Proposed actions for a sustainable energy transition through systems based on the Nanogrid concept combining Photovoltaic, Battery Energy Storage System, and Information/Communication Technologies

A Position Paper of the Intelligent Utilization of Photovoltaic Technology in the Mediterranean region (IUPVMED) Hub Committee

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Keywords

Nanogrid; microgrid; photovoltaic; energy storage; battery; demand side management; self-consumption; self-sufficiency; hybrid system; energy system; energy sustainability; renewable energy sources

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List of acronyms

BESS	Battery Energy Storage System
DER	Distributed Energy Resources
DSM	Demand Side Management
DSO	Distribution System Operator
EV	Electric Vehicle
ICT	Information and Communication Technologies
IUPVMED	Intelligent Utilization of Photovoltaic Technology in the Mediterranean region
MED	Mediterranean region
NZEB	Near Zero Energy Building
PV	Photovoltaic
RES	Renewable Energy Sources
ToU	Time-of-Use

About us

The Intelligent Utilization of Photovoltaic Technology in the Mediterranean region (IUPVMED) Hub was created by the BERLIN project partnership, which investigates the integration of Photovoltaics (PV), Battery Energy Storage Systems (BESS), and Information and Communication Technologies (ICT), under the concept of a hybrid nanogrid system. The BERLIN project is funded by the ENI CBC MED Programme and includes cost-effective rehabilitation of public buildings into smart and resilient nanogrids using storage. The BERLIN project includes the following partners: University of Cyprus (Cyprus), University of Western Macedonia (Greece), Municipality of Eilat (Israel), University of Cagliari (Italy), Ben Gurion University of the Negev (Israel), Deloitte Ltd (Cyprus), and Hevel Eilot Regional Council (Israel).

Mission

The IUPVMED Hub has been created from the BERLIN project partnership to promote the wider adoption of Distributed Energy Resources (DER) in the Mediterranean region (MED), in under the nanogrid concept. It is used to share information on regional legislation and relevant strategies among participating countries, regarding this technology and to propose roadmaps to aid its promotion.

Vision

The IUPVMED Hub aims to be a leading source for supporting research collaboration, dissemination, and technology transfer in the MED in the aforementioned field of interest. The Hub comprises of a wide range of key stakeholders, including distribution and transmission system operators, scientists from regulatory authorities, consultants, installers, engineers in the wider field of DERs, and academics/researchers. Members can exchange information, experiences, and ideas on current regional situations regarding PV+BESS+ICT systems in the participating countries, and potentially collaborate with other experts and key stakeholders in the field.

How this position paper was developed

This position paper covers the key outcomes from the IUPVMED Hub committee meetings. Specifically, it includes several propositions related to regional legislations and technological advances (within the scope of the Hub) and discusses the current and future strategies for promoting PV+BESS+ICT systems.

IUPVMED Hub members endorsing this position paper

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Introduction

Background

Although the high solar irradiation potential in the MED creates an opportunity for generation of electricity through solar PV technology, most MED countries still depend on imported fossil fuels for electricity generation. In recent years, new energy policies have been adopted in MED countries, such as net metering, which is an electricity billing mechanism that allows consumers who generate some or all of their own electricity to use that electricity anytime, instead of when it is generated. This is particularly important with Renewable Energy Sources (RES) like wind and solar, which are non-dispatchable. Monthly net metering allows consumers to use solar power generated during the day at night, or wind from a windy day later in the month. The MED is expected to suffer more than other areas due to climate change, and therefore 'green' electrification and carbon neutrality are necessary for its decarbonisation.

To deploy innovation at the system level across all traditional sectors it is necessary to employ digitalisation and flexibility. Moreover, to maximize self-generation and self-consumption it is necessary to combined RES with practical and efficient energy storage units that allow DSM. Currently the most widespread energy storage method is BESS, where commercially available batteries such as Lithium-Ion Batteries or Lead-Acid Batteries are utilized to store RES-generated electricity and use it when RES-generated electricity is unavailable. DSM is an energy management strategy which intervenes in the electricity usage in power system operations; it aims at the optimization of energy usage, reduction of peak power, improvement of reliability, and emission reduction.

