSULATE WG is a solution applicable for the replacement of historical glass with improvement of energy transmittance without affecting the overall configuration of the window.
- Contemporary window** - EENSULATE WG is a solution applicable for the replacement of double-glazed units. Triple-glazed units in existing windows with improvement of energy transmittance without affecting the overall configuration of the window.

Figure 1 Best Practice Booklet

3.2 Training videos

Three training videos were developed for the EENSULATE project. They are related to installation of the EENSULATE facade modules / windows at the demonstration sites. All EENSULATE project videos are stored in the project website (<http://www.eensulate.eu/videos>) as well as on the YouTube channel (<https://www.youtube.com/channel/UCIC6QSaaOrtw3EGRT0cxQ-g>)

Installation of the EENSULATE façade module – Public school, Dzierzoniów

The video focuses on the installation process of the EENSULATE façade module on the demonstration site in Dzierzoniów – the Public school.

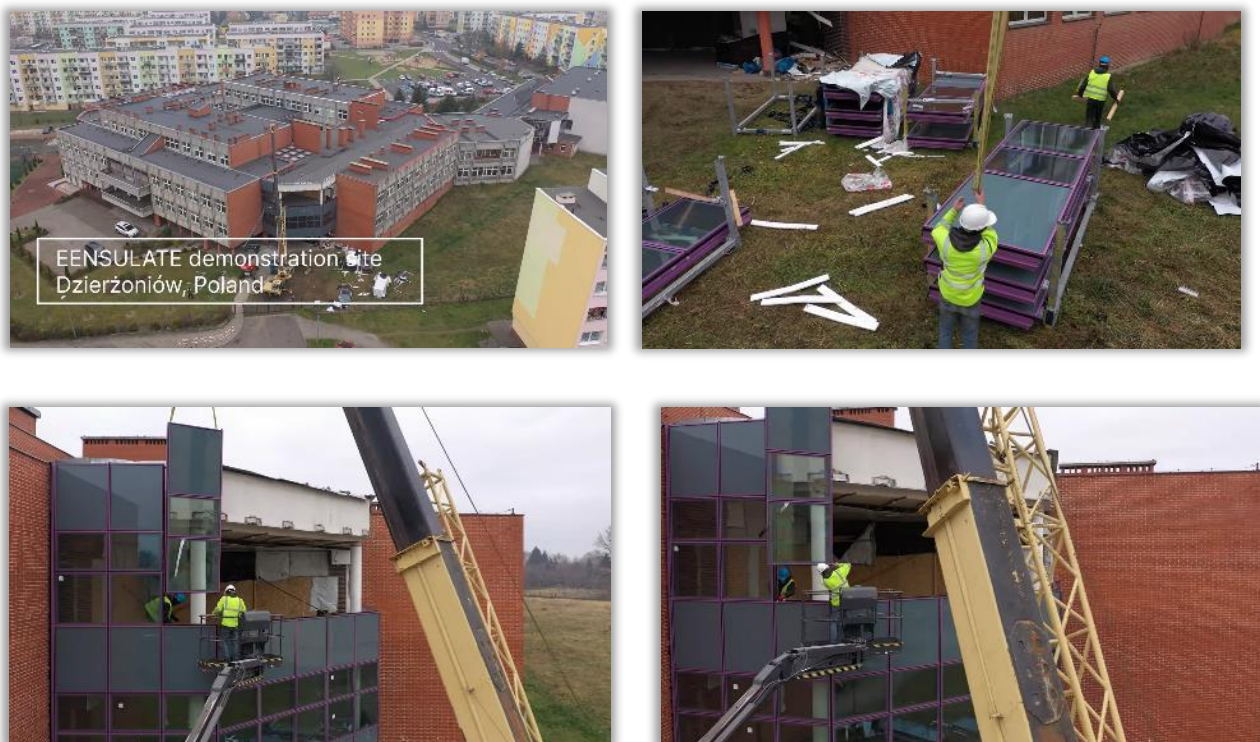


Figure 2 Training video 1: Installation of the EENSULATE facade module

Final state of the EENSULATE façade module – Public school, Dzierzoniow

The video showcases the final state of the EENSULATE façade module at the demonstration site in Dzierzoniow – the Public school.



