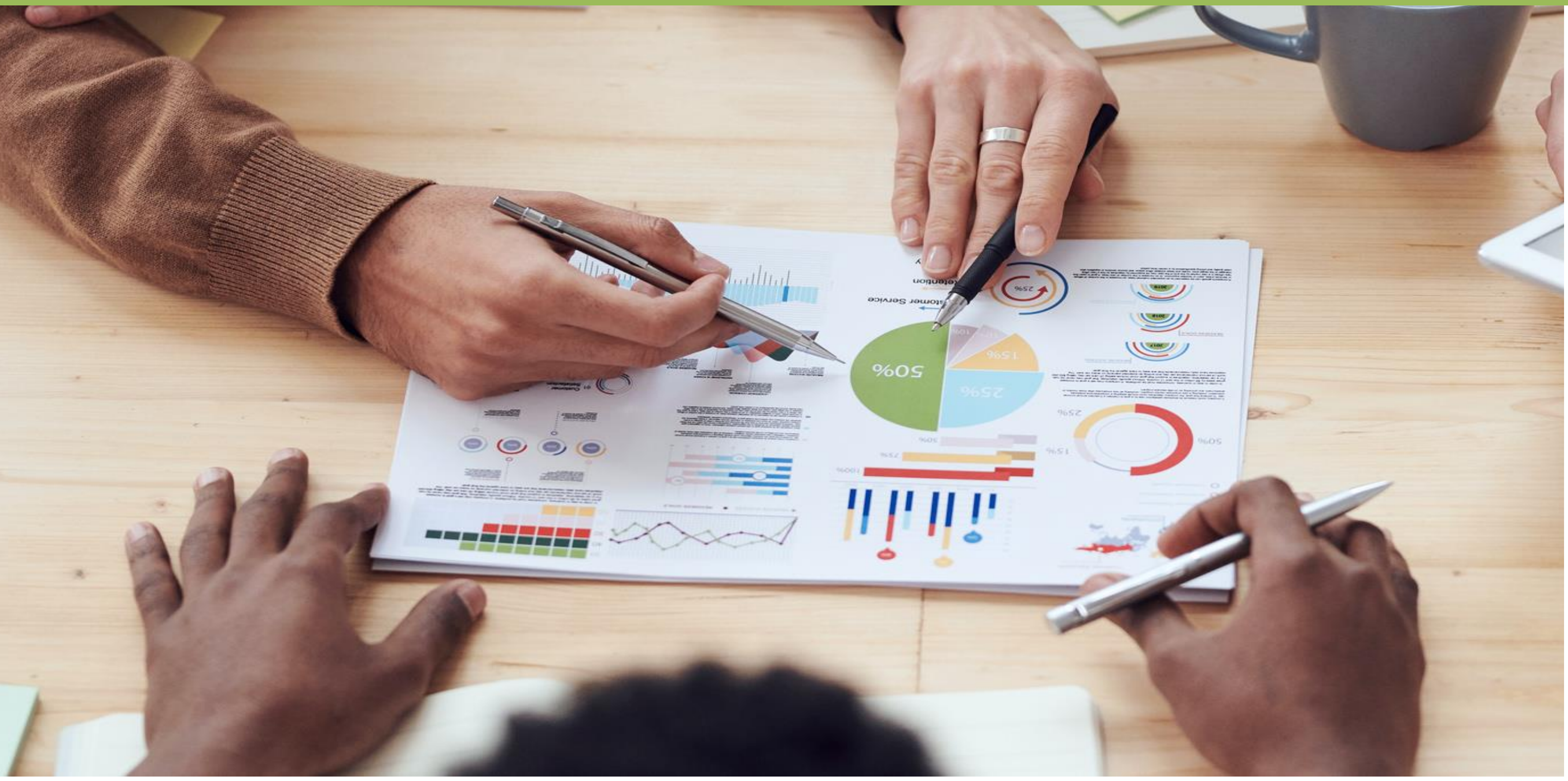
Good Practice

The Solar House – A nearly Zero Energy Building at Transilvania University of Brasov, Romania



In order to submit a practice, you will have to register in the Interreg Europe website.
You can submit your practice through your user dashboard ('Good practices' tab).