The BERLIN Project

The BERLIN project aims to:

- Address the high building energy consumption, which is still mainly fossil fuel based.
- Support areas of weak grids resulting to low reliability and frequent outages, which are common in rural and other areas of the MED.
- Increase RES penetration to the grid, whilst ensuring grid stability and power quality.
- Fight energy poverty which is increasing with the ongoing financial crisis.
- Achieve a sustainable socio-economic development.

The project aims to develop, test, and implement cross-border pilot measures to support innovative and cost-effective energy rehabilitations in public buildings based on the nanogrid concept (building block for smart microgrids). This will include the optimal integration of PV, BESS, and ICT in cross-border pilot measures to transform pilot buildings into smart nanogrids of high energy resilience. The pilots of the BERLIN project include the design, benchmark, and optimization of the joint technical solution for building energy rehabilitations, data collection and validation at regional and central dataset points, data analysis and development of a consumption model for each pilot, and development of regional dynamic electricity tariffs and testing effective DSM solutions. The pilots involve nanogrid systems where the main power generator is based on solar PV technology, and the typical way to store energy is through BESS. The operation of the pilots generates several useful data, namely power generation data, power consumption data, energy storage data, and weather data. This helps the pilot sites to become state-of-the-art testing grounds for new policies related to RES and BESS.

Specifically, the pilot actions aim to support national and regional governments into shaping new policies by materializing systems that are based on innovative technologies, such as PV, BESS, and ICT, under the nanogrid concept. The results will help to inform the relevant policies, especially in relation to schemes that promote self-consumption and moreover extend the capacity of RES-generated electricity. The outcomes of the pilot actions will also help increase RES share through onsite power generation and increase self-consumption and self-sufficiency. Crucial benefits can be expected for the local communities adopting such systems, in the form of decarbonization, greater autonomy and grid-independence, lower electricity costs, and energy efficiency.

Paper Objectives

This paper aims at including the positions of the IUPVMED Hub members on policies for energy transition for PV-BESS-ICT systems in the MED. The proposals derive from the annual IUPVMED Hub meetings between members of the partnership and Hub members. In the meetings, the participants shared information and discussed existing problems on regional legislation among the participating countries. Simultaneously, the participants discussed arising opportunities for the development of new policies and schemes that can promote microgrid/nanogrid based system configurations, which have been developed in the pilot systems throughout the duration of the BERLIN project timeline.

The position paper includes several recommendations for future strategies and roadmaps based on the findings of the BERLIN project. Overall, the paper includes the recommendations that were formed based on the evolutions of all IUPVMED Hub meetings throughout the project timeline. These cover the information that evolved throughout the presentations of the project status related to the pilots and other relevant activities of the BERLIN project, and the round-table discussions from all IUPVMED Hub committee meetings.

Issues raised throughout the IUPVMED Hub meetings

The most significant issues raised throughout the IUPVMED Hub Committee meetings are summarized below:

- A significant challenge faced in the existing energy infrastructure is the difficulty in introducing new technologies, due to the lack of energy policies that can help promote digitalisation, flexibility, and increase the abundant solar energy in the MED.
- It is important to educate people on sustainable energy solutions; especially residents which need to become aware of the use of greener energy solutions. This should be done from a young age, by training future generations on using such systems and also conveying the message to their parents and moreover to their community, through studying in 'green schools'. Therefore, children can help change the public behaviour on energy efficiency in buildings.
- A significant barrier for the nanogrid concept is the complexity and high cost of such systems. Therefore, effective measures/actions are needed to convince residents to use sustainable energy systems.
- It is necessary to establish clear standards and regulations specific to nanogrids.
- Conducting pilot projects allows for real-world testing and demonstration of nanogrid technologies.
- The cost of nanogrid components, especially BESS and controllers must decrease to allow a wider adoption.
- Financial incentives like tax credits or subsidies can make nanogrid installations more economically viable.
- Public outreach campaigns, workshops, and educational programs can help familiarize communities, policymakers, and industry professionals with the benefits and potential of nanogrids.
- Nanogrids should be designed to seamlessly integrate with the existing power grid. This will allow a two-way power flow, enabling energy exchange between nanogrids and the main grid.
- The standardization of communication protocols and grid connection requirements is necessary to ensure compatibility and grid stability.
- Governments should promote nanogrid adoption through supportive policies and incentives.
- Case studies, success stories, and quantifiable data can demonstrate the positive impact of nanogrids on energy security and sustainability.
- There is a need for Distribution System Operators (DSOs) to improve their visibility and ability options of DER and storage technologies because currently storage is insufficiently monitored (due to the absence of effective communication systems).
- Most of the storage has to be integrated to PV generation, as a first bulk to enable these technologies, until policies, intensives and costs are in a level that allow prosumers to freely install integrated PV + storage solutions.
- Islanded operation is still not allowed in the participating countries of the BERLIN project (Cyprus, Greece, Israel, and Italy).