Figure 3 Training video 2: Public School Dzierzoniow

Final state of the EENSULATE VIG demo – Museum, Dzierzoniow

The video showcases the final state of the EENSULATE VIG at the demonstration site in Dzierzoniow – the Muzeum.



Figure 4 Training video 3: Muzeum Dzierzoniow

3.3 Public webinar organization and recording

Webinar session format and recording

In M55, the EENSULATE project organized a public webinar focused on the project results and progress along with the themes and interests of the target groups identified (see chapter 2 of this Deliverable), such as: EENSULATE main technologies introduction, the development process, design, and its benefits; EENSULATE real-scale demonstration, etc... The format of the webinar was a moderated panel discussion with three speakers and a moderator. The event was organized in cooperation with the Build Up portal in order to attract bigger audience, to have a strong media partner and to add credibility to the event. 50 attendees were present at the event. The session was highly interactive, there were 2 polls for the audience to participate in and the video from the installation of the EENSULATE façade module was played in real time. There was also a Q & A session, where the audience raised various questions and the EENSULATE experts answered them in detail.

The whole webinar was recorded and shared on the project website (<http://www.eensulate.eu/webinar>) and YouTube channel (<https://www.youtube.com/watch?v=cg8TRDwd6mE&t=1500s>) for further training and educational purposes.

