

# Interreg



## Balkan-Mediterranean PV-ESTIA



### **Enhancing storage integration in buildings with Photovoltaics**

**PV-ESTIA**

**Report on the policy barriers and opportunities related  
to NZEBs and PV integration in Balkan Med area**

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University of Cyprus

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## 1 Project Summary

The Balkan-Mediterranean (Balkan Med) region is facing the challenge of sustaining and increasing the growth of photovoltaic (PV) systems that is endangered by several barriers and their unpredictable nature. This is especially important in the built environment as member states are developing plans to increase the number of Nearly Zero Energy Buildings (NZEBs), which most probably employ PVs, to reach their 2030 climate change targets. As the number of NZEBs increases, PV integration in the distribution grids of the Balkan Med region will not remain as straightforward as today, unless buildings become more grid-friendly and policies/regulations are suitably adapted. In the above context, the overall objective of PV-ESTIA project is to enhance the penetration of PVs in the built environment. This will be achieved by using storage, which will transform the building into a more predictable power source. With the high solar potential of the Balkan Med region and the decreasing cost of PV/storage systems, such a solution is becoming cost-efficient. The project aims to change the way buildings with PVs are treated and conceptualize them as systems, which are efficiently interacting with grids. In addition, it aims to alleviate the above barriers and pave the way for unobstructive NZEB development.

## 2 Introduction

It is widely known that buildings account for 40% of the European Union's (EU) total energy consumption. The sector is expanding and so too are its energy demands. Forty per cent (40%) of households used as permanent dwellings were built before 1981 and fifty-four per cent (54%) were built between 1981 and 2006, i.e. before any minimum energy performance requirements were adopted. In a similar way, eighty-three per cent (83%) of the office buildings (public and private) as well as buildings in the accommodation sector (hotels, tourist establishments and restaurants) were built before the first minimum energy performance requirements were adopted (Zingheri, 2016).

The increase of NZEBs will help EU reduce its energy dependency and greenhouse gas (GHG) emissions and advance towards its goal of reducing the overall energy consumption by 20% by 2020.

The transformation of the EU's building stock to NZEBs has already started and is expected to continue rapidly in the following years. Hence, it is certain that a new environment for the electrical grid is emerging, where buildings with a substantial amount of volatile Renewable Energy Sources (RES) will create crucial challenges. However, up to now, there is not enough knowledge and sophisticated case studies/pilots about the stress real buildings with PVs impose on electrical grids.

In the context of smart grid development, high-resolution indices that describe the interaction of on-site generation, building load and the grid, are necessary.

**Activity 3.2 of the Work Package (WP) 3 focuses on identifying the main barriers and opportunities in the Balkan Med region, by analysing the current policies in each country related to PV integration in buildings and NZEBs.** Towards this objective, a comparative analysis of the current policies performed, while stakeholders' workshops and targeted meetings in each country organized, providing valuable inputs and a further insight in the existing regulatory framework.

In this report, the analysis of the current situation in the EU and the participating countries is presented in terms of NZEBs towards achieving the 2020 energy targets. Further to this, the study focuses on the current relevant legislation in each participating country, highlighting the barriers for further NZEBs promotion as well as best practices, measures, and policies related to buildings' renovation that can be considered in the Balkan Med region. In addition, the solar potential and renewable sources for each region is presented as well as an overview of the existing situation about the evolution of RES in the EU and specifically in the Balkan Med region. This report also presents the PV related legislation that exists in each participating country with emphasis on the support schemes for PV systems. The current relevant legislation in each participating country for coupled PV- energy storage systems (ESS) installations are also highlighted. Finally, the stakeholders' targeted meetings and workshops are analysed that will provide valuable data for the implementation of the project's objective.

To conclude, this report constitutes the starting point that depicts the current situation in Europe and the participating countries and will provide the necessary input for the development of subsequent schemes to promote the transition toward NZEBs for improving the energy efficiency in the Balkan Med region.

### 3 Energy policy and buildings in Europe

The building sector is one of the key sectors to achieve the 20/20/20 targets of Europe, which also aims at bringing drastic reductions of greenhouse gas emissions in the residential and service sectors of 88% to 91% compared to 1990 by 2050 (Hermelink A., 2012).

European energy policies are focused on the reduction of energy consumption in buildings by 2020 and improve the energy performance of buildings in the EU, considering various climatic and local conditions. These are an effective way to foster innovation and achieve a significant reduction of greenhouse gas emissions and energy use, contributing to the energy independence of the EU.

The European Commission encourages Member States to decrease energy consumption in buildings and convert national building stocks from energy consumers to energy producers

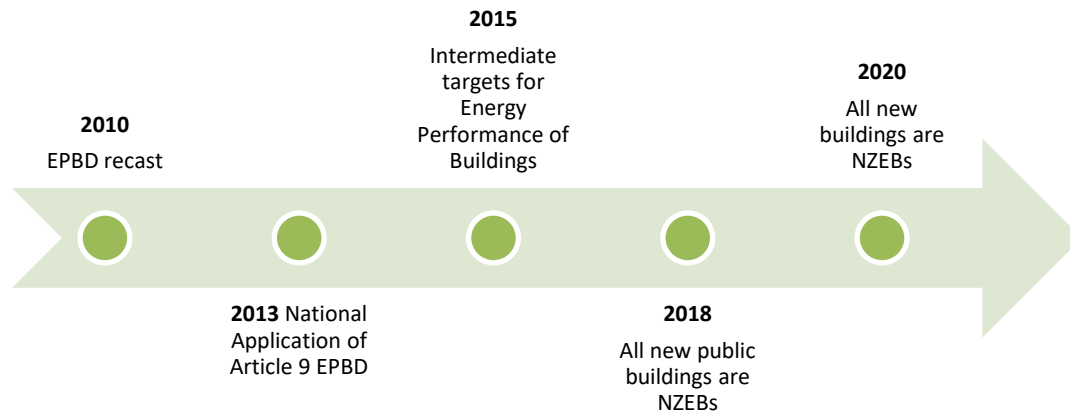
through retrofit measures and renewable energy sources. The implementation of NZEBs from 2018 represents one of the biggest opportunities to increase energy savings and reduce greenhouse gas emissions (D'Agostino D., 2017).

To enhance the penetration of NZEBs in the building sector, the Energy Performance of Building Directive (EPBD, Directive 2010/31/EU) introduced the definition of NZEB. An NZEB is a building that “has a very high energy performance with the nearly zero or very low amount of energy required covered to a very significant extent by energy from renewable sources, including renewable energy sources produced on-site or nearby”. The first part of this definition establishes energy performance as the defining element that makes a building an “NZEB”. This energy performance must be very high and determined in accordance with Annex I of the Directive. The second part of the definition provides guiding principles to achieve this very high energy performance by covering the resulting low amount of energy to a very significant extent by energy from RES (D'Agostino D., 2017) (EPBD, Directive 2010/31/EU, 2010).

According to the EPBD, Member States must ensure that new buildings occupied and owned by public authorities are NZEBs after December 31, 2018 and that all new buildings are NZEBs by December 31, 2020. New buildings must meet the minimum standards and contain high-efficiency alternative energy systems whereas existing buildings, when undergoing major renovation, must upgrade their energy performance to meet the EU requirements (EPBD, Directive 2010/31/EU, 2010).

Article 9 of the EPBD also foresees the settlement of national NZEB definition and actively promotes higher market uptake of such buildings. Member States must prepare and submit to the European Commission the national plans with clear definitions and measures (e.g. policies and financial incentives) to promote NZEBs. The EPBD requires EU countries to set cost-effective minimum energy performance requirements in buildings. These requirements should be reviewed every 5 years at the latest and must cover heating, hot water, air-conditioning and large ventilation systems ( D'Agostino D., 2017) (EPBD, Directive 2010/31/EU, 2010) ). Intermediate targets for improving the energy performance of buildings must be provided as part of National Plans for increasing the number of NZEBs by 2015. Member States must also develop policies and take measures to stimulate the transformation of refurbished buildings into NZEBs (D'Agostino D., 2017) (EPBD, Directive 2010/31/EU, 2010) (BPIE, 2015).