- In some countries, such as Italy, PV + storage incentives are currently available.
- In Cyprus, a flexibility services' scheme is currently under development to provide incentives to the DSO. This will be done to pave the way for local flexibility markets, and accelerate Demand Response capabilities, while activating citizens to engage and participate in the market (e.g., large consumers). Additionally, efforts are currently being made for both upwards and downwards flexibility actions.
- Although the nanogrid concept is not currently regulated in the EU, other similar systems, such as closed distribution systems, i.e., Energy Communities, are already available, which can offer flexibility.
- Energy storage in the framework of the existing net-billing scheme is not yet appealing since a high payback time is needed.
- A key challenge for nanogrid systems lies on the commissioning of the switch between the modes of operation, namely grid following and grid forming, in relation to the BESS. Many tests with the battery supplier are often necessary to achieve this, and also to reveal and identify the possible risks of switching between the two modes of operation and observe the response of the Energy Management System of the BESS during real-time operating conditions.
- The operation of a nanogrid requires optimizing the demand side in a controlled way that will maximize the economic benefits of the local system and allow it to run in three levels of optimization, namely: (a) building-side, (b) neighbourhood-side, and (c) nanogrid/microgrid level. This optimization will have to run in parallel to the whole system, to allow optimization of the 'leftovers', i.e., optimization of the local use of resources.

Proposed actions for a sustainable energy transition through systems based on the nanogrid concept combining PV, BESS, and ICT

The following specific actions for each participating country are proposed to promote a sustainable energy transition through systems based on the nanogrid concept combining PV, BESS, and ICT.

CYPRUS

1. Policy aspects

Step 1.1: Update energy-related policies: Existing policies must be revised and updated to promote and increase the self-sufficiency of public buildings. Specifically, a comprehensive policy framework must be developed to promote self-sufficiency with the utilization of PV, BESS, and ICT.

2. Regulatory aspects

Step 2.1: Implement energy storage-related regulations: Develop a regulatory framework that promotes RES-storage combined energy systems, and specifically combined PV-BESS. Such regulations will remove existing barriers, and therefore can help promote integration of BESS with new or existing PV systems.

Step 2.2: Abolish the current net-metering scheme: The current net-metering scheme allows end-users to use the power network as a virtual and unlimited storage asset. The use of a new scheme based on the more effective net-billing scheme can help create more active participation of prosumers, with more dynamic electricity tariffs that can help accelerate the sustainable energy transition with a higher RES share.

Step 2.3: Implement energy community-related regulations: A dedicated regulation on energy communities will help generate synergies in new decentralized energy systems such as microgrids. It will also help provide clear guidelines, and incentives for the establishment and development of such energy communities, with active citizen participation and promotion of RES-storage systems. The regulation should clearly define how energy is generated, stored, and traded within the energy community. The participation of public buildings in energy communities that benefit from BESS and DSM capabilities could optimize energy usage by sharing the large storage capacity among community prosumers.

3. Market aspects

Step 3.1: Transition to Time-of-Use (ToU) tariffs: Currently only a simple two-rate ToU tariff exists, and therefore the transition to more advanced ToU tariffs could encourage end-users to reduce their electricity consumption during peak hours and/or shift loads to off-peak hours. This is due to the fact that ToU tariffs are designed to reflect cost of the structure of the utility, which means that rates are high during peak hours, and low during off-peak hours.