Summary

This Good Practice has been documented by PROMOTER Partner →
and is given the reference code →
(Codes shall be inserted by Lead Partner)

1. Contact information	
Name	MOLDOVAN Macedon
Email	macedon.moldovan@unitbv.ro
Telephone	***+40740300804***
Your organisation	
Country	Romania
Region	Centre Region, Brasov County
City	Brasov

2. Organisation in charge of the Good Practice

[If your Organisation is not the one in charge of the Good Practice, you can indicate the relevant organisation in this section of the form]

Is your organisation the main institution in charge of this Good Practice?	***NO***

In case 'no' is selected, the following sections should be filled in:

Location of the organisation in charge:	*Country*	Romania
	Region	Centre Region, Brasov County
	City	Brasov
Main institution in charge	*Transilvania University of Brasov, Romania*	

3. Good Practice general information

Title of the Practice	**The Solar House - A nearly Zero Energy Building**
Source of the Good Practice	Transilvania University of Brasov, Romania

Please select the project acronym	SH - nZEB
Geographical scope of the Practice (*Select National/Regional/Local)*	Local

Location of the Practice	Country	Romania
	Region	Centre Region, Brasov County
	City	Brasov

3.1 Classification *according to one of the following 5 Categories*

	1) Legislative
	2) Behavioral / Organizational
	3) Economic
X	4) Technological
	5) Operation scope and environment. Other features

7) Others *(please provide details in the space below)*

4. Detailed description	
4.1 Short summary of the Practice	*The Solar House is a nearly Zero Energy Building embedding passive solar design and energy efficiency solutions that are mainly covered by geothermal and solar energy systems in order to lower the building's energy demand from fossil fuels.*
4.2 Detailed information on the Practice	*The development of the Solar House addressed the problems related to the high share of fossil fuels used in the built environment, namely the depletion of these resources and the increasing of environmental pollution generating important climate changes.* *The main objectives consisted in contributing to the reduction of the energy demand, as well as to the increase of the energy efficiency and of the renewable energy share.* *These objectives were reached through:* ✓ *passive solar design solutions, e.g. large curtain walls implemented to passively use the solar energy during sunny winter days and to reduce the thermal energy demand* ✓ *energy efficient lighting and appliances to reduce the electrical energy demand,* ✓ *a renewable energy mix consisting of a ground-coupled heat pump with an installed capacity of 10.8 kW, a solar thermal system with six flat plate- and three evacuated tubes - solar thermal collectors, and a photovoltaic platform with an installed capacity of 10 kW, covering a significant part of the Solar House energy demand.* *The main stakeholders and beneficiaries of the Solar House are Transilvania University Brasov and the students enrolled in it for:* ✓ *The Bachelor Program Study Engineering of the Renewable Energy Systems* ✓ *The Masteral Program Study Sustainable Product Design and Environment Protection* ✓ *The Doctoral Studies in the field of Mechanical, Industrial and Material Engineering* *These students are using the Solar House as a testing rig to assess its' energy consumption and the renewable energy produced by the implemented systems*
4.3 Timescale (start/end date)	2008-2009

4.4 Partnership

List of partners involved in the Practice:

Partner 1

Name of Institution/company: Transilvania University of Brasov, Romania
Brief description: Transilvania University of Brasov is a public superior studies institution, that has about 20,000 students enrolled in the bachelor's degree programmes and master's degree programmes provided by its 18 faculties, covering all fundamental domains, such as engineering sciences, exact sciences, social sciences, arts and humanities, medicine, physical education and sports.
Web: www.unitbv.ro

Other partners

Name of Institution/company: - Brief description: - Web: -

4.5 Stakeholders / Target groups

*Identify Stakeholders and target groups/customers of the Practice, by crossing the relevant cell (column **ST** if stakeholder, column **TG** if target group, or both if applicable)*

ST	TG	
		National authority
	X	Regional authority
	X	Local authority
X	X	Private companies (large)
X	X	Private companies (SMEs)
	X	Chamber of Commerce / Economy
		Regional Innovation Agency
		Financing institution
		Business incubator
X	X	Research institution
X	X	University
		Technology transfer institution
X		Regional Development Agency
X		Planning institution
X	X	Educational institution / training centre
X		Association (e.g. friends of the theme)
		Employers' association
		Trade union
X	X	Environmental interest group
		Cultural initiative group / organization
		Non-Governmental Organization
		Transport operators
	X	Other interest groups (*provide details in the space below*)

- Private companies involved in building construction

4.6. Products and services

Describe specific products and services developed in the framework of the Practice (i.e. physical assets, services, manuals, training courses, catalogues, software, maps, agreements or other regulations, websites, newsletters, etc.):

A training infrastructure in the field of energy-efficient built environment and renewable energy systems was developed in the framework of this project, therefore the infrastructure became the basis for designing, developing, and conducting training courses, projects, and laboratories.

