



## **COST-EFFECTIVE REHABILITATION OF PUBLIC BUILDINGS INTO SMART AND RESILIENT NANO-GRIDS USING STORAGE**

### **DEAR READERS,**

It is our pleasure to welcome you to the sixth and final edition of the BERLIN Newsletter!

"BERLIN Cost-effective rehabilitation of public buildings into smart and resilient nano-grids using storage" is an ambitious project funded by the European Union under the ENI CBC Med Programme that brings together seven organizations from four Mediterranean countries, Cyprus, Greece, Israel, and Italy.

In the sixth and final edition of our newsletter, we present the project's latest news and final results.

If you would like to keep up with all the latest developments of our project, follow us on Facebook and Twitter.

Kind Regards,  
The BERLIN Consortium

## **PROJECT DURATION**

**02 September 2019**

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**01 September 2023**



## ABOUT BERLIN

BERLIN focuses on increasing photovoltaics (PV) grid penetration, combined with energy storage systems (ESS) and demand side management (DSM), along with enhancement of energy efficiency in buildings. BERLIN implemented six pilots in Cyprus, Greece, Italy and Israel. The pilots will optimally integrate PV/ESS/DSM in an innovative way and transform each pilot into a self-sufficient nanogrid, as an energy rehabilitation solution in a range of climatic zones. Such a solution can contribute to alleviating the regional and global problem of high-energy consumption in buildings - 1/3 of energy consumption in Mediterranean Partner Countries, 40% in EU- and of resulting CO<sub>2</sub> emissions increase. Equally important is the need to support weak grids that are particularly common in MENA region and rural areas, with low reliability and frequent outages.

To this end, BERLIN will provide knowledge on achieving high levels of building energy self-resilience using smart nanogrids and design the solution as a cost-effective renovation. In addition, MED countries, despite their excellent solar potential, face the problem of its low grid penetration. BERLIN through onsite PV/ESS/DSM, will contribute to achieving higher levels of PV entering the grid whilst ensuring grid stability and power quality. Through these interventions, MED countries will benefit greatly from project's learning curves.

## AIM OF THE PROJECT

BERLIN aimed to implement cross-border pilot measures to support innovative and cost-effective energy rehabilitations in public buildings based on the nanogrid concept, the building block for smart microgrids.

The motivation is multi-fold:

- to **address** high energy consumption in building sector that is primarily fossil-fuel based,
- to **support** areas of weak grids, common in MENA region & rural areas, as high energy consumption in buildings can compromise electric service reliability,
- to **achieve** higher grid penetration of RES whilst ensuring grid stability and power quality.



€2.5 MILLION  
EU  
CONTRIBUTION

€2.8 MILLION  
TOTAL BUDGET



## PROJECT IN NUMBERS



7

PARTNERS



4

COUNTRIES



6

TECHNICAL OUTPUTS

### WHAT WILL BE IMPROVED

- **Reduction of energy consumption** and CO2 emissions at the level of pilot buildings.
- **Replication in other Mediterranean/EU regions** and enhanced interest and capacity of public authorities in building energy retrofits.
- **Encourage a widespread policy adoption** for high photovoltaic grid penetration and high levels of self-sufficiency in buildings.
- **Boost SMEs competitiveness, R&D growth, investments** in photovoltaic grid integration, interest from local building professionals to train in new innovations for high efficient buildings, and business and job opportunities in building retrofitting.

### WHO WILL BENEFIT

The main target groups and final beneficiaries are:

1. **Energy stakeholders** (e.g. policy-makers, investors, distribution system operators, regulatory authorities, energy consultants, photovoltaic installers).
2. **Local/regional/national authorities** & their employees and building users.
3. The **scientific community**.
4. **Project consortium**.
5. **General public**.

### ACHIEVEMENTS

- **6 case studies** on the photovoltaic, energy storage solutions and demand side management hybrid technology.
- **Country-specific recommendations** to stimulate the uptake of photovoltaic, energy storage solutions and demand-side management.
- **2 tools** developed for renovating public buildings using photovoltaic, demand-side management and energy storage systems.
- **6 pilot actions** in buildings in 4 countries.
- **3 cost-effective technologies** in public buildings optimally integrated.
- **5 public institutions supported** towards the adoption of cost-effective policies to increase the use and local consumption of photovoltaic energy.