The current situation towards the establishment of applied national NZEBs definitions in European Countries has improved recently. Figure 1 demonstrates the timeline for the implementation of NZEBs according to the EPBD recast (D'Agostino D., 2017).



**Figure 1:** Timeline for NZEBs implementation according to the EPBD recast (D'Agostino D., 2017).

The European Commission evaluated the progress of Member States towards the establishment of NZEB definitions based on the National Plan and the templates, the Commission report of 2013 and its update of October 2014, as well as information from the EPBD Concerted Action (CA), National Energy Efficiency Action Plans (NEEAP), and National Codes. Some of the aspects considered were the following: building category, typology, physical boundary, type and period of balance, included energy uses, renewable energy sources, metric, normalization, and conversion factors (D'Agostino D., 2017).

So far, progress may be seen in many EU countries compared with the very first attempts to establish NZEB definitions. This has been achieved with the assistance of greater guidance provided to EU countries in the setting of consistent NZEBs requirements (D'Agostino D., 2017).

Regarding the energy calculation, one of the main topics discussed, the analysis of national NZEBs definitions exposes that:

- The main included energy uses are heating, domestic hot water (DHW), ventilation and cooling. Auxiliary energy and lighting are considered in almost all EU Member States and several include appliances and central services.
- The most common choice about the energy balance calculation is the difference between the primary energy demand and the energy generated, over a period of one year and considering annual constant weightings/factors (e.g. primary energy factors).
- Single buildings or building units are the most frequent indicated physical boundary for the calculation, but the overall impression is that the differences among building units/sizes/zones/parts need to be better addressed.
- Regarding the normalization factors, conditioned area is the most agreed upon choice in EU Member States although other options such as net floor area and treated floor are selected.

- The most common RES option considered is the on-site generation, but many countries also consider external and nearby generation (but probably not always with the same meaning).
- Almost all Member States prefer the application of low energy building technologies and available RES. The most widely used technologies are PV, solar thermal, air- and ground-source heat pumps, geothermal, passive solar, passive cooling, wind power, biomass, biofuel, micro combined heat and power (CHP), and heat recovery.

An NZEB can be achieved by combining highly efficient technologies with RES (D'Agostino D., 2017).

From EPBD definitions given in Articles 2, 9 and Annex I it follows that Member States must choose an energy performance indicator and a numeric indicator or primary energy use. Also, the time interval over which to calculate the performance may be a year but shorter sub-intervals might be the basis for calculations or included in the other indicators that might be used to evaluate energy performance as described in Annex I (Hermelink A., 2012).

Technically, the NZEB level for new buildings cannot be below than the 2021 cost-optimal level that has been calculated according to the Article 5 of the Directive. The cost-optimal level is the minimum level of ambition for NZEB performance. The NZEB level of energy performance for new buildings is determined by the best technology available and well introduced on the market at that time, financial aspects and legal and political considerations at national level. One of the key points around NZEBs at EU level is how to successfully stimulate cost-effective deep renovation of existing buildings to NZEBs (D'Agostino D., 2017).

With regards to the Directive, Member States must define the detailed application in practice of “a very high energy performance” and the recommendation of “a very significant extent by energy from renewable sources, in line with their local characteristics and national contexts”. This, in conjunction with the absence of a harmonized calculation methodology for energy performance, leads to applied national approaches not fully comparable. Furthermore, within EU Member States, the achievement of an NZEB clear definition is not fully reached and the implementation of NZEBs into construction practices and routines, especially at a refurbished level, is far to be obtained. The transformation of the built environment into NZEBs implies several obstacles at European level (D'Agostino D., 2017).

Barriers and challenges can be found in relation to both NZEBs renovations and new buildings. Most of these barriers are linked to residential NZEBs renovation and they appear common along all European countries. Nevertheless, some challenges and barriers are more country specific (D'Agostino D., 2017).

According to the NEEAP Guidance, Member States were requested to provide within their Renovation Strategies an overview of the policies measures to stimulate cost effective deep renovations of buildings to:



- i) Give an appraisal of existing measures/policies in the Member States
- ii) Provide an analysis of existing barriers to deep building renovation
- iii) Give an appraisal of relevance of policies used in other territories
- iv) Provide a design of new policy landscape that addresses barriers and enables the delivery of the required ramp up in deep renovation activity, with a focus on those measures which need to be introduced within the next years (D'Agostino D., 2017).

Overall, Member States addressed quite exhaustively Article 4(c) requirements, providing a comprehensive set of policy designed to address the identified barriers, with 23 strategies that resulted to be fully compliant, 6 partly compliant and only 1 non-compliant (i.e. Belgium Wallonia). There is a great heterogeneity of policy packages in different EU Member States, both in terms of absolute numbers and in terms of policy type, with a predominance of financial and regulatory measures (D'Agostino D., 2017).

## 4 The concept of NZEB in Europe

Directive 2010/31/EU on the energy performance of buildings states that a “Nearly zero-energy building is typically a grid connected building that has a very high energy performance, in which the nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby” (EPBD, Directive 2010/31/EU, 2010) (MECIT, 2017) The EPBD requires all new buildings to be nearly zero-energy by the end of year 2020 and all new public buildings must be nearly zero-energy by 2018 (MECIT, 2017).

To achieve this target Member States, must take measures for increasing the number of NZEBs. These measures are the following: 1) draw up national plans which shall include detailed application in practice of the definition of NZEB, intermediate targets for improving energy performance of new buildings and information on the policies and financial or other measures adopted and 2) develop policies and take measures such as setting of targets in order to stimulate the transformation of buildings that are refurbished into NZEBs (JRC).

The Regulation on the Energy Performance of Buildings (Requirements and technical characteristics that must be met) by a Nearly Zero-Energy Building) Decree of 2014 (RAA 366/2014), which was adopted on 1 August 2014, sets out the requirements that must be met by a building to be classified as NZEB. RAA 366/2014 specifies the maximum permissible primary energy consumption and the minimum share of RES in energy consumption. It also establishes stringent requirements regarding thermal insulation levels compared to the minimum energy performance requirements currently in force for new buildings (MECIT, 2017).

In most of the European countries, the NZEB definitions refer to maximum primary energy as one of the main indicators. In a few cases (e.g. the Netherlands and the Belgian Region of Flanders), the primary energy use of the building is calculated through a non-dimensional coefficient, comparing the buildings' primary energy use with a "reference" building with similar characteristics (e.g. building geometry). In several countries such as the United Kingdom, Norway and Spain carbon emissions are used as the main indicator, while in other for example in Austria and Romania carbon emissions are used a complementary indicator to primary energy use (BPIE, 2015).

For dwellings, most jurisdictions aim to have a primary energy use not higher than 50 kWh/m<sup>2</sup>/year. Often, different requirements are established for single family houses as well as apartment buildings and higher values are established for areas with lower temperatures (e.g. France and Romania) (BPIE, 2015).

For non-residential buildings, the requirements can have a broader range in the same country depending on the type of building. Some authorities set a single target only for offices and schools as in the case of Brussels Capital Region while other like Romania and Estonia also include requirements for hospitals. Overall, due to the different calculation methodology, climate conditions and building topology, the maximal primary energy level for non-residential buildings in Europe ranges from 0 to 270 kWh/ m<sup>2</sup>/year (BPIE, 2015).