The training infrastructure consists of:

1. *A nearly Zero Energy Building, the Solar House, with a RES laboratory on the first floor and a multifunctional room on the second floor, with a total surface of 290 m^2. The building has very well-insulated opaque elements (20 cm of polystyrene on exterior walls and 20 cm of mineral wool on the roof) to decrease the thermal losses. Large windows are installed for solar passive heating in sunny winter days. The electrical and thermal energy consumption of the Solar House is fully monitored with dedicated energy meters as well as the indoor air temperature and relative humidity.*

2. A geothermal heat pump system providing space heating and cooling for the Solar House as well as domestic hot water. The geothermal heat pump system extracts the geothermal energy from 600 m^2 of ground, through a horizontal geothermal heat exchanger consisting of 600 m of polyethylene pipes buried at a depth ranging between 1.5 and 2m. The ground-coupled heat pump has an installed heating power of 10.8 kW and stores the thermal energy in a storage tank with a capacity of 120 litres. The thermal energy is distributed to the underfloor heating system of the Solar House, through a domestic hot water storage tank with a capacity of 300 liters.

3. A solar thermal system providing domestic hot water for the Solar House and for the showers in the gym's changing rooms. This system consists of three solar thermal collectors with evacuated tubes and six flat plate solar thermal collectors used to prepare domestic hot water at 60°C in a storage tank with a capacity of 300 liters and to store the excess thermal energy in two storage tanks having each a capacity of 1000 liters at a temperature up to 90°C

4. A photovoltaic system providing electrical energy for the Solar House (for its lighting system and geothermal heat pump). This system consists of 48 photovoltaic modules, each with a capacity of 210 W, generating 10 kW of Direct Current (DC) power at Standard Test Conditions (STC). Three inverters, each with a capacity of 3.3 kW, transform the Direct Current (DC) in Alternating Current (AC) and insert the AC into the electrical grid of the building.

5. A hybrid photovoltaic-wind turbine system providing electrical energy for the Solar House. This system consists of silicon monocrystalline, polycrystalline, and amorphous PV modules with a total capacity of 1 kW and a small wind turbine with an installed capacity of 1 kW, both connected to a hybrid inverter transforming the DC in AC and inserting the AC into the electrical grid of the building. The training courses, projects and laboratories were developed based on the above described infrastructure and, currently, are used in the Bachelor Program Study of Engineering of the Renewable Energy Systems (Renewable Energy Systems - introductory course and laboratory in the 1st year, Sustainable Development - course and laboratory in the 2nd year, Solar Thermal Systems - course, project and laboratory in the 3rd year, Geothermal Heat Pump Systems - course, project and laboratory in the 3rd year, Photovoltaic Systems - course, project and laboratory in the 3rd year, Wind Turbine Systems - course, project and laboratory in the 3rd year, Hybrid PV-WT Systems - course, project and laboratory in the 4th year, Implementation of Renewable Energy Systems in the Built Environment - course and laboratory in the 4th year) and in the Master Program Study for Sustainable Product Design and Environment Protection (Energy and environment, RES Design, Renewable energy systems for thermal energy production I (geothermal and biomass systems), Renewables for thermal energy production II (solar thermal and hybrid systems) , Renewable energy systems for electrical energy production I (wind and micro-hydro systems), Renewables for electrical energy production II (photovoltaic and hybrid systems , Renewable energy systems in the built environment, RES implementation, operation and maintenance.

5. Resources

5.1 Summary	*The Solar House and the implemented renewable energy systems had been an investment carried out by Transilvania University of Brasov that used their own funds (public funds) more specifically, the building costs were about 200k €, whereas or the renewable energy mix the costs amounted to 50k €. The project team consisted of one project manager and 9 project team members.*

5.2. Financial resources

Specify the resources utilized for financing the different stages of the Practice (design, implementation. maintenance, management) providing a breakdown by stage:

The concept and the design of the project were developed by an "in house" team of professors and researchers from Transilvania University of Brasov, members of the Renewable Energy Systems and Recycle Research Centre and of the Product Design and Environment Faculty. Thus, the design costs were fully reduced since they did not require external expertise. The implementation of the project (around 200k€ for the building and 50k€ for the renewable energy mix) was sustained by Transilvania University from Brasov through their own funds. The maintenance of the Solar House (around 2k€ every five years) is financially supported by Transilvania University from Brasov from their own funds, while the maintenance of the renewable energy mix is conducted each semester with the help of the students during laboratories and workshops, obviously with financial support from the Transilvania University from Brasov when some equipment acquisition is required.