## ACCOMPLISHMENTS

During the period of December 2022 to August 2023, the project entered in its final phase. All activities were smoothly implemented and all the deliverables are fully completed. Throughout the project implementation period the partners were fully dedicated to deliver impactful work, leading to high-quality project results.

The pilots in the four countries (Italy, Greece, Israel, Cyprus) were commissioned. The data gathered from the pilot installations were compiled into the data analysis report. At the same time, partners are actively participating in networking events and scientific conferences in order to disseminate the results of the project effectively, maximise the project impact, and achieve greater project scalability by replicating solutions in other regions.



## PILOT PHASE DEVELOPMENTS

### CYPRUS

The University of Cyprus announced the tender for the supply and installation of a turnkey solution, smart nanogrid at its premises in the PV Lab. Interested parties, were given the opportunity to visit the pilot site on several occasions. After the evaluation process, the successful tenderer was announced in August 2022 and desk works started as soon as the contract was signed i.e. September 2022, and were completed by early 2023.

### ISRAEL - EILOT

The installation of the photovoltaics on the school's pergolas are finalized as well on the bus station. The installation has 126 kWp capacity on the pergolas and 302 kWp on the bus station/parking. The installation of the BESS took place in mid July. The PV is generating electricity for the school and reducing its consumption dramatically.

### ISRAEL - EILAT

The installation of the photovoltaics on the school's open court as well as on the building has been finalized with a total of 209 kWp. The solar is generating most of the school needs during radiation hours and the storage facility with 475 kWh is adding the needed energy mostly during mornings and after noon. The storage unit was installed during the first week of July.

### GREECE

The two pilots located in Greece are operational and measurements are collected to assess the energy performance of the buildings. In particular, a system of 12.5kWp PV and 11 kWh of battery capacity is operating in the student dormitories of the university and a system of 10 kWp PV and 13.8 kWh of battery capacity is operating in a municipality building. An electric vehicle charger is also operating at the dormitories. Except from the electrical measurements, meteorological data were also collected for the two pilots.

### ITALY

The installation of outdoor weather station and smart multi-meters in the pilot building of the Campus was completed in 2021, starting a measuring campaign of the solar irradiation in the pilot site and of the building electricity consumption. The BESS and EMS has been purchased in 2021, tested in the UNICA Laboratory at the Department of Electrical & Electronic Engineering, and installed in the MV/LV substation of the pilot building. The photovoltaic system on the rooftop of the pilot building and the DSM equipment within the building were installed in 2022. All the integrated pilot system has been tested for its correct operation and connected to the grid.



## PROJECT MEETINGS AND ACTIVITIES

### 2nd Project meeting in Israel - Change of energy consumption habits in schools

The 2nd transnational project meeting of BERLIN was held in **Eilat, Israel**. Partners visited **Yelem School** and **Nof Edom School**, observing the pilot activities and equipment. They experienced **an interactive game and an online energy consumption control platform** developed by Ben Gurion University. The meeting involved constructive discussions on project development, particularly the pilot installations. The partners left the meeting determined to support each other in implementing any remaining activities and with the aim to maximize the project's impact by replicating solutions in other regions and utilizing BERLIN's scale-up potential.



### BERLIN final project meeting: Leading the way in fighting climate change and making an impact

The 3rd and final consortium meeting of the BERLIN project was held on **July 12–13, 2023, in Limassol and Nicosia, Cyprus**. This meeting was organized and hosted by the Deloitte Innovation and Entrepreneurship Center, one of the Cypriot partners in the project.

During the meeting, the partners reviewed the **final steps** in completing the project deliverables, such as **full data collection** from the pilot installations, completion of trainings, and finalisation of **the policy recommendations**, among other things.



Furthermore, the consortium thoroughly reviewed the project's achievements and **challenges** during its implementation, fostering insightful conversations. A productive session followed on the project's potential for **scalability and transferability**, with the aim of **maximizing the project's impact** by **replicating solutions in other regions** and employing BERLIN's methodology. In addition, the partners also had the opportunity to visit the pilot installations at the Cyprus University of Nicosia.