Step 3.2: Deployment of demand response schemes: Demand response schemes should be deployed and become available to end-users. These schemes can help manage congestion, reduce peak demand, and provide balancing. Such schemes will enable public buildings to participate electricity demand management and actively optimize energy usage. Demand response could have a tremendous impact in public buildings, since such buildings have many controllable (deferrable) loads such A/C units, refrigerators, EVs, domestic water heaters, and lighting. Such capabilities could help provide effective solutions during critical grid periods or high-demand situations.

4. Network aspects

Step 4.1: Use of smart meters: The deployment of smart meters should be accelerated to enable end-users to access ToU tariff schemes, while actively managing their consumption. Additionally, smart meters integrated with BESS will allow end-users to reduce costs through optimum, flexible energy management. This is because the necessary information provided by the smart meters can help the end-users to optimally operate their BESS in combination to relevant communication protocols and modern data acquisition capabilities.

Step 4.2: Use of smart plugs/appliances: The deployment of smart plugs/appliances in combination with ToU tariffs can maximize energy management in building and help reduce consumption-related costs. These devices have wireless communication capabilities, which allows end-users to schedule operation.

Step 4.3: Optimize the grid infrastructure: The grid infrastructure must be upgraded to allow its smooth and optimum integration with decentralized PV-BESS systems. To achieve this, the grid reliability and stability must be enhanced, while verifying that the conditions and limitations under which end-users are allowed to own and operate a PV-BESS system are clearly defined.

5. Incentive aspects

Step 5.1: Subsidies for BESS: Since commercially available BESS are currently expensive, but simultaneously necessary for the increase of self-sufficiency rates, it is important to allow relevant subsidies, when utilized in integrated PV-BESS systems. Such subsidy schemes should ensure minimum bureaucratic procedures and provide relevant financing opportunities to end-users.

6. Marketing aspects

Step 6.1: Improve end-users' awareness: Take the necessary actions to improve the awareness of end-users on decentralized energy systems and system efficiency, by using the PV-BESS systems as a case study of increasing self-consumption and self-sufficiency, while reducing carbon emissions and operational costs. Illustrate how such systems can have a positive impact on the central power grid in comparison to using only grid-connected PV systems which create grid stability issues and enforce curtailment of RES-generated electricity. Also, communities and businesses should be encouraged to adopt such systems.

Step 6.2: Provide training on PV-BESS systems: Develop and provide (possibly through public funding) training programs for various professionals (engineers, technicians, and installers). The training programmes should provide the necessary skills and knowledge to design, install, and maintain RES-BESS systems.

GREECE

1. Policy aspects

Step 1.1: Authorities and government commitment: Policy and regulatory responsible authorities should express their will and strongly commit to promoting customers' energy self-sufficiency. The government must commit to allocating the necessary financial resources to implement the measures recommended by the authorities.

2. Regulatory aspects

Step 2.1: Removal of restrictions on storage systems: All restrictions on the installation of storage systems must be removed. Storage systems must be allowed in all facilities (normal and virtual net-metering) without power limitations. The only restriction is that the storage system should not be charged from the grid.

Step 2.2: Changes to the net-metering scheme: The net-metering scheme uses the network as a large storage system. The scheme should be changed to consider the state of the energy market at the time of storage or consumption from the grid and become a net-billing scheme where netting is at the level of energy costs and not at the energy level. At a later stage, even the net-billing scheme should be abolished, and prosumers' export of energy to the grid will not be compensated.

Step 2.3: Virtual storage system from energy-communities: Introducing the virtual storage system must strengthen the institution of energy communities. Specifically, installing a storage system in power production facilities (new and existing) of energy communities will be allowed. An energy storage system will lead to a smoother power curve from the production facility and perform energy production from the facility during the night. This will have positive consequences in the calculation of energy remuneration of the facility and the profits of the energy community members.

3. Market aspects

Step 3.1: Introduction of hourly rate tariffs: The introduction of hourly rate tariffs and the differentiation of the energy cost depends on the consumption time and the current conditions of the energy market. The possibility of hourly billing is currently possible for medium voltage consumers who have telemetering infrastructure.

