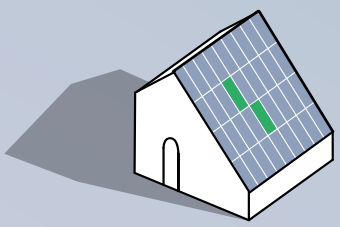
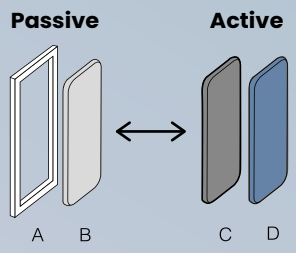
PVadapt

Combined Innovation in Modular Construction

3

Production and Integration of Passive and Active BIPV Components





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About

The PVadapt Project aims to provide a cost-effective, smart, sustainable and multifunctional Building Integrated PhotoVoltaics system (BIPV), empowered by solar thermal features, a smart energy management system and a circular-by-design approach. For more information you can visit this website: www.PVadapt.com.

The third release of the **PVadapt project newsletter** will present in details the designing and prototyping activities of the multifunctional BIPV building block, in the framework of Work Package 4. Specifically, the development of the passive and active components will be presented, as well as their integration and the development of the secondary building blocks, namely the Green Wall.

Production and Integration of Passive and Active BIPV Components

PVadapt is, at its core, a system which harvests solar energy converting it to electric power through the solar cells included in the PV module, while at the same time heating a continuous water circuit to be used as domestic hot water through the heat extraction from the solar cells, that build up heat during the electric power generation process. This heat extraction ability is the key differentiating aspect of the system when compared to regular PV installations, as ideally, no energy is lost and the solar cells are kept at the ideal working temperature, preventing performance losses due to elevated temperatures.

Designing and prototyping the multifunctional BIPV building block

The overall goal of the project is the delivery of a prefabricated, modular, and multifunctional turnkey BIPV system. The two-component integrated BIPV system will be produced separately and an assembly method will be developed for on-site integration.
The **structural** and **passive components** feature a construction grade steel frame and a passive component based on three main material formulations. The **active part** of the system consists of a **heat mat** bonded to **PV modules**. The combination of the two will deliver electric power and heat to the end user, suitable for roof and façade installations, as well as new constructions. To enable architects to create aesthetically pleasing installations, the project produces **secondary building blocks** to complement the BIPV system.
It gives the architect the freedom to select existing building blocks or customize and insert different components and features, such as different PV technology, thermal or aesthetic elements.

Structural and passive components

Sustainable passive multifunctional components were developed and upscaled focusing on bio-waste based oriented strand boards, fibre reinforced geopolymers and expanded perlite to be integrated in BIPV products.
Focus was set on the utilization of materials sourced from waste, low complexity, non-energy intensive and safe processes to produce the thermal and structural

Application of the adhesive and panel handling

components. Through these technological innovations we achieved an eco-friendly building block for BIPV installation.

Active components

The heat mat and its thermal interface manifold was designed in such a way that it meets with the physical and thermal requirements of the other elements making up the BIPV building block. The finalised heat mat is to be produced at 1.8 m wide and in various lengths to support between one and four PV modules when mounted in landscape.
Achieving low-cost PV production requires a unique unitary format of the PV module and thus it was concluded to stay with standard dimensions of conventional PV modules. The junction box of the PV module was replaced on to the backside of the heat mat making it aesthetically pleasing when finally integrated into the buildings. It allows the heat mat to cover almost the entire PV module surface for enhanced heat transfer. To achieve considerable mechanical bonding strength and heat transfer capabilities between the heat mat and the PV module an adhesive bonding solution was developed. The adhesive bonding solution was proved to be strong enough after passing accelerated climate aging tests.

Secondary building blocks

In the project we streamlined the design and prototyping of a so-called Green Wall, a nature-based solution, hosting plants which receive sunlight through a semi-transparent PV module, which is a unique feature and that can dramatically improve building aesthetics and increase functionality and flexibility. The option of combining modular and prefabricated construction elements, energy generation through BIPVs and nature-based solutions in a single product addresses all the corresponding market needs simultaneously, giving it a competitive advantage.