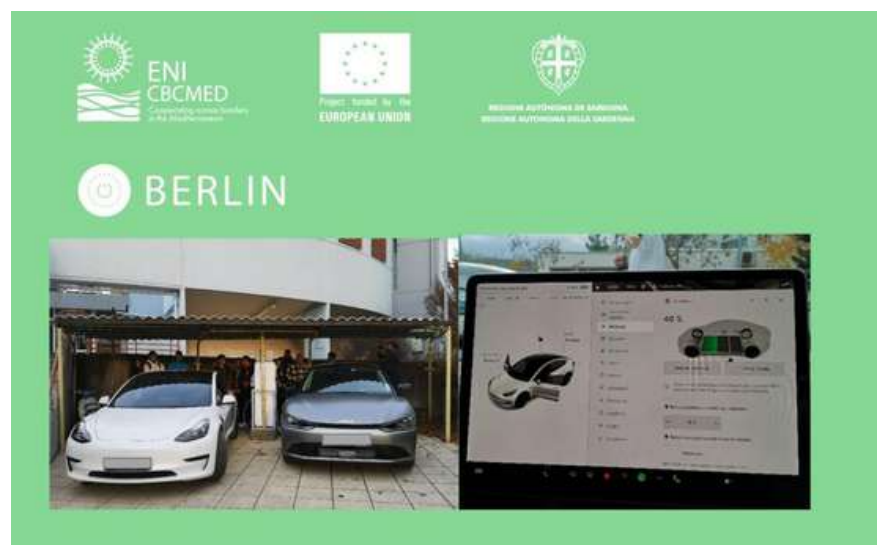
The meeting was an important step forward in promoting regional cross-border cooperation and exploring future initiatives. The meeting concluded with everyone feeling motivated and inspired to continue contributing to sustainable development and growth and dedicated to supporting each other in completing the last tasks prior to the completion of the BERLIN project.



## The involvement of students and local community in the energy efficiency efforts of the university buildings in Western Macedonia, Greece

In December 2022, the University of Western Macedonia conducted a demonstration of their pilot installation as part of the BERLIN project. **Students, residents of the university dormitories and local EV owners** visited the pilot sites to learn about the project's goals. The demonstration showcased Photovoltaic (PV) inverters, battery packs, monitoring equipment, and an EV station.

The tour showcased the transformation of the building into a self-sufficient nanogrid through smart use of PV energy, including energy storage and demand-side management. The participants **provided positive feedback** and the concept of resilient nanogrids in public buildings **was considered successfully transferred**.



## BERLIN aligns with the commitment of the European Union for a sustainable energy future in Mediterranean region

Representatives from the **Delegation of the European Union (EU)** in Israel visited Yhelim school in Eilat on June 1, 2023. Led by EU Ambassador Mr. Dimiter Tzantchev, they were briefed by BERLIN partners from **Eilat and Eilot Municipalities** on the progress of the project. Yhelim school, one of the selected public buildings, had a nano grid system installed with photovoltaic panels in an open courtyard to provide shelter and educational benefits. The school staff showcased an online educational tool developed within the project.



## BERLIN pilots have the potential to be expanded with the coupling of other energy carriers

The BERLIN project aims to develop pilots in participating countries that utilize Photovoltaic (PV), Battery Energy Storage System (BESS), and Demand-Side Management (DSM) technologies, within the microgrid concept. The Cyprus pilot focuses on converting the Photovoltaic Technology Laboratory of the University of Cyprus into a **Living Lab nanogrid**. The pilot aims to increase self-consumption and self-sufficiency while generating and storing electricity for Electric Vehicles charging. To achieve these targets, the PV-BESS-DMS configuration is effective, but additional energy carriers are needed for seasonal variations in supply and demand.

The integration of **green hydrogen** and **heat** subsystems can enhance the nanogrid system's capabilities. Green hydrogen can be generated using excess electricity and stored for longer durations, enabling **power-to-gas-to-power**, **power-to-heat** and **seasonal energy storage**. Fuel cell units within the hydrogen subsystem also produce heat, which can be utilized for space heating and domestic hot water needs. The **heat subsystem**, utilizing **electric vapor-compression heat pumps** and **thermal energy storage combination**, provides efficient conversion of excess electricity to heat.

This allows for satisfying space heating, cooling and hot water demands can be satisfied with the consumption of **significantly less electricity**, while reducing carbon emissions and operational costs compared to conventional technologies.