4. Network aspects

Step 4.1: Installation of smart meters in low voltage customers: The tender procedure for replacing analogue or industrial meters with smart meters in the Low Voltage network should be finalized. HEDNO should start installing the 7.3 million smart meters as soon as possible. The smart meters will allow extending the hourly rate tariffs to all Low Voltage consumers.

Step 4.2: Use of smart devices in buildings: The use of smart devices can significantly improve the management of building loads. Many appliances already have wireless communication capability, allowing users to schedule their use time. Combined with hourly tariffs, they can generate significant changes in the load curve of consumers.

5. Incentive aspects

Step 5.1: Incentives through administrative procedures: The Greek RES market is partly saturated, and there is a long waiting time for the issuance of connection terms for new RES units. Prosumers' power systems that include a storage system must precede all other power units and be connected to the grid as soon as possible.

Step 5.2: Subsidy for storage systems: Energy storage using lithium batteries is still expensive, and their utilization should be accompanied by a market subsidy, such as the recent "rooftop PV" program. Other incentives, such as faster grid connection for new PV installations combined with batteries, may help to spread the introduction of storage systems further.

Step 5.3: Building renovation subsidies: The building energy renovation actions have significant financial support from the EU and the state. Adding PV+BESS+DSM installation to the list of supported actions will significantly improve the introduction of the above systems in the prosumers energy market.

6. Marketing aspects

Step 6.1: Actions aiming at raising consumers' awareness: Actions explicitly aiming at raising consumers' awareness, like informing them about the benefits of improving self-consumption and its impact on grid operation and environmental issues, should be highly promoted. The user must be aware of the risks of power grid instability created by the high penetration of RES production and the need to help with their energy behaviour to increase penetration further.

ISRAEL

1. Policy aspects

Step 1.1: Ensure Long-Term Policy Stability for RES Growth: Establish and maintain long-term policy stability at national and municipal levels. Provide clarity on support mechanisms, feed-in tariffs, and incentive programs to build investor confidence in the renewable energy sector. Long-term policy stability is essential for attracting investment and fostering the growth of RES systems.

2. Regulatory aspects

Step 2.1: Enhance Regulatory Framework and Utility Structures for DSM Implementation: The regulatory framework in Israel should be revised to address barriers hindering DSM programs, such as inflexible rate structures, inadequate pricing mechanisms, and discouraging regulations. Promote regulatory flexibility by designing rate structures incentivizing demand response and dynamic pricing models. Encourage innovation in DSM approaches and ensure regulations support the implementation of demand response programs and dynamic pricing, which are vital for effective DSM. Foster collaboration among regulators, utilities, and consumers to develop regulatory reforms that create a favourable environment for DSM implementation while protecting consumer interests.

Step 2.2: Optimize Land Utilization and Collaboration for Renewable Energy: Efficiently allocate existing land resources, balancing renewable energy goals with other land uses. Engage local authorities in decision-making, establish planning regulations for agrovoltaic projects, collaborate with the Ministry of Defence for land use opportunities, and develop regulations and pricing mechanisms. Encourage local authorities to create climate change action plans and allocate standardized budgets. Explore solar installations above or alongside roads for widespread solar production.

Step 2.3: Streamline Permitting and Siting Processes for Energy Storage: Simplify and expedite the permitting process for energy storage facilities by establishing clear rules and guidelines for grid-scale projects. Address regulatory ambiguities to reduce uncertainty and attract investors. Improve coordination among regulatory authorities and streamline environmental impact assessments to minimize project delays and costs.

Step 2.4: Establish and Enforce Energy Efficiency Standards: Develop and enforce robust energy efficiency standards for buildings, appliances, and industrial processes. Clear and consistent standards will ensure accountability and promote energy-saving practices. Strengthen enforcement mechanisms to drive compliance and achieve energy efficiency goals effectively.

Step 2.5: Enhance Regulatory Support for Energy Efficiency: Revise and strengthen regulatory frameworks to prioritize energy efficiency initiatives. Implement building codes that require minimum energy performance standards and ensure effective enforcement of energy efficiency regulations. Provide incentives for builders and developers to prioritize energy-saving measures, fostering a culture of energy efficiency in construction and development practices.