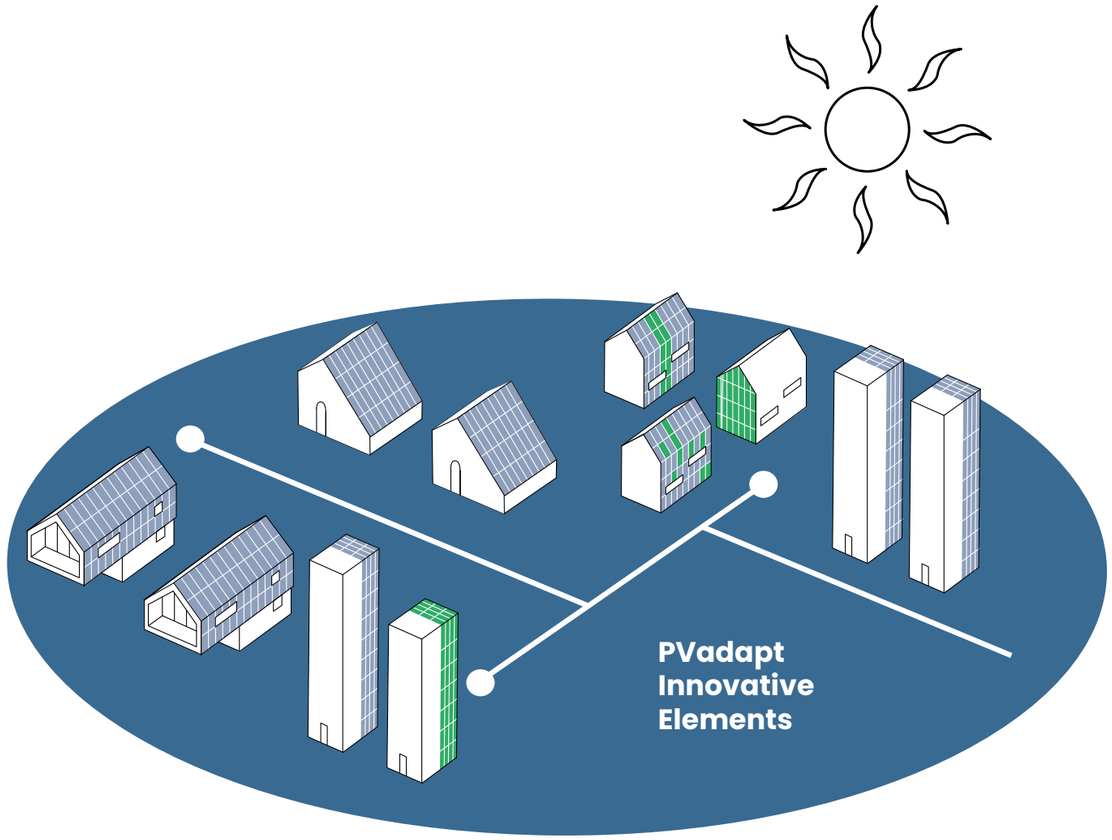
Breaking News

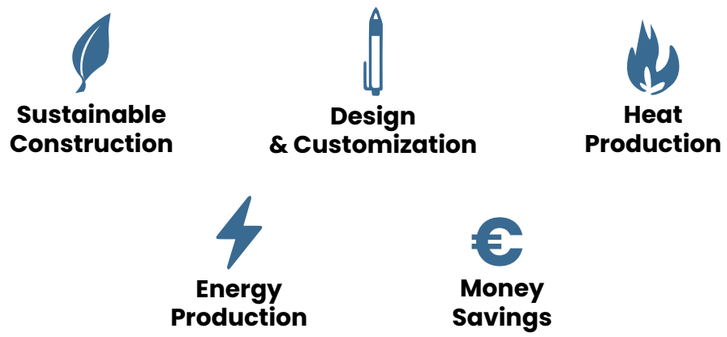
4th Project Steering Committee
October 14th–15th 2020
Digital Event

Last October PVadapt project partners met digitally for the fourth semestral Project Steering Committee. Work Package leaders have shown to the entire consortium the progresses made in the project development and productive discussions have arisen in each session. Many challenges emerged, so coordinated and agreed strategies were defined, thanks to a smooth communication across the consortium. All the partners proved to be on the same ambitious page, working for generating the best possible impact for PVadapt. Tangible outstanding results emerged, to be soon promoted and disseminated. Follow the updates through the project website (www.pvadapt.com) and the social media platforms!

Sustainable Places Event Participation
October 27th–30th 2020
Digital Event

The Sustainable Places Event represents since its first edition in 2013 the reference point for the dissemination and discussion of project results in the field of Circular Economy and all those topics that could be related to “Sustainability”, in its multifaceted meanings. The eighth edition took place digitally from the 27th to the 30th October and several topics were addressed across more than 30 different sessions: Digital Twins, BIPV, Local Energy Communities and Sustainable Digital Infrastructure. PVadapt was presented by Antonis Peppas, from NTUA, on behalf of the entire consortium, to show the ambitious objectives of the project and the remarkable results already produced. For more details check the event website: www.sustainableplaces.eu/.