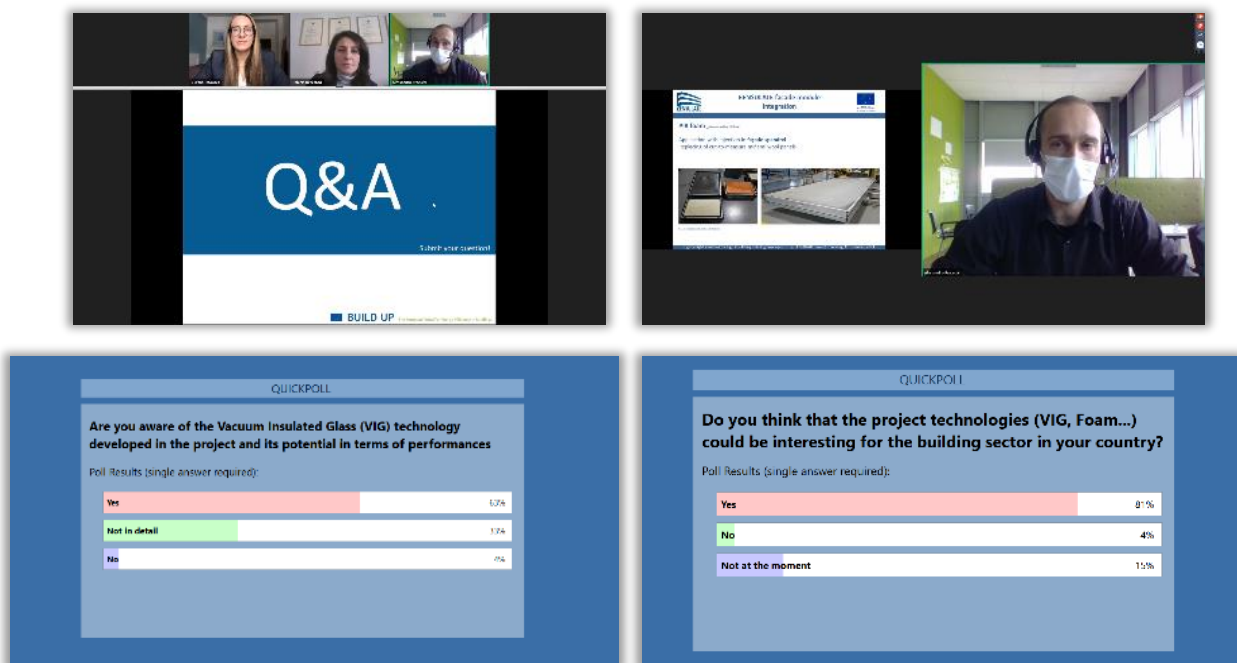


Figure 5 EENSULATE Webinar

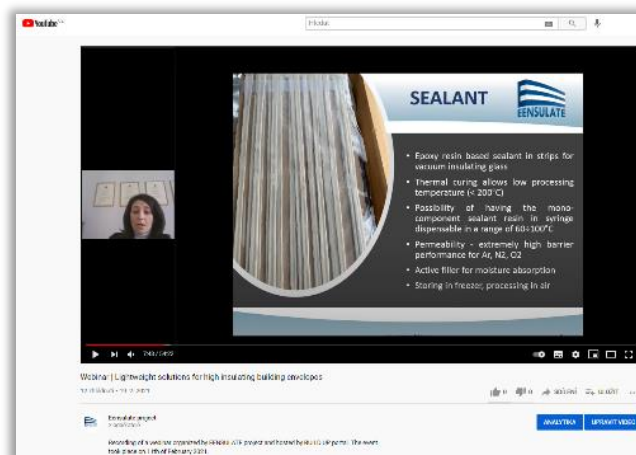
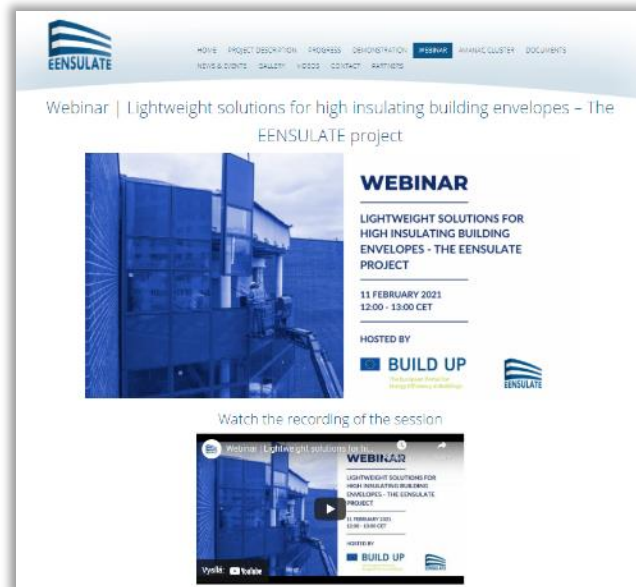


Figure 6 Webinar recording on EENSULATE website and YouTube channel

Further details regarding the dissemination campaign and the content of the Webinar can be found in D6.8 “Policy workshops and awareness campaign”.

3.4 EENSULATE Installation Guidelines

A booklet on “EENSULATE installation guidelines” was created by FENIX in cooperation with technical partners – especially BGTEC. The Guidelines are aimed at Technical Experts (architects, engineers, designers, construction industry, installers, etc.) and service providers (thermo-technical companies, construction companies, ESCOs) and therefore includes a more technical information. To be available as a standalone publication, the EENSULATE demo sites and the interventions are described similarly as in the “Best practice booklet”.

The guidelines are available on the EENSULATE project website and similarly as the “Best practice booklet” were intended for printing and distribution on physical events. EENSULATE project will, due to ongoing travel restrictions, put emphasis on the online dissemination of the material, social media profiles, press releases, newsletter, etc. The booklet will be available on the project website, in the section “Training” (<http://www.eensulate.eu/documents/training>).

The main topics covered in the guidelines are the following:

- EENSULATE products introduction – installation guidelines for - façade module, VIG
- EENSULATE real-scale demonstration – description of demo building and the conducted interventions
- EENSULATE retrofitting installation process in different scenarios – Curtain wall façade (facade replacement), windows (historical and contemporary)
- Individual steps of the interventions with images and descriptions
- Conclusions

EENSULATE

HIGH END MATERIAL FOR MODERN BUILDINGS

Development of innovative lightweight and highly insulating energy efficient components and associated enabling materials for cost-effective retrofitting and renovation of existing buildings.