Energy performance is determined on basis of calculated or actual annual energy consumed and shall reflect needs in heating/cooling and domestic hot water. The methodology of calculation should consider at least the following:

- a) Actual thermal characteristics of building: thermal capacity, insulation, passive heating, cooling elements, thermal bridges
- b) Heating installation and hot water supply
- c) Air-conditioning installations
- d) Natural and mechanical ventilation
- e) Built-in lighting installation (mainly in the non-residential sector)
- f) The design, positioning and orientation of the building
- g) Passive solar systems and solar protection
- h) Indoor climatic conditions
- i) Internal loads

The methodology for calculation should also consider positive influence of:

- a) Local solar exposure conditions, active solar systems and other heating and electricity systems based on energy from RES
- b) Electricity produced by cogeneration

- c) District or block heating and cooling systems
- d) Natural lighting

In addition to the above, buildings should be classified into the following categories:

- a) Single-family houses of different types
- b) Apartment blocks
- c) Offices
- d) Educational buildings
- e) Hospitals
- f) Hotels and restaurants
- g) Sports facilities
- h) Wholesale and retail trade services buildings
- i) Other types of energy consuming buildings

The EU Directive also states that the energy performance calculation and definition of NZEB should be expressed with numerical indicator of primary energy. If national energy frame is not based on primary energy, Member States must develop new frame and implement in building code. In practice though, different energy performance indicators and combinations are used to determine NZEB status and calculated energy performance such as maximum primary energy (kWh/m<sup>2</sup>/year), non-dimensional primary energy use, carbon emissions, passive house, on-site RES and quantitative/qualitative share of RES.

The numerical indicators for NZEB include the following:

1. The primary energy indicator which ranges between 0 and 270 kWh/m<sup>2</sup>/year due to different calculation methods, climatic conditions, building topology, the higher values from hospitals or other special non-residential buildings. In addition, for residential buildings the primary energy indicator ranges from 45 to 50 kWh/m<sup>2</sup>/year for most of the countries.
2. The non-dimensional value of primary energy use, which is calculated comparing buildings' primary energy use with a reference building with similar characteristics
3. The CO<sub>2</sub> emissions indicator
4. The energy performance class
5. The share of RES either quantitative or qualitative

In general, at country-level, harmonization of EPBD and national policies and implementation is not straightforward, there is lack of clarity and coherence for NZEB definitions across EU and some NZEB definitions are still under development or not approved. In our case, only Cyprus has defined national energy frameworks for NZEBs.

**Table 1:** Overview of the main aspects related to national NZEB definitions in the participating countries (Source: Buildings Performance Institute Europe (BPIE) factsheet 2015, ‘Nearly Zero Energy Buildings Definitions across Europe’)

		NZEB definition for new buildings				NZEB definition of existing buildings	
Country	Status of definition	Maximum primary energy indicator [kWh/m²/year]		Share of RES	Other indicators	Maximum primary energy indicator [kWh/m²/year]	
		Residential	Non-residential			Residential	Non-residential
Greece	Under development	-	-	Minimum share in current requirements for all buldings	-	-	-
Cyprus	✓	100	125	Quantitative*	EP	100	125
Bulgaria	Approved	95	~50-275**	Quantitative - 55%	EP	95	~50-275**
		Included in the calculation; building needs to comply with class A				Included in the calculation; building needs to comply with class A	
FYROM	Still to be approved	-	-	-	-	-	-

EP: Envelope performance;

\* Quantitative: min/max share defined

\*\* Depends on the type of the building – total of 9 types are considered

Although, the directive requires nearly zero energy buildings it does not give minimum or maximum harmonized requirements as well as details of energy performance calculation framework. For this reason, the Federation of European Heating, Ventilation and Air Conditioning Associations (REHVA) proposes a technical definition for nearly zero energy buildings required in the implementation of the energy performance of buildings directive recast to help the experts in the Member States to define the NZEBs in a uniform way (Kurnitski J., 2011)

Table 2 presents a qualitative evaluation of the status of NZEB development in EU Member States and compliance with the EPBD requirements. It includes the main aspects discussed in this report, such as the NZEB applied definitions, the inclusion of RES in the NZEB concept and measures to promote NZEB renovation. For this evaluation three colours have been used: green indicates a satisfactory development of the specific NZEB issue, orange indicates partial development and red denotes lack of definition or of clarify (D'Agostino D., 2017).

**Table 2:** Assessment of NZEBs development in EU countries (green: satisfactory development, orange: partial development, red: not defined/unclear)

Member State	NZEB Definition	RES included in the NZEB concept	Measures promoting deep or NZEB renovation
Austria			
Belgium Brussels			
Belgium Flanders			
Belgium Wallonia			
Bulgaria			
Croatia			
Cyprus			
Czech Republic			
Denmark			
Estonia			
Finland			
France			
Germany			
Greece			
Hungary			
Ireland			
Italy			
Latvia			
Lithuania			
Luxemburg			
Malta			
Netherlands			
Poland			
Portugal			
Romania			
Slovenia			
Slovakia			
Spain			
Sweden			
United Kingdom			

Most Member States refer to both new and retrofit, private and public, and residential and non-residential buildings in their definitions. Results show that most usual selections are demand/generation as balance, performed over a year using conditioned area as normalization factor and static conversion factors as time dependent weighting. Nevertheless, many countries have not yet defined the selected type of balance. Single building or building unit are the most frequent indicated physical boundary, and on-site the most common considered RES options (D'Agostino D., 2017).

In addition, EU countries use the existing flexibility to adapt to national circumstances. Different system boundaries and energy uses are the cause of high variations within the described definitions. The level of energy efficiency, the inclusion of lighting and appliances and the recommended renewables to be implemented vary from country to country (D'Agostino D., 2017).

Specifically, the requirements provided by the EU countries in terms of primary energy indicate a significant variability and reflect different national and regional calculation methodologies and energy flows. National energy policies have evolved with new legislation and methodologies introduced with technical regulatory measures to improve the energy efficiency of buildings and RES generation (D'Agostino D., 2017).

Member states mainly focused on the requirements for new buildings and rarely introduced different limits for the existing ones. The EPBD requires adjusting the major renovation to the new constructions, but some of them decided to introduce less stringent and probably realistic requirements. This is the case of Bulgaria, Germany, France, Ireland and Slovenia (D'Agostino D., 2017).

Most Member States decided also to consider to higher energy requirements for the non-residential buildings, which typically consume more energy for cooling and lighting but in some cases different energy limits for different non-residential categories have been defined (D'Agostino D., 2017).

The reduction of energy demand through energy efficient measures and the utilization of RES to supply the remaining demand have reached common agreement towards the implementation of the NZEB concept across Europe (D'Agostino D., 2017).

Several Member States set a definition that comprises both a numerical target for primary energy use (or final energy) and consider the share of renewables in a quantitative or qualitative way. In some of these states (Cyprus, Lithuania, Latvia, Romania, Slovakia, Ireland, France, Region of Flanders), these jurisdictions, the share of primary energy consumption which must be covered by renewable energy is explicitly stated, while in other authorities such as Czech Republic, Denmark, Estonia and Brussels Capital Region renewable sources are considered indirectly. In Denmark on

the other hand, while a minimum share of renewable sources has not been established, a gradual evolution of primary energy factors has been planned and an increase in the share of renewable energy above 50% is expected in 2020 (BPIE, 2015).

The main RES type for buildings is the PV technology. Although, the Balkan Med region is blessed with high solar potential, due to various technical/policy/administrative and information barriers it has not reached its full potential. New PV installations are very few, while in certain regions even very small installations are forbidden by the local grid operators due to security reasons. The challenge therefore for Balkan Med countries is significant, considering also the different level of PV penetration in each country. The situation gets more challenging when looking at the bigger picture with lots of NZEBs with PVs. This may result in unacceptable stress on the grid, thus hindering the set goals for the number of NZEBs in each country (D'Agostino D., 2017).