The coupling of energy vectors and combination of short- and long-term energy storage enhance the **overall energy efficiency and cost effectiveness of the nanogrid system, by providing advanced flexibility, load balancing, grid stability and smart operation capabilities.**

A schematic configuration of the UCY Living Lab nanogrid, incorporating the proposed coupling of green hydrogen and heat subsystems, is illustrated in **Figure 1**.

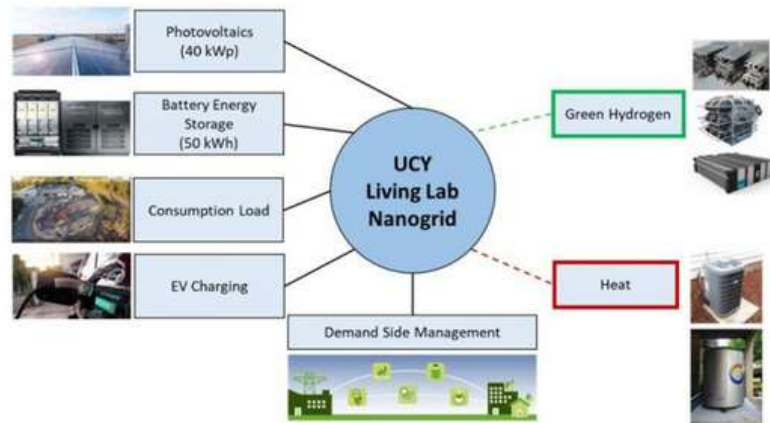
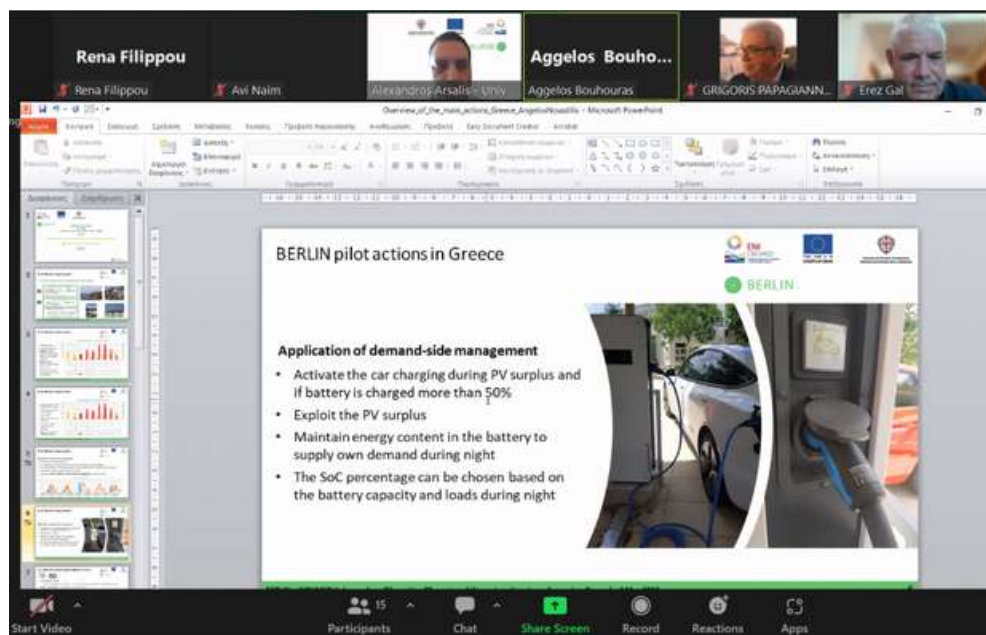


Figure 1 Potential of expanding the University of Cyprus Living Lab Nanogrid with Green Hydrogen and Heat subsystems.

### Third Hub meeting activity - Enhancing resident awareness on photovoltaics, energy storage systems, and demand side management microgrid systems



The 3rd Intelligent Utilization of Photovoltaic Technology (IUPVMED) Hub meeting was held in hybrid mode in Eilat, Israel on May 4, 2023. The meeting aimed to explore the integration of **photovoltaic (PV), energy storage system (ESS) and demand side management (DSM)** within a hybrid nanogrid system. Brought together stakeholders from academia, industry and local authorities committed to a fruitful collaboration for promoting the wider adoption of distributed energy resources in the Mediterranean region.