INSTALLATION GUIDELINES

EENSULATE REAL-SCALE DEMONSTRATION

PROJECT PARTNERS

The project has received funding from European Union under Horizon 2020 research and innovation programme grant agreement No. 101019154

EENSULATE PRODUCTS

1. EENSULATE façade module

The EENSULATE façade module is part of the curtain wall system which integrates VIG and ICF (IC component) panel for the spandrel part, in combination with a contained profile.

2. EENSULATE VIG

The EENSULATE Vacuum Insulated Glass (VIG) is a lightweight and thin vacuum glazing suitable for new existing architectural modules or used as the curtain wall module.

- Facade installation consisting of building preparatory works, supporting system fitting and modules installation, taking into consideration all connections, sealing and finishing.
- Substitution of existing glazing with vacuum glass only by window such demounting.

POLISH SCHOOL - DZIERZONIOW, POLAND

The Public school makes in a curtain wall building which the Dzierzoniow municipality aims to refurbish to improve the facade performance. The EENSULATE renovation intervention consisted of installing curtain wall modules to enhance the building profile to zero energy in line with EU and national targets for public buildings. After the implementation of EENSULATE solutions, the building became a show case among the project results to both national and international stakeholders and enhancing the image of Dzierzoniow municipality.

INTERVENTION DETAILS

The renovation intervention consisted of the full substitution of the curtain wall facade building corner of the school building. The selected facade was one of three facades of the building. The selected facade area is equivalent to an open space where students spend their free time during breaks.

In order to compare the performance of the project developed solution, the facade was partially covered by EENSULATE modules with VIG and partially by the same module, but using standard IGU (Triple-Glass Unit).

Demonstrator	Location	Total area	Type of intervention	Note
School	Dzierzoniow, Poland	1150m ²	Facade system, VIG modules	1 facade with VIG and IGU

MUZEM MIEJSKIE DZIERZONIOWA - DZIERZONIOW, POLAND

The Museum, built in 1893 originally belonged to Herman Cichy, Cichy-Gotlibski, co-founder and was one of the first mechanical weaving mills in Dzierzoniow. The building has undergone many renovations and adaptations in order to adjust the space for museum purposes. Historical elements of the interior gradually returned to its former state thanks to conservation work. Today the museum hosts permanent exhibitions, including temporary collections concerning Dzierzoniow and the surrounding area. A large collection of artifacts illustrates the development of the region since the late 19th-century times.

INTERVENTION DETAILS

The intervention and the implementation of EENSULATE (VIG) based on VIG technology was done in a selected number of museum windows. Being a historical building, renovation works, including the ones related to the windows, are subject to special and strict restrictions to preserve its artistic value. For this reason, the implementation of VIG directly in the original windows maintained the respect of the intervention respecting the insulation capacity with a benefit for the people inside the room. This kind of operation is possible thanks to the low thickness (12.2 mm) and light weight of the VIG, perfectly adapting to the original window increasing their performance without changing neither the structure, the window frame is the original one for the aesthetic aspect.

Demonstrator	Location	Total area	Type of intervention	Note
Museum	Dzierzoniow, Poland	620m ²	Windows	Complete substitution of old single glass with VIG

PUBLIC LIBRARY SAN GIOVANNI - PESARO, ITALY

Hosted by the ancient monastery of the Friar Minor Osservanti, once annexed to the church of San Giovanni Battista (one of the most beautiful architectural works) and planned by the Della Rovere family architect Gaspare Genga, the library San Giovanni is an example where the historical value fuses being the avant-garde and contemporary architecture elements concept. There elements are a large window system for the lighting of the public space and a curtain walling facade in the building main entrance. The building acted as a demo for testing EENSULATE glazing in one door window along the main corridor of the library. Although the municipality is not a proper partner that made this building available at demonstration site of the EENSULATE project.

INTERVENTION DETAILS

The intervention was done by implementation of EENSULATE (VIG) based on VIG technology in a door window located in an area of the building reserved as an open space facing a Mall Area. The VIG was installed directly in the original frame of the door window, replacing the most central part as well as the frame of wood.