## 4.1 The concept of NZEB in the participating countries

### 4.1.1 Greece

The Energy Performance of Buildings Directive (EPBD 2002/91/EC) was transferred to national Greek legislation with Law 3661/2008 and the EPBD recast 2010/31/EU with Law 4122/2013. In Law 4122/2013 the concept of NZEB is introduced, but without providing a full definition that includes the required RES percentage. The commitment to implement NZEB in every new public building by 1.1.2019 and in every new private building by 1.1.2021 is expected to increase the interest of engineers and construction companies for solutions with high energy efficiency.

The energy performance upgrade of existing houses is very common in Greece, due to a very successful incentive program with grants for energy efficiency improvements of homes (programme “Exikonomo”). Also, there are some pilot projects for innovative constructions, mainly focusing on high energy performance solutions in the building envelope. In Table 3, the insulation type on current houses based on their construction time is presented.

**Table 3:** House insulation based on construction time

Insulation type	Aggregated	Before 1919	1919-1945	1946-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2005	2006+
In Greek territory	6,371,901	163,759	318,372	605,693	1,002,902	1,437,424	1,049,931	806,977	539,009	447,834
Double glazing	1,655,254	12,926	32,445	93,885	221,390	354,369	282,683	298,083	208,013	151,460
Outer wall insulation	401,875	6,326	12,238	26,334	50,735	97,875	106,821	55,988	25,926	19,632
Other kind of insulation	321,709	13,027	26,637	47,006	60,511	77,522	56,116	25,141	9,492	6,257

Double glazing and outer wall insulation	918,601	2,563	4,957	12,800	27,369	66,325	138,544	240,343	216,058	209,642
Double glazing and other kind of insulation	62,799	817	1,801	5,152	9,687	13,736	11,051	10,008	5,915	4,632
Outer wall insulation and other kind of insulation	21,706	637	933	1,574	2,440	4,742	6,227	2,831	1,236	1,086
Double glazing and outer wall insulation and other kind of insulation	86,363	389	877	1,704	3,364	6,624	13,238	21,208	18,774	20,185
No insulation at all	2,903,594	127,074	238,484	417,238	627,406	816,231	435,251	153,375	53,595	34,940

The building sector has been in a deep recession since 2010 due to the financial crisis, and the refurbishment of existing homes is one of the fields which keeps the construction business alive. After completing a 3-year implementation period the “Exikonomo” support scheme was until very recently paused. During that period many engineers, architects, construction technicians and installers gained significant experience in the field. The significant success of the programme, as implied by the amount of applications and completed projects (over sixty thousand houses), led to the design and launching of its second phase. The new “Exikonomo 2” programme was launched on March 2018 under the 2014-2020 programming period and was designed as a follow-up to the corresponding programme of the 2007-2013 programming period. The design of the Program considers the integrated energy saving intervention in the residential building sector and has as its main objective, the reduction of the energy needs of buildings, the emissions of pollutants contributing to the aggravation of the greenhouse effect and the achievement of a cleaner environment. “Exikonomo” aims to provide incentives for energy-saving interventions in the residential building sector. It concerns buildings that have a building permit or other legitimate document, buildings that are used as the main residence and whose owners meet certain income criteria. There are seven (7) categories of incentives to which the Beneficiaries are classified



according to the income, as defined from the income tax statement. The program is funded by ERDF and national resources and provides incentives in the form of a grant (direct support) and a loan (the "Saving II" Fund) with an interest rate subsidy. The implementation of the Program is based on the implementation of the institutional framework established by the Energy Performance of Buildings Regulation (KENAK, DEPA/house178581/30.06.2017, Government Gazette B'2367/12.07.2017), under the authorization of Law 4122/2013 (Gazette 42/A'/19.02.2013), concerning the energy efficiency of buildings, and Law 4409/2016 (Government Gazette 136/A'/28.07.2016), for energy inspectors, aiming at the correct identification of the energy needs of the buildings as well as the necessary interventions that will lead to the maximization of the energy saved, ESRP/Fin.182365/17.11.2017 (Government Gazette B'4003/17.11.2017) decision of the Minister of Environment and Energy titled "Adoption and implementation of the technical regulations for energy efficiency of buildings", as in force. The implementation of the Programme within the framework of this institutional context ensures an integrated approach for the implementation of energy saving actions.

The EPBD is implemented in Greece under the national law 3661/2008 – 'Measures for the reduction of energy consumption in buildings and other provisions'. This law was set in force in 2010 and has been accompanied by the publication of the new 'Regulation for Energy Efficiency of Buildings—KENAK', which outlines the energy assessment method in accordance to the European Standards. The recast of the EPBD has been integrated in the Greek Law 4122/2013 'Energy Performance of Buildings – Transposition of Directive 2010/31/EU'.

According to Law 3661/2008, the construction of new buildings and the full renovation of existing buildings should be based on the KENAK. In both cases for issuing the building permit, an Energy Performance Assessment of the building should be performed. According to the KENAK, each new or fully renovated building should achieve an Energy Performance level of at least 'Category B'. After the construction or the full renovation of a building, an Energy Auditor should audit the building energy performance and will issue an Energy Performance Certificate (EPC). Also, an Energy Performance Certificate should be issued by an accredited Energy Auditor in case of sale or renting of existing buildings.

The Energy Performance Certificate (EPC) ranks a building according to its energy performance and provides recommendations on cost-effective energy saving measures. EPCs must be issued for new buildings, existing buildings that undergo major renovations and for all buildings with a floor area exceeding 50m<sup>2</sup>, when sold, rented or the ownership is transferred to another party. A database has been established by the Ministry for Environment, Energy and Climatic Change to collect the results from the building energy assessments and EPCs, along with the reports from inspections of boilers, heating installations and air-conditioning systems. In Table 4, the energy consumption coverage by the available energy sources for a typical residence is presented.

**Table 4:** Energy consumption coverage per energy source type

Energy source	% distribution for energy use regarding:		
	Cooking	Heating	DHW
In Greek territory	100	100	100
Electricity	92.9	8.7	49.5
Natural gas	0.6	8.5	4.1
Oil	0.1	66.7	10.1
Solar power	0	0.2	32.7
Biomass	0.8	5.7	1.0
Other	5.3	5.5	2.4
No source	0.3	4.8	0.1

According to the Greek EPBD implementation, a building is ranked in one of nine classes ranging from H (lowest performance) to A+ (highest performance) according to the ratio (T) of its calculated primary energy consumption divided by the corresponding value of a reference building (asset rating).

KENAK has been updated in 2017 and in this updated version there are many additions and improvements in respect to KENAK 2010, but they do not substantially change the minimum requirements and specifications of materials and installations. For example, the updated U-coefficient values in 2017 KENAK in respect to 2010 KENAK are presented in Table 5.

**Table 5:** Updated KENAK U-coefficient values

Structural element	KENAN 2017				KENAK 2010			
	Climate zone				Climate zone			
	A	B	C	D	A	B	C	D
	Maximum U-coefficient value [W/(m <sup>2</sup> K)]							
Roof	0.45	0.4	0.35	0.3	0.5	0.44	0.4	0.35
Outer wall	0.55	0.45	0.4	0.35	0.6	0.5	0.45	0.4
Wall in contact with closed non-heated space	1.3	0.9	0.7	0.65	1.5	1	0.8	0.7
Wall in contact with ground	1.3	0.9	0.7	0.65	1.5	1	0.8	0.7
Floor facing parking lot	0.45	0.4	0.35	0.3	0.5	0.44	0.4	0.35
Floor in contact with ground	1.1	0.8	0.65	0.6	1.2	0.9	0.75	0.7

Additionally, in Greek Law 4122/2013, Article 9, it is stated that the government should develop a National Plan, which will include the technical characteristics of the nearly zero-energy buildings,

targets to improve the energy performance of the new buildings until 2015 and information concerning the promotion of the NZEBs. However, the National Plan is yet to be defined.