The roundtable discussion focused on raising residents' awareness of energy-efficient practices. Participants actively shared their concerns, brainstormed strategies and explored tools to enhance energy efficiency awareness among residents. The meeting served as a platform for fruitful collaboration and knowledge exchange in this important area.

## The triple helix joins forces in promoting the wider adoption of distributed energy resources in the Mediterranean region through position paper



The 4th and **final Intelligent Utilization of Photovoltaic Technology (IUPVMED)** Hub meeting took place in hybrid mode at the University of Cyprus in Nicosia, Cyprus, on July 13, 2023. The meeting was a continuation of the previous three meetings, aiming to investigate the **integration of photovoltaics (PV), energy storage systems (ESS), and demand-side management (DSM)** under the concept of a **hybrid nanogrid system**.

Participants at the event were various stakeholders, coming from the triple helix (academia, industry, and public local authorities), that actively took part in the discussions held during the event. Determined to foster and promote the wider adoption of distributed energy resources in the Mediterranean region, the participants of the event had a fruitful collaboration during the event and are working towards finalizing the position paper on the main conclusions of the investigation.

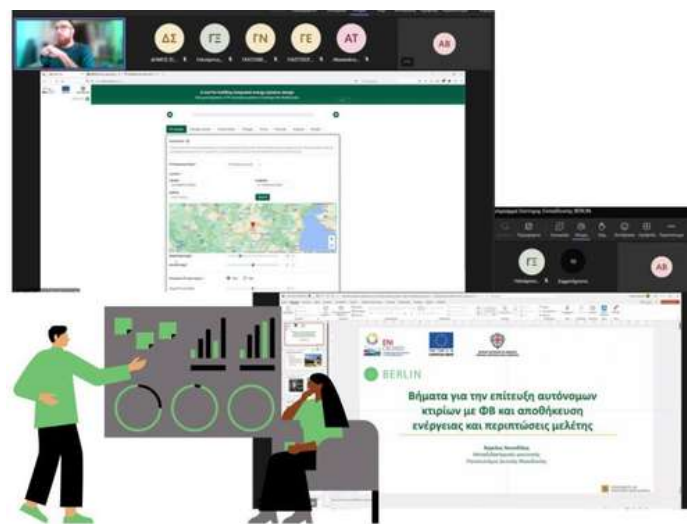
## BERLIN supports the capacity building of local authorities in Greece for the energy efficiency of public buildings

An effective **training** took place on June 20, 2023 in Greece, during which the **Photovoltaic (PV), Energy Storage Solution (ESS) and Demand Side Management (DSM)** were presented. The participants were the employees of two different **municipalities** in Greece and they were mainly engineers and financial managers. One of the **mayors** also joined the training.

The short training gave an overview of the steps towards the **energy transformation** of public buildings into high **self-sufficiency buildings**, using PVs, batteries, and load management.

During the first part of the training there was a short presentation of BERLIN project, the current situation of **renewables** and **storage systems** in Greece, the financial tools that exist, the lessons learnt from the BERLIN pilots and the **energy performance of the PV+ESS+DSM solution**.

During the second part, the **BERLIN online tool** was demonstrated, by explaining all its capabilities and by running some indicative case studies for public buildings in Greece. The training concluded on the roadmaps that facilitate the adoption of PV+ESS+DSM in public buildings targeting mainly energy managers and engineers in key positions of public institutions.



**BERLIN project results are raising awareness about the high energy consumption in the building sector and inspiring stakeholders with its proposed solutions and methodology in fighting climate change.**

The BERLIN consortium organized the **final project event** on Thursday, July 13, 2023, at the University of Cyprus in Nicosia, Cyprus. **Guest speakers** included the Rector of the University of Cyprus, Professor Tasos Christofidis; the Ambassador of Italy, Ms. Federica Ferrari Bravo; the Eastern Mediterranean Office Coordinator of the ENI CBC Med Program, Dr. Esmat AlKaradsheh; and the BERLIN Project Coordinator, Professor George E. Georghiou.

During the event, the **results** of this project **were presented**, and the **inauguration** of the new **Living Lab of the FOSS Sustainable Energy Research Center**, in which the methodology of the BERLIN project was piloted, took place. Thus, the participants of the event had the opportunity to visit the FOSS Nanogrid-Living Lab and see it in operation, the concept of which is only found in a few systems worldwide!