The simple substitution of the glass part of the door window with a high-insulating VIG increases the thermal insulation of the window system with a consequent benefit for the visitors. The door window is composed of two parts, the door one is fixed (without the possibility of opening) and the bottom part is an emergency door and leading directly inside the building.

Demonstrator	Location	Total area	Type of intervention	Note
Public Library	Pesaro, Italy	220m ²	Door	1 door substitution of IGU with VIG

EENSULATE RETROFITTING INSTALLATION PROCESS

The following retrofitting scenarios were defined in order to demonstrate the applicability of EENSULATE components in different building retrofitting cases.

1. Curtain Wall Facade (facade replacement)

EENSULATE module replacing existing Curtain Wall Facade (Public Primary School case): the module is part of the curtain wall system, which integrates VIG and component foam to fill the spandrel volume in combination with a contained profile. This lightweight solution contributes to reduce the weight on the load bearing structure of the building and to increase its energy performance.

2. Windows (historical and contemporary)

EENSULATE VIG is a light and thin vacuum glazing suitable for historical and existing windows.

Historical window - VIG for replacement of old single glass with improvement of energy performance without affecting the overall view of the window.

Contemporary window - VIG for the replacement of standard IGU (IGU) in existing window with improvement of performance without affecting the overall configuration of the window.

PRIMARY SCHOOL IN DZIERZONIOW - CURTAIN WALL

The building has been built in 1911 and it has a total curtain wall facade area of around 500 sqm. One of the three existing facades with surface of around 133 square meters was dismantled and the new EENSULATE facade was installed. The replacement of the building was in line with the same appearance in terms of shape, divisions and colours as existing aluminium facade to be compliant with the two other facades.

CURTAIN WALL FACADE RETROFITTING

THE INTERVENTION

Installation process begins with proper positioning of the brackets located on the board of the floor slabs. Location of the area of the building interior is recorded and a grid of position is signed on a drawing. Two brackets installation is used as a construction reference.

PUBLIC LIBRARY SAN GIOVANNI - WINDOW RETROFITTING

The facade units are then fastened to the brackets located in the building slab. To settle the modular curtain wall units into position and securing to the bracket located on the slab are performed from the outside of the building.

The units are lifted from a platform area on the ground near to the facade.

INSTALLATION STEPS:

Particular modules are lifted and directed to the appropriate location by means of crane then guided and hoisted into position by the crew in order to be secured to the pre-installed anchors.

Modules are attached sequentially following instruction marked on prepared documentation. To guarantee that the units are correctly in position and for guaranteeing permeability of the facade wall, it is necessary to pay attention to brackets, seals and joints are properly applied.

The new Eensulate facade is keeping the same thickness to be in line with existing facade.

DZIERZONIOW CITY MUSEUM - WINDOW RETROFITTING

EENSULATE activities in this demo include substitution of three glazing panels in existing glazing in windows located in one room on the ground floor.

INSTALLATION STEPS:

Due to the historical character of the building the original window frames were completely retained substituting existing old single glass with EENSULATE VIG by demounting the window with and without affecting window construction and its appearance.

Existing windows were old four windows with double sash opening to the inside, fixed with a single glass (6+6+6mm), by dismantling the window sash.

All the window construction were dismantled to be able to install the new glass, each sash is removed by working pointing using the most similar material as existing ones and performing all necessary works required for proper fastening.

THE INTERVENTION

Window sash is removed carefully in order to perform reconstruction works.

The old glass is removed, and the wooden sub-frames are dismantled and reworked.

BEFORE GLAZING APPLICATION, WOODEN ELEMENTS PARTS ARE PROTECTED WITH TIPS

After cleaning the area for inserting VIG, the new glazing is applied.

The Eensulate VIG is prepared with tailored dimensions by particular window sash.

Previously manufactured EENSULATE VIG is inserted into existing window window frames by using vacuum hoister.

To cover weather and gether, the VIG edges are painted with special coating with the same colour as window construction. Then, window sashes is equipped using the same colour as existing windows.