For existing buildings, in case of a major refurbishment it is compulsory to upgrade the energy performance of the building up to B class at least. The main obstacle regarding deep energy renovation of buildings towards NZEB is the lack of the corresponding legislation.

There are also certain difficulties regarding the integration of PV when the building is in densely built areas, which is the common case for Greek urban buildings. This is due to the lack of space availability, extensive co-ownership of buildings' roofs, the reduced solar potential due to shadowing, etc. Since in Greece the legislation defining the levels of NZEB and the contribution of RES in the energy performance of NZEB is under development, it is important to define the 'nearby areas', as indicated by EPBD, in a flexible way to remove the barriers in the integration of PVs and therefore make NZEB levels achievable.

#### 4.1.2 Cyprus

In Cyprus, buildings are a strategic focus of past and ongoing policies aiming to achieve a sustainable and competitive low-carbon economy by 2020.

The first attempt to adopt energy savings measures for buildings was made by adopting the CYS98:1999 national standard in 1999. In accordance with that standard, the U-value for opaque structures should be lower than  $1 \text{ W/m}^2\text{K}$ . Conformity to the standard was optional. However, from 2004 to 2007, when the minimum energy performance requirements were adopted, conformity thereto was a precondition for aid to be granted under the energy savings measures by the Special Fund for RES and energy systems (ES). The aid schemes of the Special Fund for RES and ES entered into force in February 2004, and an estimated EUR 67 million was granted as an economic incentive to implement energy savings and renewable energy measures in buildings, such as heat insulation, frames, energy efficient lighting, heat recovery, automation and RES systems in air conditioning and heating (Energy Service of the Ministry of Energy, Commerce, Industry and Tourism, 2014). The mandatory energy performance improvement of new buildings was adopted upon transposition of Directive 2002/91/EC on the energy performance of buildings and the setting of minimum energy performance requirements (MECIT, 2017).

The Ministry of Energy, Commerce, Industry and Tourism after consultation with the stakeholders has prepared the technical definition of NZEB in Cyprus. Also, in September 2012, it has developed an action plan for NZEBs. Financial incentives about NZEBs are proposed in the framework of Structural Funds for the period 2014-2020, but only for residential buildings that are refurbished (D'Agostino D., 2017).

The requirements for new buildings and building units are laid down in the Regulation on the Energy Performance of Buildings (Minimum energy performance requirements for buildings)

Decree, as adopted by the Minister for Energy, Commerce, Industry and Tourism under Article 15(1) of the Regulation on the Energy Performance of Buildings Laws of 2006 to 2012 and published in the Cyprus Government Gazette. In adopting the Decree, the Minister consulted with the advisory committee for the promotion of energy savings in buildings and the promotion of nearly zero-energy buildings, as set up under the above Laws (MECIT, 2017).

The first Minimum Energy Performance Requirements Decree, as adopted on 21 December 2007, laid down maximum permissible U-values for new buildings, thus making the thermal insulation of the building envelope and double-glazing in external frames essentially mandatory (MECIT, 2017).

As of 1 January 2010, an additional minimum energy performance requirement was added to the effect that all new buildings should be classified as a minimum under energy class B in the energy performance certificate. This fostered the application of better thermal insulation than that provided for by the requirements for individual building elements. Moreover, the installation of a solar hot water production system was made mandatory for all new homes, and the fitting of a standby installation for the use of renewable power systems was made mandatory for all new buildings (MECIT, 2017).

By the Decree of 2013, the maximum U-values were reduced by approximately 15%, while a maximum shade factor for windows was adopted for the first time. This factor is the product of the sunlight reduction factor by a fixed shade multiplied by the external movable shade and the sunlight transmission through the glazing. The Decree states that at least 3% of total energy consumption in non-residential buildings must originate from renewable energy sources (MECIT, 2017).

An official NZEB definitions has been launched by the legislative act August 1<sup>st</sup>, 2014. The definition includes all buildings (single family houses, apartment blocks, offices, educational buildings, hospitals, hotels/restaurants, sport facilities and wholesale/retail) and it differs only between residential and non-residential buildings. It considers private and public buildings, indicating single building or building unit as physical boundary and one year as calculation period for the balance. Heating, DHW, ventilation, cooling, air conditioning auxiliary energy use are included with energy uses, both for residential and non-residential buildings. For system boundary energy generation, on-site and nearby are considered. In relation to RES generation, solar thermal, geothermal, passive solar, passive cooling, heat recovery, and PV are included (D'Agostino D., 2017).

In 2016, the U-values for the building envelope were further reduced aiming to have the cost-benefit ratio over the life cycle of the building reach its cost-optimal level, i.e. close to the NZEB requirements, as laid down in RAA 366/2014. The minimum percentage of total energy consumption that must originate from renewable sources was also increased significantly both for residential and non-residential buildings. The new minimum energy performance requirements

entered into force on 1 January 2017 and are deemed to constitute the last and decisive step towards a smooth transition to NZEBs (MECIT, 2017).

**Table 6:** Requirements and technical characteristics that must be met by a nearly zero-energy building, as laid down in RAA 366/2014

Requirements		
1	Energy efficiency class in the energy performance certificate of a building.	A
2	Maximum primary energy consumption in residential buildings, as determined in accordance with the methodology used to calculate the energy performance of buildings.	100 kWh per m <sup>2</sup> per year
3	Maximum primary energy consumption in non-residential buildings, as determined in accordance with the methodology used to calculate the energy performance of buildings.	125 kWh per m <sup>2</sup> per year
4	Maximum energy demand for heating for residential buildings.	15 kWh per m <sup>2</sup> per year
5	At least 25% of total primary energy consumption, as determined in accordance with the methodology used to calculate the energy performance of buildings, comes from renewable energy sources.	
6	Maximum mean U-value for walls and load-carrying elements (pillars, beams and load-carrying walls) which are part of the building envelope.	0.4 W/ m <sup>2</sup> K
7	Maximum mean U-value for horizontal building elements (floors in a pilotis, floors in a cantilever, terraces, roofs) and ceilings which are part of the building envelope.	0.4 W/ m <sup>2</sup> K
8	Maximum mean U-value for (door and window) frames which are part of the building envelope. Excluding shop windows.	2.25 W/ m <sup>2</sup> K
9	Maximum mean installed lighting power for office buildings.	10 W/ m <sup>2</sup>

According to the Article 5 of Directive 2010/31/EU (Ministry of Commerce, Industry and Energy, Tourism, 2013), the cost-optimal levels of minimum energy performance requirements were calculated to observe if the minimum energy performance requirements in force at the time (RAA 446/2009) were importantly different from the optimal levels and if the corrective action had to be taken. Bearing in mind of the results of the calculation from the investor's perspective and for the types of buildings for which calculations were made, i.e. detached houses, apartment blocks and offices, the main conclusions that can be reached for new buildings are the following (MECIT, 2013):

1. Energy-class B is within the cost-optimal levels
2. Investing in lower U-values primarily for the roof and secondarily for the walls is the optimal way to reduce energy consumption
3. A shading strategy appears to be significant for all types of buildings. However, cost-effectiveness may vary depending on the shading measure implemented
4. In office buildings, energy consumption for lighting represents a major part of the energy consumption. Installing efficient lighting systems and, above all, making sure that these systems are correctly designed to constitute an important measure given that the extra initial cost is relatively small for a new building.
5. Photovoltaic systems installation in conjunction with implementing energy savings measures is best practice that requires no subsidy, as it is combined with existing measures, i.e. net metering and auto-production.