In conclusion, the event was a success, and the audience was intrigued by the solutions and methodology proposed in the BERLIN project in increasing grid penetration, combined with energy storage and demand-side management, along with enhancement of energy efficiency in buildings to make them greener, smarter, more innovative and sustainable.



## BERLIN PROJECT REPRESENTATION IN EVENTS

### BERLIN project results are part of the climate change mitigation discussion in Israel

**Climate change and mitigation actions** are important topics on the global climate agenda. On May 30, 2023, Eilat Municipality organized the **2nd Urban Climate Summit** during which the **Director of the Environmental Unit Assaf Admon**, presented the Municipality's actions addressing the impact of climate change.



The **BERLIN project** is considered as a supportive activity of the Municipality's efforts to achieve its ambitious climate neutral targets. The presentation was focused on one of the BERLIN pilot buildings which **is the first public building in Israel that is 100% energy self-sufficient and will act as a resilience centre of 5000 citizens in case of an emergency.**

Other subjects of discussion included the danger occurring from the construction of an oil pipeline in Eilat, the rationale behind the climate action plan of Eilat municipality, the effect of climate change on the coral reefs in the Red Sea with a focus on Eilat reefs and the policy assessments for extreme weather events in the region.

### The BERLIN project serves as a case study of 'Near Zero Energy Buildings' (NZEB)

The BERLIN project was presented as a case study in the postgraduate course **Building Integration of Photovoltaics (BIPVs) – Towards nearly zero energy buildings (NZEB)** of the University of Cyprus. Dr. Alexandros Arsalis, a Special Scientist involved in the project, served as the instructor for the course. The lecture focused on the microgrid concept, with emphasis on the Living

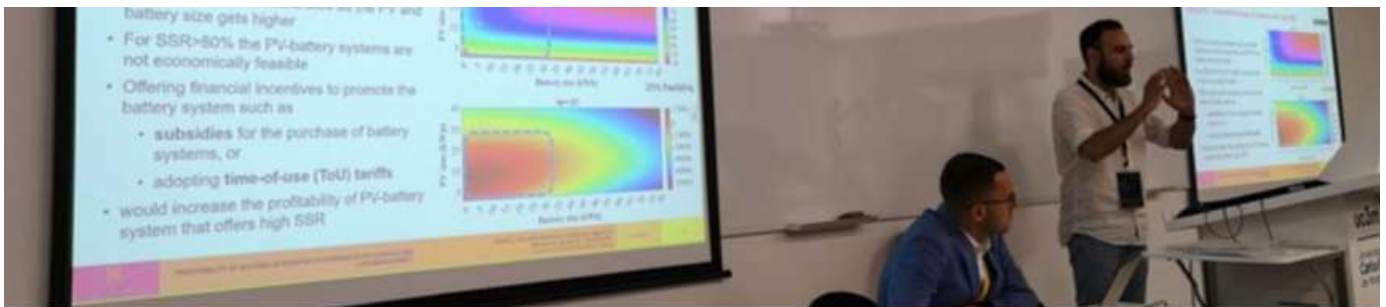


Lab nanogrid based on Photovoltaic, Battery Energy Storage and Demand Side Management technologies. The lecture covered the motivations, aims and pilot developments of the BERLIN project. **It highlighted the project's potential to promote distributed energy generation in Mediterranean regions** through cross-border pilot actions for the innovative and cost-effective energy rehabilitation of public buildings. The lecture mentioned the purpose and technological characteristics of each pilot of BERLIN.



## BERLIN's impact in academic research and industry

On June 6-9, 2023, the 23rd International Conference on Environment and Electrical Engineering (EEEIC) was organized in Madrid, Spain. More than 400 scientists, industry stakeholders and students participated at the conference both onsite and in a hybrid mode. BERLIN partner University of Western Macedonia participated in the conference with a submission of a scientific paper. The paper is entitled "Profitability of Building Integrated PVs Enhanced by Storage and Load Management" and it was authored by Angelos I. Nousedilis, Nikolaos S. Kelepouris, Aggelos S. Bouhouras and Georgios C. Christoforidis. The paper is focusing on the project's outcomes and particularly on the results of the cost-benefit analysis on the project's outcomes and particularly on the results of the cost-benefit analysis conducted in the framework of the project; it was presented in front of a wide audience of academics, stakeholders in the energy field and representatives from the industry.