Finally, the same sashes with EENSULATE vacuum glass are installed in the existing frame on site.

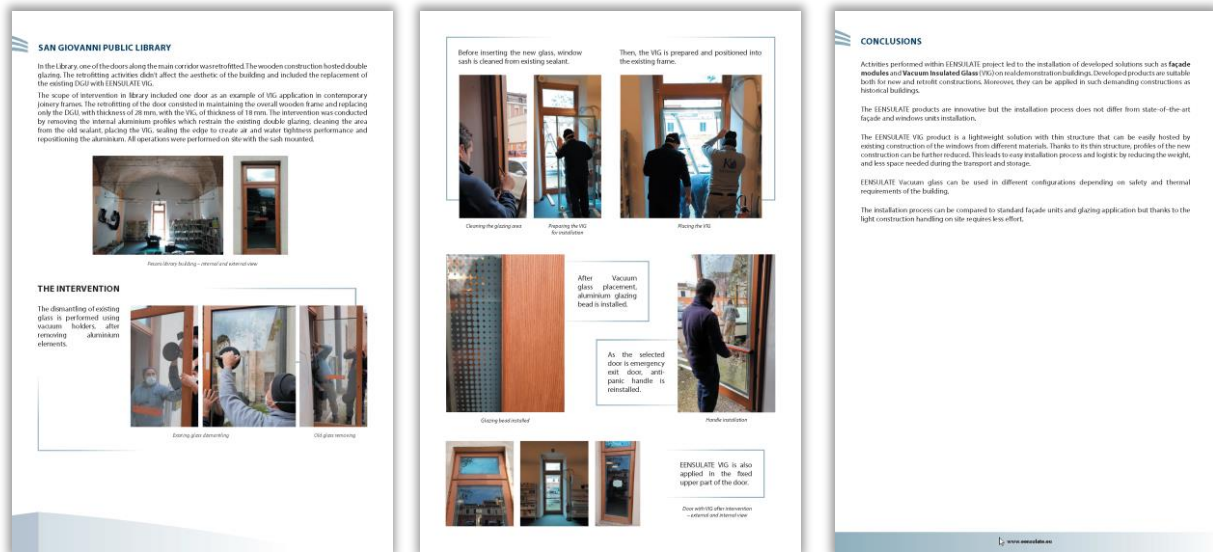


Figure 7 EENSULATE Installation Guidelines Booklet

3.5 Project website implementation

The EENSULATE project website acts as a main hub for all project information. The website will be kept online after the end of the project and therefore all information needs to be available – including a dedicated section in training activities. The website will be updated in the final month of the project to reflect the whole duration of the project.

The website will include:

- Project description, technologies description, project progress
- Training section (Training manual – “EENSULATE Best Practice” booklet, Training videos – Demonstration site installation process, Public webinar recording and the EENSULATE installation guidelines)
- Demonstration sites description, intervention details etc.
- Documents – all promo materials, presentations, publications, newsletters
- Videos – all videos produced – including Final EENSULATE video
- Contact & Partners information – for follow up work, exploitation, and projects.
- Final statement of the project coordinator

4 Conclusion

This report contains a summary of all training activities performed for the EENSULATE project. The training activities were carefully selected considering the selected target groups and their main themes of interest. The booklet “EENSULATE Best Practices” contains detailed technical information about the development of the EENSULATE main technologies, its benefits, design, EENSULATE real-scale demonstration and more, as described in the 3.1 chapter of this deliverable. Three training videos were created, there was a public webinar organized in cooperation with the Build Up portal which attracted solid number of the project stakeholders which was partly due to the strong partner that was chosen and partly due to the extensive promotion campaign. A recording from the event is available on all the project communication channels and the Build Up portal as well. A set of EENSULATE Installation guidelines was also created with the intention to share the intervention details with a more technical focused audience.

Most of the training activities were carried out during the last six months of the project. Every output of the training activities is accessible online through the project website, which will be kept online for minimum 2 years after the project ends. This means that the training material will be available even after the project reaches its end.