Specify the source/s of financing (divided between public and private funds, in % terms) also broken down by stage as applicable:

The source of financing is 100% from the public funds of the Transilvania University of Brasov.

5.3. Human resources

Specify the persons (type & n°) engaged in the Practice, including their specialization / background:

The project manager has an extensive experience in project management, product design and mechanical engineering and nine other members of the team participated in the project. In order to successfully implement the project, several people with different expertise were involved. One team member is specialized in civil engineering and energy efficiency in the built environment. Four team members responsible for the design of the renewable energy systems providing thermal energy for the Solar House are specialized in geothermal

heat pump systems and solar thermal systems. The other four team members responsible for the design of the renewable energy systems providing electrical energy for the Solar House are specialized in photovoltaic and wind turbine systems.

5.4. Legal framework

Specify any regulatory requirement relevant to the implementation of the Practice

Law no. 220/2008 of the Romanian Parliament establishing the system for the promotion of renewable energy production

6. Monitoring and evaluation

Insert: If the Practice has not been assessed yet, please enter NONE in 6.1

6.1 Summary	*300*

The Solar House is continuously monitored in terms of thermal and electrical energy consumption as well as the output of the renewable energy mix as performance indicators. To assess the energy performance of the Solar House and of its renewable energy mix, the weather parameters are on-site measured as well as the costs generated by the SH.

6.2. Assessment methods and tools

A complex monitoring system is installed in the Solar House. Several sensors are installed in each room to measure the indoor air temperature and relative humidity to assess thermal comfort. The supply and return temperatures and the flow rates of the water in the underfloor heating circuits are measured to assess the thermal power and energy supplied in each room. Electrical energy meters are installed on each electrical circuit (lighting, power outlet, equipment) to measure the current and the voltage, and thus the electrical power and energy consumed; A Delta T weather station is used to measure each minute the exterior air temperature and relative humidity, the wind speed and direction, the global and diffuse solar irradiance in horizontal plane and the precipitation quantity. These measuring tools are definitely useful in the training courses, laboratories, and workshops involving the students.

6.3 Indicators

Specify the qualitative and quantitative indicators used to assess the Practice:

-The energy performance of the Solar House is assessed through its yearly specific energy consumption for space heating, space cooling, domestic hot water preparation, and lightning expressed in kWh/(year·m^2).
-The energy output of the renewable mix is assessed through the Coefficient of Performance (COP) and Seasonal Coefficient of Performance (SCOP) of the geothermal heat pump system, and through the instantaneous conversion efficiency in the case of solar thermal and photovoltaic systems.
- The nearly Zero Energy Building status of the Solar House is assessed through the yearly renewable energy share obtained by reporting the yearly output of the renewable energy mix to the energy consumption of the Solar House.

6.4. Monitoring materials available: Yes/No

Yes	No
X	

If Yes, please specify (report, spreadsheet, etc.)

The measured values are used by the students in laboratory activities to assess the energy performance of the Solar House and the output and the efficiency of the renewable energy mix. Also, the monitored parameters are used in the validation of the mathematical models developed to assess the behaviour of the Solar House and of its renewable energy mix and the results are published in international scientific journals [Moldovan et al, 2021; Visa et al, 2014].

7. Success factors / difficulties encountered

7.1 Summary	

The Solar House and its renewable energy mix were implemented to demonstrate the feasibility of a nearly Zero Energy Building in a temperate continental mountain climate and this has been successfully done since 2009. This complex infrastructure is used in the training process of the bachelor and master students enrolled in the Engineering of Renewable Energy Systems bachelor study programme and Renewable Energy Systems Design and Management master study programme, thus, allowing students from different study programs to fully understand the operation and performance of the Solar House renewable energy mix.