## PROJECT PARTNERS



### UNIVERSITY OF CYPRUS COORDINATOR

[www.ucy.ac.cy](http://www.ucy.ac.cy)

FOSS Research Centre for Sustainable Energy of the University of Cyprus (UCY) is a research powerhouse in the field of sustainable energy solutions and in particular Photovoltaics. Committed to undertaking high quality research in order to tackle the climate and energy security challenges of today and the future, FOSS has currently over 40 active research projects, mainly funded by European grants, achieving imposing results. Through its research projects, FOSS has substantial experience in pilots where Photovoltaics are integrated with Energy Storage, and this knowledge will be transferred in the BERLIN project.

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### UNIVERSITY OF WESTERN MACEDONIA

[www.uowm.gr](http://www.uowm.gr)

The Department of Electrical & Computer Engineering of University of Western Macedonia (UoWM) has been involved in several European, regional and national projects with various tasks such as the integration of renewable energy resources, intelligent control of electric power generation and consumption, photovoltaics and storage hybridization and relevant pilot activities, smart grids and cyber security.

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### THE MUNICIPALITY OF EILAT

[www.eilat.city](http://www.eilat.city)

The Municipality of Eilat city is a leader in energy efficiency, as 75% of the city's daytime electricity is supplied by renewable energy (RE), and by 2020, the city will become energy independent. As in Eilat region there is more than 1850 sun hours per year, there is an advantage of using PV. The current state and the planned solutions are based on solar PV systems and energy efficiency, mostly in the cooling systems. Eilat is also a member of several H2020 projects in which a planning for a positive energy district is being developed.

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Università degli Studi di Cagliari



## UNIVERSITY OF CAGLIARI

[www.unica.it](http://www.unica.it)

UNICA participates in the BERLIN project through the Department of Electrical and Electronic Engineering (DIEE) that has a long history of participation to EU projects and calls and each year a significant portion of its budget is based on EU projects. The department cooperates with research labs (both industrial and public) and with other academic institutions worldwide.

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## BEN GURION UNIVERSITY

[www.in.bgu.ac.il](http://www.in.bgu.ac.il)

BGU is one of Israel's leading research universities and among the world leaders in many fields. BGU participates in the BERLIN project through the Department of Structural Engineering adding much needed structural/architecture expertise to consortium. Modern structural engineers face a variety of technological developments and challenges.

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# Deloitte.

## DELOITTE LIMITED

[www2.deloitte.com/cy](http://www2.deloitte.com/cy)

Deloitte participates in BERLIN through the Innovation and Entrepreneurship Centre (Deloitte IEC). Deloitte has an important role in the project as it has vast experience in managing successful European and local funded projects. The team of Deloitte IEC uses multiple research methods and tools for European Union-funded and ad hoc research for internal or external purposes in a number of areas covering Cyprus and the rest of Europe. Specifically, Deloitte IEC involvement in EU-funded projects is mainly on socio-economic impact studies, cost-benefit analyses, project and financial management, quality management and communication and dissemination.

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## HEVEL EILOT REGIONAL COUNCIL

<https://www.eilat.org.il>

Hevel Eilat Regional Council contribution will be on the off-grid applications, policy making at regional level and multi-level governance. Hevel Eilat is at the forefront of RE in Israel. The Eilat region established the Company for Renewable Energy (NGO) that works on the regulation and assimilation of innovation in the region. The regional council was the first one in Israel to build a PV solar farm and its developing new project as well as supporting start-ups.

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## ASSOCIATED PARTNERS

	Organization	Country
Associate 1	 <b>MUNICIPALITY OF KOZANI</b>	Greece
Associate 2	 <b>Municipality of Ussaramanna</b>	Italy
Associate 3	 <b>REGIONE AUTONOMA DE SARDIGNA REGIONE AUTONOMA DELLA SARDEGNA</b>	Italy

For more information please contact the project coordinator Prof. George E. Georghiou, Director of FOSS Research Centre for Sustainable Energy, University of Cyprus, Tel. +357 22892272, email: geg@ucy.ac.cy.