Based on the above, the minimum energy performance requirements were revised initially in 2013 (RAA 432/2013) and then in 2016 (RAA 119/2016).

Although there is no need to achieve cost-optimal levels in the case of NZEBs, the calculation of cost-optimal levels of minimum energy performance requirements has allowed looking into the construction of NZEBs from the perspective of the investors. The results showed that the NZEBs deviated from cost-optimal levels (i.e. the minimum energy performance requirements in force as of 1<sup>st</sup> January 2017), but they still have a significant economic value over the life cycle of the building as compared to applying no requirements at all (MECIT, 2013).

Some examples of NZEB in Cyprus is the American Heart Institute and the New Nicosia Town Hall building, which is currently under development. The American Heart Institute was designed to implement energy saving techniques, utilize natural lighting and has efficient technologies for heating, cooling and lighting. The building uses 100 kWp PV system installed on its roof and a central Building Management System has been incorporated that allows monitoring, adjustment and forecasting of the building energy needs. The bioclimatic architecture building of Nicosia Town Hall will have natural ventilation design principles and very low energy consumption. Its energy performance figures energy needs for heating (8.9 kWh/m<sup>2</sup>/year, according to Swiss norm SIA 380/1) and energy need for cooling (33.8 kWh/m<sup>2</sup>/year, according to Swiss norm SIA 382/1). The thermal insulation level of the building envelope includes thermal transmittance (U) through the external walls of 0.36 W/m<sup>2</sup>/K, the roof 0.23 W/m<sup>2</sup>/K and windows 0.85 W/m<sup>2</sup>/K with glass thermal transmittance 0.7 W/m<sup>2</sup>/K (triple glazing). The building allows storage of a high amount of heat in building components and an optimal use of free cooling strategies (e.g. night-time natural ventilation). In addition, the natural ventilation of the New Nicosia Town Hall is optimized through dedicated openings and stack chimney ventilating central core of building and finally, solar panels for hot water production and heat pumps for top-up heating and cooling were installed.

The use of solar energy for electricity generation is significantly limited in all dwellings despite the significant solar potential that exists in Cyprus. Around 5% of owner-occupied dwellings do not use any type of solar energy technology as opposed to 10% rented buildings. Since, renewable energy technologies such as solar thermal and PV systems are most cost-effective in Cyprus due to the high solar irradiation; these technologies can have a higher contribution to tighter energy performance requirements (D'Agostino D., 2017).

#### 4.1.3 Bulgaria

In order to meet the requirements of Directive 2010/31 / EC, a list of measures and instruments has been compiled detailed in report of the Ministry of Energy. A National Long-Term Program for encouraging investments to implement measures for improvement of the energy performance of buildings from public and private national housing and commercial buildings was developed. The program was developed by a scientific team at the Technical University of Sofia after being awarded by the Ministry of Regional Development and Public Affairs and includes the following measures: 1) obligatory energy audit and certification of public service buildings; 2) public administration; 3) annual renewal of 5% of the total built-up area, including all heated and/or cooled buildings, 4) financing projects from the Energy Efficiency and Renewable Energy Fund in buildings, 5) energy efficiency credit line for households, 6) implementation of projects under Operational Program "Regions in growth" 2014-2020 and 7) National Energy Efficiency Program for multifamily residential buildings. Energy saving by 2016 are a total of 1 971,79 GWh/year and the projected effect for 2017-2020 of 1), 2) and 7) is 1 671,9 GWh/y and annual refinement of the actual savings of 3), 4), 5) and 6). The Energy Act applies the Directive 2010/31/EU that coordinates and implements the energy performance certification of buildings. The Executive Agency for Sustainable Energy Development develops guidelines for the certification of the energy performance of buildings and creates and maintains a national building register - a national information system.

Bulgaria has developed a National Plan for Near-zero Energy Buildings 2015-2020 (NNSCNP) based on Art. 9, paragraph 1 of Directive 2010/31/EC on the energy performance of buildings. The plan is based on a concept reported by the Bulgarian authorities to the European Commission (EC) in 2013. The plan aims at making the concept of nearly zero-energy buildings a practical alternative to the future construction of new buildings in Bulgaria after 2018, and in the case of proven cost effectiveness - in the renovation of existing buildings for the different sub-categories of buildings. The plan meets the growing need for efficient use of energy resources, improving the quality of life through energy efficiency measures and limiting the negative environmental impact of fossil fuel use. It is a framework and dynamic document as the objectives set out in it cannot be seen in isolation from Bulgaria's national energy savings target in 2020. This plan is the result of the cumulative implementation of national measures to promote energy efficiency by levels higher

than the minimum requirements set in the legislation and to make a specific contribution to the national target in 2020.

The National Residential Buildings Plan sets the cost-effective methods for improving the energy performance of the buildings concerned. The implementation of the Plan supports the implementation of the national EE target of the Republic of Bulgaria until 2020. The country's national targets for buildings with near-zero net energy consumption are formulated in the National Plan by Council of Ministers Resolution 1035 end of 2015 presented to the EC on February 1, 2016.

Official nZEB definition was presented in 2015, when a new Law on Energy Efficiency, which transposes Directive 2012/27/EU on Energy Efficiency, was adopted and implemented in Bulgaria. The Law amends and supplements Ordinance № 7 of 2004 on Energy Efficiency in Buildings. Thus, the definition for nZEB in Bulgaria has been published within the state gazette on 14.04.2015.

nZEB buildings needs to simultaneously satisfy the following two conditions:

- 1) the energy consumption of the building, defined as primary energy, needs to meet energy efficiency Class A of the scale of energy consumption classes for the type of the building (*9 type of buildings are considered Residential, Administrative, Schools, Universities, Kindergartens, Sport buildings, Hospitals, Hotels, Trade buildings*) ;
- 2) not less than 55% from the energy consumption for heating, cooling, ventilation, DHW and lighting should be renewable energy. Renewable energy should be produced on-site or near the building (the maximum distance is not specified).

Based on the Law on Energy Efficiency, in order a Residential building to be considered as nZEB, its primary energy consumption has to be below 95 kWh/m<sup>2</sup>.y (see Table 7) and at least 55 % of the energy consumption should be covered from renewable energy.

**Table 7:** Primary energy consumption for NZEB buildings in Bulgaria.

nZEB in Bulgaria	A+ EP (kWh/m <sup>2</sup> y)	A EP (kWh/m <sup>2</sup> y)
Residential	< 48	48-95
Administrative	< 70	70-140
Schools	< 25	25-50
Universities	< 45	45-90
Kindergartens	< 33	33-65
Sport buildings	< 88	88-175
Hospitals	< 70	70-140
Hotels	< 85	85-170



Trade buildings	< 138	138-275
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Thus,

- after December 31, 2018, all new buildings occupied or owned by public authorities should be nZEB
- after December 21, 2020, all other new buildings should be nZEB

**Table 8:** Requirements and technical characteristics that must be met in order a residential building to be considered as nZEB (Law on Energy Efficiency, Ordinance №7 on Energy Efficiency in Buildings).