7.2. Enablers of the Practice

Identify among the actors mentioned in 4.5 those who contributed the most to the success of the practice and list them below:

Transilvania University of Brasov and private building companies (SC Viessmann SRL, SC Termo Confort SRL, SC ICPE SA, SC Accept SRL) that were contracted and were involved in the construction of the Solar House and in the implementation of the renewable energy mix.

7.3. Success Factors of the Practice

Describe success factors:

The Solar House is the first nearly Zero Energy Building in the Centre Region of Romania, to the best of our knowledge. Since the completion of the Solar House, its energy demand has been covered mainly by renewable energy sources. As an example, in 2020 the thermal energy demand of the Solar House (around 47.09 MWh) was fully covered by the geothermal and solar thermal systems while its yearly electrical energy consumption (around 15.17 MWh) was 70% covered by the photovoltaic system (9.96 MWh) meeting the nearly Zero Energy Building standard and contributing to the mitigation of the CO_2 emissions with 10549.85 kg of CO_2.

7.4. Challenges encountered

Describe difficulties encountered and solutions adopted to overcome them:

The main challenge was to architecturally integrate the Solar House into the existing built environment of TransIlvania University of Brasov Colina Campus and to maximize the energy output of the renewable energy systems through optimal design strategies.

7.5. Innovative content of the Practice

Specify additional information useful to justify this Practice as innovative, compared to similar practice design, implementation, and management:

The Solar House was built aiming at developing a nearly Zero Energy Building with reduced CO_2 emissions, architecturally integrated into the university campus and providing a high level of individual comfort to its users.

Describe the innovation content in relation to one or more of the following:

Process:

The design of the Solar House followed the Kyoto Pyramid design strategy, addressing the reduction of heat loss through the building's envelope by good thermal insulation on opaque building elements, reducing electrical energy consumption by efficient lighting with very low energy consumption, and embedding elements of passive solar use. Significant energy savings were also obtained by the natural ventilation insured, both in heating and cooling seasons, through the non-traditional egg-shaped architecture. State-of-the-art renewable energy systems were implemented to provide thermal and electrical energy for the Solar House.

Product:

The methodology developed for the design of nearly Zero Energy Buildings could be considered innovative in comparison with the actual design process. Also, the Solar House could be considered an innovative product with tailored solutions implemented to decrease its energy consumption from fossil fuels.

Result:

Besides the developed infrastructure, the database of the monitored parameters represents an important asset, based on which mathematical models are developed to describe diverse processes related to nearly Zero Energy Buildings and further improve the proposed methodology.

Partnership:

The Solar House infrastructure is used as a collaborative framework to facilitate knowledge sharing with stakeholders and target groups in a coordinated effort towards reaching sustainable development goals.

Other (indicate):

7.6. Added value of the Practice

Specify returns: generated revenue or savings, other results proving added value of the Practice, as applicable:

The savings generated through the implemented energy efficiency solutions and renewable energy mix allowed the payback of the initial investment after the 7th year and the infrastructure is used all over the year for both energy supply and laboratory activities with the students.

7.7. Possible leverage effect to trigger further improvements in policy instrument or practice

The Solar House is a Good Practice example providing valuable insights to trigger further improvements in the development of both new and existing built environments.

8. Transferability and Durability

8.1 Potential for learning or transfer (Summary)

The Solar House is a showcase of the implemented solutions continuously transferred to the students enrolled in the Bachelor and Master studies of the Faculty of Product Design and Environment of the Transilvania University of Brasov, as well as to our partners (other universities and research institutes, companies, authorities, etc.) working in the field of the sustainable built environment and renewable energy systems. *The experience gained through the implementation of the Solar House and its renewable energy mix was further used in the design process of the Research and Development Institute of the Transilvania University of Brasov, intended to be a nearly Zero Energy Community, extending thus the standard of nearly Zero Energy Building defined in the European Directive 2010/31 to a community level.*

8.2. Transferable activities and features

The project provides a methodology that could be applied to new or existing buildings aiming at obtaining the nearly Zero Energy Building status. It is a showcase of an energy-efficient building where thermal and electrical energy is feasibly provided mainly from renewable energy sources.

8.3. Conditions required for the Practice to be adopted in other contexts

The proposed methodology could be adopted in other contexts after a detailed analysis of the implementing site (renewable energy potential and weather data), of the building itself (technical and functional characteristics) and of the renewable energy systems available on the market.