3. Market aspects

Step 3.1: Stimulate Market Availability and Competition for Energy Efficiency: Promote a diverse and competitive market for energy-efficient products by encouraging suppliers to offer a wider range of options. Facilitate the availability of energy-efficient appliances and products, empowering consumers to make informed decisions and fostering competition among suppliers to drive innovation and improve energy efficiency options in the market.

Step 3.2: Develop Favourable Market Structures for Energy Storage: Create well-designed market structures and mechanisms to enhance the economic viability of energy storage. Establish favourable tariff structures and enable participation in grid ancillary services markets. By providing adequate market incentives, potential investors will be encouraged, leading to increased deployment of energy storage systems.

4. Network aspects

Step 4.1: Strengthen Grid Infrastructure and Integration for RES and Energy Storage: Upgrade and expand the existing grid infrastructure to accommodate the integration of energy storage and intermittent renewable energy sources. Enhance grid capacity, transmission, and distribution networks to handle bidirectional power flows and fluctuating power output. Prioritize infrastructure upgrades in remote regions with limited transmission capacity to enable efficient renewable energy transmission. Implement smart grid technologies, energy storage, and demand response systems to enhance grid flexibility and optimize RES integration.

Step 4.2: Streamline Interconnection Processes for RES Systems: Simplify administrative procedures and paperwork involved in interconnecting RES systems to the grid. Establish clear technical standards and regulations for grid interconnection, ensuring compliance with voltage stability and power quality requirements. Streamlining interconnection processes will reduce delays, lower costs, and facilitate the timely implementation of RES projects.

Step 4.3: Gradual Deployment of Smart Meters in LV and MV Infrastructure: Continuously deploy smart meters in the low voltage infrastructure across different regions in Israel. Conduct pilot projects to test the integration of smart meters in the medium voltage infrastructure. Focus on improving energy efficiency, enabling demand response programs, and enhancing grid management through the widespread adoption of smart meter technology.

5. Financing and Incentive aspects

Step 5.1: Improve Financial Support and Accessibility for Energy Efficiency and RES Systems: Enhance financial incentives such as tax credits, subsidies, and favourable financing options to encourage investment in energy-efficient technologies and RES systems. Develop clear revenue streams and robust business models to mitigate perceived risks associated with energy storage projects. Foster innovation and cost reduction through research and development to make energy storage technologies more affordable. Increase accessibility to financing options for RES systems, addressing upfront costs and investment risks to promote widespread adoption.

Step 5.2: Align Incentives for Energy Efficiency in Rental Properties: Introduce policies and incentives to address split incentives in rental properties. Encourage property owners to invest in energy-efficient upgrades by offering financial incentives, tax credits, or subsidies. Empower tenants to participate by providing information, education, and incentives for energy-saving measures, fostering a collaborative approach to energy efficiency.

Step 5.3: Enhance Financial Incentives and Access to Financing for DSM and Energy Efficiency: Develop robust incentive programs and tariffs that reward energy efficiency and demand response actions, motivating consumers to invest in energy-saving measures. Establish specialized financing options, such as low-interest loans and energy efficiency grants, to overcome upfront costs and facilitate the adoption of energy-saving technologies.

6. Technology and Green Construction aspects

Step 6.1: Develop Domestic Manufacturing Capabilities for RES Technologies: Investment in developing a strong domestic manufacturing base for RES components like solar panels reduces reliance on imports, shortens lead times, lowers transportation costs, and minimizes supply chain vulnerabilities. Improve accessibility and availability of energy-efficient technologies in the local market by supporting domestic manufacturing initiatives.

Step 6.2: Facilitate the Adoption of Advanced DSM Technologies: Address technical challenges by promoting the development and production of green building materials. Raise awareness through campaigns to enhance the availability of advanced energy management systems, smart meters, and IoT infrastructure. Encourage architectural and design innovations that prioritize sustainability and energy-efficient technologies. Provide training and support to improve technical knowledge and skills required to install and maintain energy-efficient technologies.