Requirements		
1	Energy efficiency class in the energy performance certificate of a building.	A or A+
2	Maximum primary energy consumption for heating, cooling, ventilation, DHW and lighting (residential buildings)	95 kWh per m <sup>2</sup> per year
3	Energy from renewable energy sources	>55 %
4	Maximum U-value for external walls in contact with outside air	0.28 W/ m <sup>2</sup> K
5	Maximum U-value for roofs in contact with outside air	0.25 W/ m <sup>2</sup> K
6	Maximum U-value for roofs in contact with internal air, air layer $\delta > 0,3\text{m}$	0.30 W/ m <sup>2</sup> K
6	Maximum U-value for heated floor in contact with the surface	0.40 W/ m <sup>2</sup> K
7	Maximum U-value for door and windows frames	1.4 W/ m <sup>2</sup> K
8	Heat recovery from exhaust air (recuperation)	>70 %
9	In order the energy produced from heat pumps to be considered as renewable energy, the minimum SCOP value is not less than	3,5

#### 4.1.4 FYROM

The national strategy for implementation of energy efficiency standards for existing buildings can be found in Annex 6 of the Rulebook for Energy Performance of Buildings (Official gazette of Republic of Macedonia No. 94/2013), Ministry of Economy of Republic of Macedonia - in Macedonian. The targets are initially set starting from the year 2015. The standards classify the buildings into two categories: new buildings that are classified in energy class C (<100 kWh/m<sup>2</sup>) as the minimum label, and significantly renovated buildings that are classified in energy class D (<150 kWh/m<sup>2</sup>) as the minimum label. Annex 4 of the Rulebook for Energy Performance of Buildings declares maximum U values of the building elements. On the other hand, certificates on the energy performance of buildings are issued with validity period of ten years for new and significantly renovated buildings. Building codes and their enforcement are introduced to ensure implementation of best practice with regards to energy efficiency of buildings.

The current Energy Law and the national legislation of FYROM still does not introduce the definition of NZEBs, neither the numerical requirement for the mandatory share of RES concerning NZEBs.

Therefore, the NZEB targets are not compulsory, because there is no transposition of NZEB definition in the national legislation. FUROM did not specify numerical requirement for mandatory share of RES concerning NZEBs. The Rulebook for Energy Performance of Buildings, Article 136 although is included in the law, it does not reference the NZEB definition. Therefore, no targets are set for buildings with almost zero energy consumption.

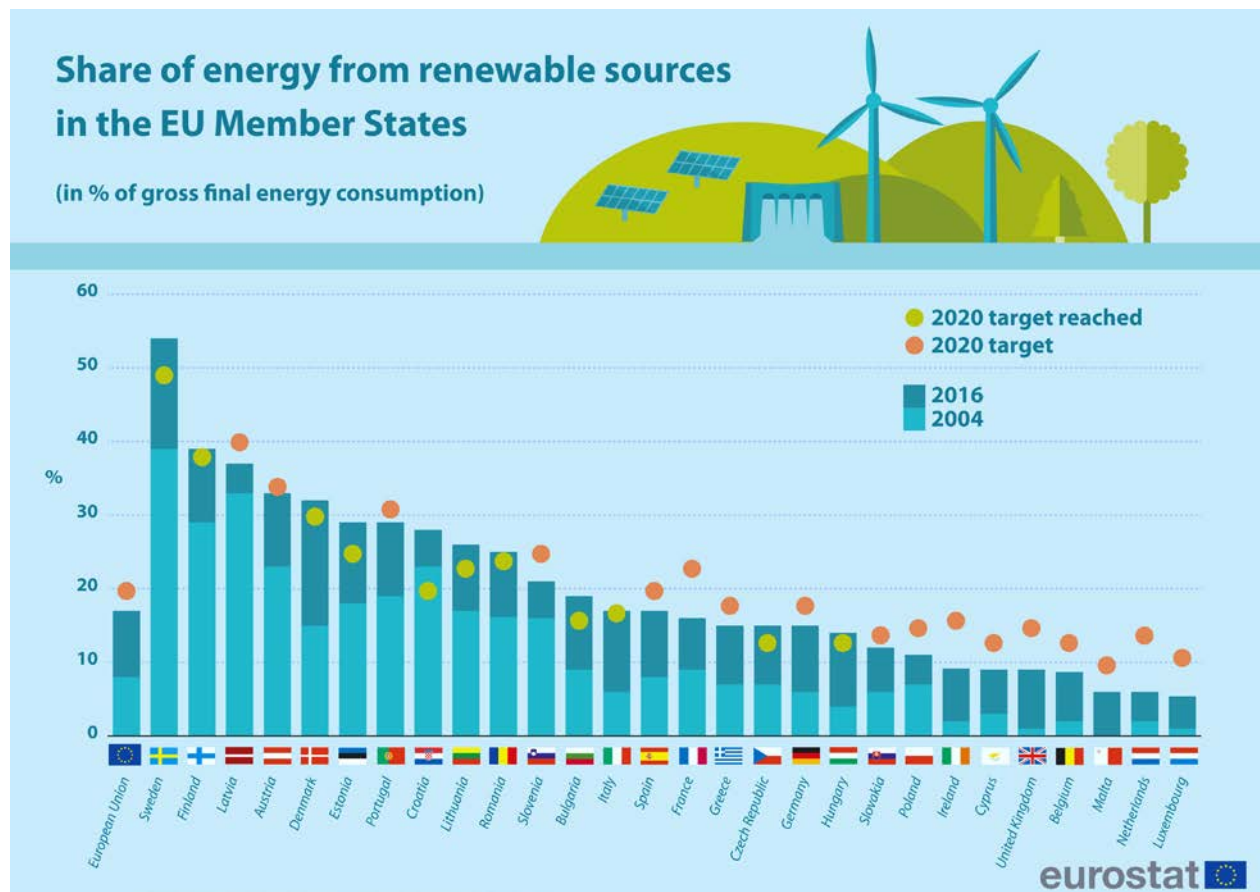
## 5 Renewable Energy Sources

The following section provides an overview of the existing situation about the evolution of RES in the EU and specifically in the Balkan Med region towards achieving the energy targets for 2020. In addition, it is widely known that solar PV is one of the most favourable RES technologies in the Balkan MED countries; the status in the energy mix in Europe is analysed. In the end, the appealing services of storage to the grid are presented, highlighting the need for financial deployment to the grid.

Energy demand is rapidly increasing since we need energy for our daily lives such as for heating, cooling, lighting and transportation. It is important for the functioning of our homes, offices, work places and the entire economy putting pressure on utilities to expand generation. This coupled with socioeconomic and environmental concerns associated with climate change has brought electricity production from RES a sensitive topic. The use of renewable energy sources has many potential benefits, including a reduction in greenhouse gas emissions the diversification of energy supplies and reduced dependency on fossil fuel markets (oil and gas).

These are some of the reasons why the Commission has proposed its Energy Union Strategy. The main objective of the strategy is the decarbonisation of the distribution grid and the integration of higher share of distributed generation through the deployment of innovative and flexible energy management schemes. As a result, RES deployment increases and the prices reduce rendering RES a very competitive alternative to fossil fuel electricity generation.

Renewable energy in Europe has developed dramatically in recent years. Specifically, the share of energy from RES in gross final energy consumption has almost doubles in the last years, from around 8.5% in 2005 up to 17.0% in 2016, as shown in Figure 2 which presents the latest data available for the share of renewable energies in gross energy consumptions and the targets that have been set for 2020. This positive development has been prompted by the legally binding targets for increasing the share of energy from RES enacted by Directive 2009/28/EC on the promotion of the use of energy from RES. Although, some Member States is on course to meet its 2020 targets, some others will need to make additional efforts to meet their goals (Eurostat, 2018).



**Figure 2:** Share of energy from renewable sources, 2004-2016 (in % of gross final energy consumption)  
[Source: Eurostat].

Since the 2020 energy plan, the share of RES in the energy mix of the EU countries shows a tremendous increase. EU's energy policy main target is the promotion of RES as a very competitive alternative to fossil fuel electricity generation. Considering the benefits resulting from the different RES technologies, EU sets the target of 20% of the total gross energy consumption to be reached by 2020. This translates into the doubling of the RES share in the EU countries over the last decades to reach the expected trajectory for the 2020 target (Eurostat).