8.4. Previous transfer experience *(if the Practice has been transferred already to another context)*

-

8.5. Other information

List articles, press notes, links to available information about the Practice:

Visa I., Moldovan M., Comsit M., Duta A., Improving the Renewable Energy Mix in a Building Towards the Nearly Zero Energy Status, Energy and Buildings, 68, 72-78, 2014, https://www.sciencedirect.com/science/article/abs/pii/S0378778813005999 *Moldovan M, Burduhos B-G, Visa I. Yearly Electrical Energy Assessment of a Photovoltaic Platform/Geothermal Heat Pump Prosumer, Energies, 2021, https://www.mdpi.com/1996-1073/14/13/3776*

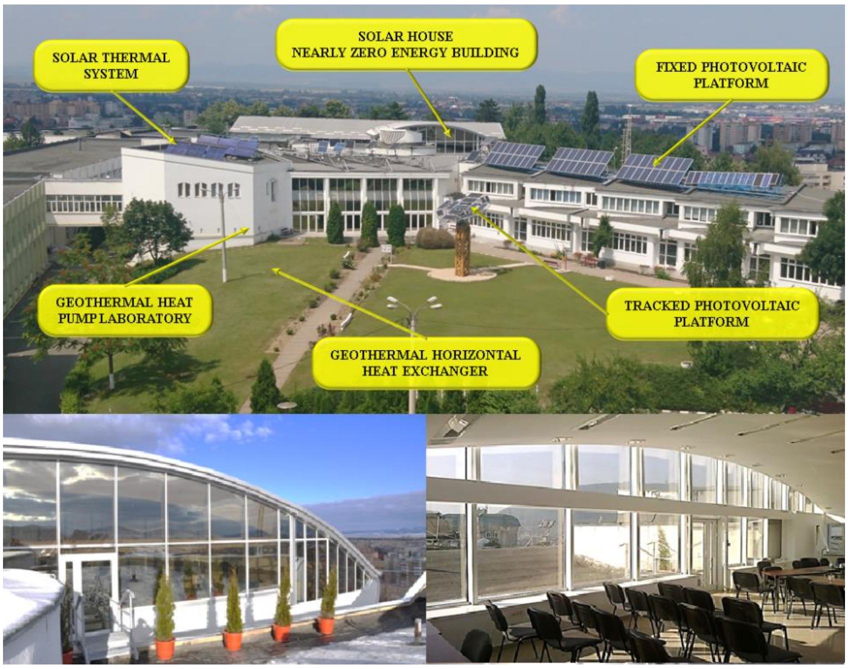
Specify any achieved public recognition of the Practice:

94 international citations of the scientific paper Visa I., Moldovan M., Comsit M., Duta A., Improving the Renewable Energy Mix in a Building Towards the Nearly Zero Energy Status, Energy and Buildings, 68, 72-78, 2014 *4 international citations of the scientific paper Moldovan M, Burduhos B-G, Visa I. Yearly Electrical Energy Assessment of a Photovoltaic Platform/Geothermal Heat Pump Prosumer, Energies, 2021*

8.6. Durability

Specify factors (financial revenues, limited or no costs, sponsorship etc.) which can make the Practice durable:

The presented practice was developed as a pilot project to experimentally check the durability of the implemented energy efficiency solutions and renewable energy mix. The experimental results obtained for over 15 years demonstrate the feasibility of the applied design since the payback period of the investment has been achieved in the 7th year of operation and the renewable energy conversion systems still work efficiently after this period. Considering that the actual prices of renewable energy systems are significantly lower than 15 years ago, and the high increases of the energy prices recorded in the last few years, with a proper design, the initial investment in a similar project could be recovered faster and greater benefits over the life of the project could be obtained.

Further information	
Upload image/s	

Enclosures:	*Moldovan M, Burduhos B-G, Visa I. Yearly Electrical Energy Assessment of a Photovoltaic Platform/Geothermal Heat Pump Prosumer, Energies, 2021, https://www.mdpi.com/1996-1073/14/13/3776* *Visa I., Moldovan M., Comsit M., Duta A., Improving the Renewable Energy Mix in a Building Towards the Nearly Zero Energy Status, Energy and Buildings, 68, 72-78, 2014, https://www.sciencedirect.com/science/article/abs/pii/S0378778813005999*

REMINDER:

Please confirm that the consent of the project representative has been obtained allowing the information on the Good Practice information to be published on Interreg Europe website.

YES