Step 6.3: Upgrade Aging Infrastructure for Energy Efficiency: Develop comprehensive retrofitting programs to address energy inefficiencies in older buildings. Prioritize upgrades such as insulation, HVAC systems, and lighting fixtures. Implement financial incentives and technical assistance to alleviate the cost burden and facilitate the transition to energy-efficient infrastructure. Foster partnerships between stakeholders to expedite the retrofitting process

7. Awareness and Marketing aspects

Step 7.1: Ensure Data Accessibility and Privacy for Effective DSM: Establish mechanisms for data accessibility while safeguarding consumer privacy and data protection. Develop frameworks that allow secure and controlled access to accurate and real-time energy consumption data for DSM implementation. Implement robust data privacy regulations to build trust and address data ownership and privacy concerns.

Step 7.2: Engage Collaborative Stakeholder Engagement for DSM Success: Facilitate stronger collaboration among utilities, regulators, consumers, and stakeholders. Enhance coordination between utilities and end-users to develop effective demand response programs. Promote engagement of consumers in energy efficiency initiatives through targeted outreach and education. Encourage regular communication and collaboration among all stakeholders to ensure the successful implementation of DSM measures.

Step 7.3: Overcome Cultural and Behavioural Barriers, Enhance Data Availability, and Promote Awareness: Implement targeted education and awareness campaigns to shift consumer attitudes and behaviours towards energy efficiency, addressing cultural norms and lack of awareness. Enhance data collection and dissemination to provide information on energy consumption patterns, potential savings, and best practices. Energy efficiency promotion can be effectively supported by overcoming cultural barriers and increasing awareness while ensuring access to reliable data and information.

Step 7.4: Encourage Demonstration Projects and Knowledge Sharing: Initiate and support demonstration projects that showcase energy storage systems' technical and economic feasibility in real-world applications. Establish knowledge-sharing platforms to disseminate information and best practices. By demonstrating the benefits and building stakeholders' confidence, wider adoption of energy storage technologies can be encouraged, overcoming uncertainties, and enhancing awareness of their potential benefits.

Step 7.5: Foster Research and Development for Energy Efficiency: Increase investment in research and development to drive innovation in energy-efficient solutions and technologies. Promote collaborations between academia, industry, and government agencies to support the development of cutting-edge energy-efficient products, materials, and systems. Continuous advancements will accelerate progress in promoting energy efficiency and facilitate the adoption of innovative solutions.

Step 7.6: Promote Accessible and Affordable Energy Audits: Facilitate the availability and affordability of energy audit services. Establish programs to train and certify auditors, ensuring a qualified workforce. Provide financial incentives or subsidies to encourage individuals and businesses to undergo energy audits. By increasing access to comprehensive audits, stakeholders can make informed decisions and prioritize energy-saving investments.

ITALY

1. Policy aspects

Step 1.1: The Italian government should develop a comprehensive policy framework to promote energy self-sufficiency through renewable energy sources. The policy framework should prioritize integrating energy communities and encourage active consumer participation.

2. Regulatory aspects

Step 2.1: Implement the RED II Decree: Ensure the full implementation of the Renewable Energy Directive II (RED II) Decree provides the main principles for a new support regime for large-scale and small-scale renewable energy plants and communities. Create a framework that promotes combining renewable energy plants with storage facilities, including BESS.

Step 2.2: Publish the implementing decree for energy communities: Finalize and publish the implementing decree for energy communities, providing clear guidelines, regulations, and incentives for establishing and operating energy communities. Ensure the decree supports the deployment of renewable power capacity and encourages citizen participation.

Step 2.3: Enable simplified procedures for BESS and PV plants: Establish simplified enabling procedures for installing and operating BESS with existing or newly authorized PV plants. Streamline the authorization process to facilitate the integration of BESS into the energy system and encourage the use of storage technologies.

3. Market aspects

Step 3.1: Promote market mechanisms for BESS: Develop market designs and regulations that support BESS's effective integration and utilization. Enable BESS participation in grid services, such as demand response, ancillary services, and capacity markets. Create mechanisms for price arbitrage, incentivizing BESS operation during periods of low electricity prices and high demand.

Step 3.2: Transition to zonal pricing: The transition from the single zonal price (PUN) to zonal pricing for energy withdrawals allows producers and consumers to benefit from dynamic pricing. Align the pricing system with renewable energy production and consumption patterns, encouraging the use of BESS and the adoption of renewable energy sources.