Publications

System efficiency of PV/T collector-driven heat pumps

Authors: Franz Hengel, Christian Heschl, Franz Inschlag, Peter Klanatsky
DOI: https://doi.org/10.1016/j.ijft.2020.100034

The use of standard heat pump (HP) systems offers an efficient option to replace conventional heating systems (e.g. oil and gas boilers) for space heating and domestic hot water. Due to the higher noise emissions and the lower overall energy efficiency of air-to-water heat pumps, the use of ground-coupled heat pump systems is increasingly in demand. The cost-efficient dimensioning of horizontal ground heat exchanger (HGHE) systems, considering possible solar waste heat potentials to improve regeneration behaviour, is particularly challenging. The reason for this is the complex system and control engineering optimisation possibilities resulting from the dynamic heat transport behaviour of the horizontal ground heat exchanger. Essential influencing variables such as the water content of the soil due to the groundwater level, rainwater infiltration and surface evaporation can only be described with massive effort using the model equations of the unsaturated zones. However, these variables are necessary to obtain a better fundamental understanding of the usable storage potential of solar-coupled systems and to be able to derive targeted optimisations at the system level. Therefore, the waste heat utilisation potential of PVT collectors for the regeneration of heat pump coupled horizontal ground heat exchanger systems are analysed employing simulations.

For this purpose, a PVT-collector model and a HGHE model based on a single-family were developed and validated by experimental investigations. Based on this, a system simulation model consisting of the components PVT-collector, heat pump, heat delivery system, HGHE and the corresponding control units were built using TRNSYS. With the help of the simulation model, parameter studies were carried out, and the main factors influencing the overall energy efficiency (COP) of the system and the seasonal performance factors (SPF) were identified. Furthermore, the solar waste heat utilisation potential of the PVT collectors was analysed to increase the efficiency of the heat pump system.

Annual performance analysis of the PV/T system for the heat demand of a low-energy single-family building

Authors: Alina Zabnienska-Gora, Navid Khordehgah, Hussam Jouhara
DOI: https://doi.org/10.1016/j.renene.2020.10.123

The interest in the energy efficiency of buildings and the integration of new technologies to reduce the heating and cooling loads through the building envelope is not new. The European Union (EU) is committed to decarbonising its building stock as almost 50% of the Union's final energy consumption is for heating and cooling, of which 80% is used in buildings. The article analysis the performance of a PV/T system (with a heat mat) for the heat demand of a low-energy two-zone, single-family building during the year.
For this purpose, a building model was built in TRNSYS using Multizone building model and TRNbuild in two variants of heating (internal - as reference and external). Then the building model was connected to a mechanical ventilation system providing heating during winter for which the heat source is a PV/T system to demonstrate if the heating requirements for the household can be provided during different seasons of the year. Additionally, it was indicated how much energy consumption reduction can be obtained in comparison to the case when a heating unit is used.

Recent advances and applications of solar photovoltaics and thermal technologies

Authors: Lujean Ahmad, Navid Khordehgah, Jurgita Malinauskaite, Hussam Jouhara-
DOI: https://doi.org/10.1016/j.energy.2020.118254

This article discusses the functionalities and developments of different types of solar panels. It explains the latest technological advances in this field, especially in the context of different types of solar panels, namely, photovoltaic (also known as PV), thermal collectors, photovoltaic-thermal (known as PV/T)
panels and concentrating solar panels. Specifically, the paper examines how each of the technologies analysed operates to produce heat and electrical power, how to improve the energy efficiency and which
technology provides the best system efficiencies and fastest return on investment. Finally, it also assesses
the extent to which the exploitation of renewable energy sources and incentives to achieve energy efficiency is supported by the European regulatory framework and policies.

Analytical modelling of a photovoltaics-thermal technology combined with thermal and electrical storage systems

Authors: Navid Khordehgah, Alina Zabnienska-Gora, Hussam Jouhara
DOI: https://doi.org/10.1016/j.renene.2020.11.058

Analyses will be conducted to indicate the energy performance of a photovoltaic-thermal (PV/T) system. In this regard, a simulation tool using the transient system simulation (TRNSYS) software will be developed to investigate if the system can be used to provide electrical and thermal energy to a household located in London, UK.
Based on this, it will be indicated if the modelled system is capable of providing the required demand and how the energy output from the system can be delivered to thermal and electrical storage components. Having indicated that, it will be demonstrated how by utilising the developed model, the energy output from the system can be improved. Furthermore, it will be discovered how different thermal energy storage systems can help to store or dissipate the absorbed excessive heat from the system. The analyses will be conducted on the most optimal short- and long-term thermal storage systems and during warm seasons
of the year.

Inspiration

“The time is always right to do what is right.”

Martin Luther King Jr.

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Do you care about sustainability in constructions and green energy?

Are you interested in knowing more about PVadapt solutions?

Are you a professional in the field of solar power interested in collaborating with PVadapt partners?

Contact us to share your feedbacks and ideas on this page.

Project Coordinator:
Nikos Kakardakos
Merit Consulting House
n.kakardakos@meritconsultinghouse.eu

Dissemination, Exploitation & Communications Manager:
Fabio Poles
UniSMART - Fondazione
Università degli Studi di Padova
fabio.poles@unismart.it

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