Step 3.3: Implement demand response programs: Expand demand response programs in the electricity market, including virtual and mixed-enabled virtual units (UVAMs). Enable these programs for congestion management, balancing, and frequency restoration reserves. Develop regulations and penalties that ensure the reliability and effectiveness of demand response services.

4. Network aspects

Step 4.1. Install smart meters: Accelerate the deployment of 2G smart meters, ensuring that at least 90% of delivery points are equipped with 2G meters by 2025 and 96% by 2026. Enable customers with smart meters to access dynamic electricity offers and actively manage their energy consumption. Facilitate the integration of BESS with smart meters, allowing owners to take advantage of flexible energy management and cost-saving opportunities.

Step 4.2: Enhance grid infrastructure: Upgrade the grid infrastructure to accommodate the integration of renewable energy sources and BESS. Assess and plan for the necessary grid reinforcements to support the increased penetration of decentralized generation and storage technologies. Ensure grid reliability and stability while optimizing the utilization of renewable energy.

Step 4.3: Develop storage-specific grid regulations: Develop specific grid regulations that address energy storage systems' unique characteristics and requirements. Consider grid connection, power quality, system stability, and code compliance. Adapt grid regulations to facilitate the smooth integration and operation of BESS.

5. Marketing and Education aspects

Step 5.1: Raise awareness about RES and BESS benefits: Conduct public awareness campaigns and educational programs to inform citizens about the benefits of renewable energy sources and BESS. Highlight the environmental and economic advantages of using RES and BESS technologies. Encourage individuals, communities, and businesses to adopt renewable energy and storage solutions.

Step 5.2. Provide training on RES and BESS: Develop training programs and educational resources to equip professionals, technicians, and installers with the necessary skills and knowledge to design, install, and maintain RES and BESS systems. Promote vocational training and certification programs to support the growth of the renewable energy and storage industry.

Step 5.3. Foster research and development: Invest in research and development initiatives to advance renewable energy and storage technologies. Support universities, research institutions, and industry collaborations to drive innovation, improve efficiency, and reduce the costs of RES and BESS. Encourage the development of new technologies and solutions to address the challenges and maximize the potential of renewable energy and storage.

6. Financial aspects

Step 6.1: Introduce Subsidies and Grants for Residential Renewable Energy Systems: Implement subsidies and grants for residential renewable energy systems like solar panels. Offer financial incentives to encourage homeowners to invest in renewable energy, reducing grid dependence and promoting self-sufficiency. Establish clear eligibility criteria and streamlined application processes to ensure broad adoption of residential renewables.

Step 6.2: Implement Net Metering Programs with Favourable Terms: Implement net metering policies with fair compensation rates, longer contracts, and favourable terms to enable residential energy producers to offset consumption. Promote the integration of energy storage systems for enhanced self-sufficiency.

Step 6.3: Establish Feed-in Tariffs for Energy Communities and Collective Self-Consumption: Introduce community-specific feed-in tariffs, incentivizing local renewable energy production and consumption. Provide financial rewards to energy communities for their sustainable practices. Establish attractive tariff rates to enhance economic viability and attract investments, fostering community-level energy self-sufficiency.

Conclusions

This position paper covers the key outcomes from the Intelligent Utilization of Photovoltaic Technology in the Mediterranean region (IUPVMED) Hub committee meetings. The Hub was created by the BERLIN project partnership, which investigates the integration of Photovoltaics (PV), Battery Energy Storage Systems (BESS), and Information and Communication Technologies (ICT), under the concept of a hybrid nanogrid system.

The included propositions aim at reaching a sustainable energy transition through updating national/regional legislations and making technological advances that can help promote PV+BESS+ICT systems based on the nanogrid concept. A number of critical issues, emphasized throughout the IUPVMED Hub Committee meetings, need to be resolved in the near future to accomplish this transition.

Additionally, based on the findings of the BERLIN project, specific roadmaps for each participating country (Cyprus, Greece, Israel, and Italy) are proposed to accelerate and facilitate a sustainable energy transition through PV+BESS+ICT systems based on the nanogrid concept. These actions include policy, regulatory, market, network, incentive, marketing, technological, awareness, education, and financial aspects.