In 2016, electricity generation from RES contributed more than one quarter (29.6% to total EU-28 gross electricity consumption). The growth in electricity generated from RES during the period 2006 to 2016 largely reflects an expansion in three renewable sources across the Europe, principally wind power, but also solar power and solid biofuels (including renewable wastes). The quantity of electricity generated in the EU-28 from solar systems was 44.4 times as high in 2016 as it had been in 2006. As a result, the shares of solar power in the total quantity of electricity generated from RES rose to 11.6% in 2016. The growth in electricity from solar power has been dramatic, rising from just 2.5TWh in 2006 reaching a level of 110.8TWh in 2016. Over this decade,

the contribution of solar power to all electricity generated in the EU-28 from RES rose from 0.3% to 11.6% (Eurostat).

Each Member State has adapted its energy plan towards achieving the national energy targets by the year 2020. The steadily increasing RES deployment has been gained through different incentive frameworks, including attractive tariff management schemes, such as Feed-in Tariff (FiT) and Feed-in Premium (FiP), and governmental subsidies. This is depicted in Table 9, showing the share of RES in the gross final energy consumption for the countries of PV ESTIA consortium over the last few years, in comparison to the national 2020 targets. It is obvious that RES penetration for all participating regions has been constantly increasing over the years with some countries closing the gap towards achieving their energy targets.

**Table 9:** Share of RES in the gross final consumption of energy (%) for the participating BM countries and the national targets by 2020 [Source: Eurostat].

Member State	2006	2011	2016	EU target 2020
Greece	7.2	10.9	15.2 <sup>e</sup>	18.0
Cyprus	3.3	6.0	9.3	13.0
Bulgaria	9.6	14.3	18.8	16
FYROM	16.5	16.4	18.2	-
EU Average	9.5	13.2	17.0	20.0

The increase of RES deployment comes at a price and substantial restricting of the electricity network. Thus, it is essential to adopt new technologies to allow further RES penetration. The strategic energy technology integrated roadmap for research in Europe highlights the necessity of the development of new technologies to enhance RES penetration and places grid integration issues and the evolution of smart grids as one of the top priorities for further research in the field of energy (COM (2013)253). EU has also put forward the winter package, “Clean energy for all Europeans”, which paves the way towards achieving the clean energy transition and provides measures to promote the industrial competitiveness in the EU (Clean Energy for all Europeans-unlocking Europe’s growth potential). Various stakeholders such as from the renewable energy industry will benefit from the directive since different uncertainties for investors will be minimized. In addition to the above, an important objective of the strategic plan is the active engagement of the consumers. Therefore, the development of new and innovative technologies such as smart energy management systems and battery storage solutions to support RES into the new energy management system is substantial. In this light and the significantly low prices of RES, the

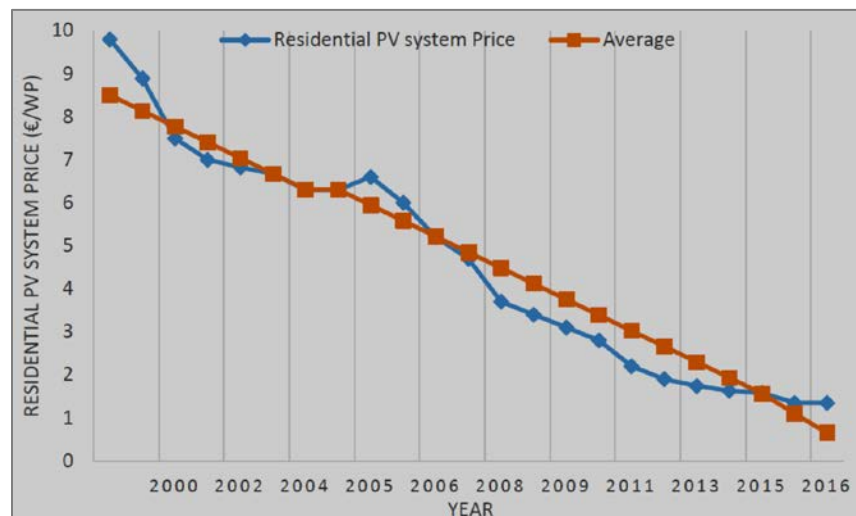
utilization of RES with benefits such as the right to produce and self-consumer electricity as well as feed any excess back to the grid are encouraged.

The energy plan for the year 2030 foresees the increasing of RES share to at least 27% of the EU energy consumption and a reduction of greenhouse gas emissions by 40%. This will lead to a low-carbon economy and proposes a flexible energy system that will allow for increased security of energy supply with less dependence on energy imports. However, the probable unregulated deployment of RES poses serious barriers, which are mainly connected to the distribution grid operation and must be considered through the currently undergoing power system transition. New grid strategies are urgently needed to maintain the grid operation stable and flexible.

Concluding, the deployment of RES has been increased tremendously over the last decade. Considering the energy targets set by the EU for the upcoming ten years, new and sustainable energy frameworks are needed for supporting the growth of RES systems. Among the different types of RES, solar PV is of interest to the MED countries due to high solar resource. In the next section, the situation regarding PV technology in Europe is presented.

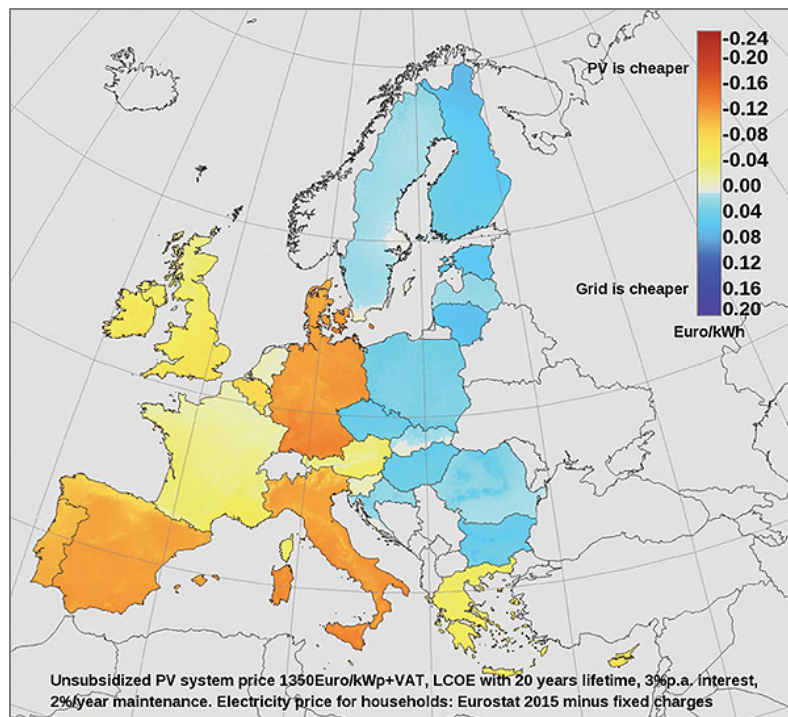
## 5.1 Photovoltaics

The growth in the Solar Photovoltaic (PV) technology sector has been robust the past few years in Europe, with Germany becoming a dominant player in the PV industry. Considering the targets set by the EU for 2020 and 2030; PV technology is an affordable and well-established renewable source for the EU countries to meet their energy targets. The result of the increasing demand of electricity over the years leads to the increase of PV systems competitiveness thus rendering PV a very competitive alternative to fossil fuel electricity generation. This situation is reflected in the rapid decline of the rapid decline of the PV system price over the last few years that is indicated in Figure 3 for the case of Germany. The rapid decrease of the system price is obvious since the price of 7€/Wp in 2002 dropped down to 1.35€/Wp by 2016 amounting to an 80% price reduction.



**Figure 3:** Solar PV system price for residential grid-connected applications in Germany up until 2016. Price includes PV modules, solar PV inverter, mounting systems and other Balance of System (BoS) components.  
[Source: JRC PV Report 2016, IEA PVPS, Eurostat]

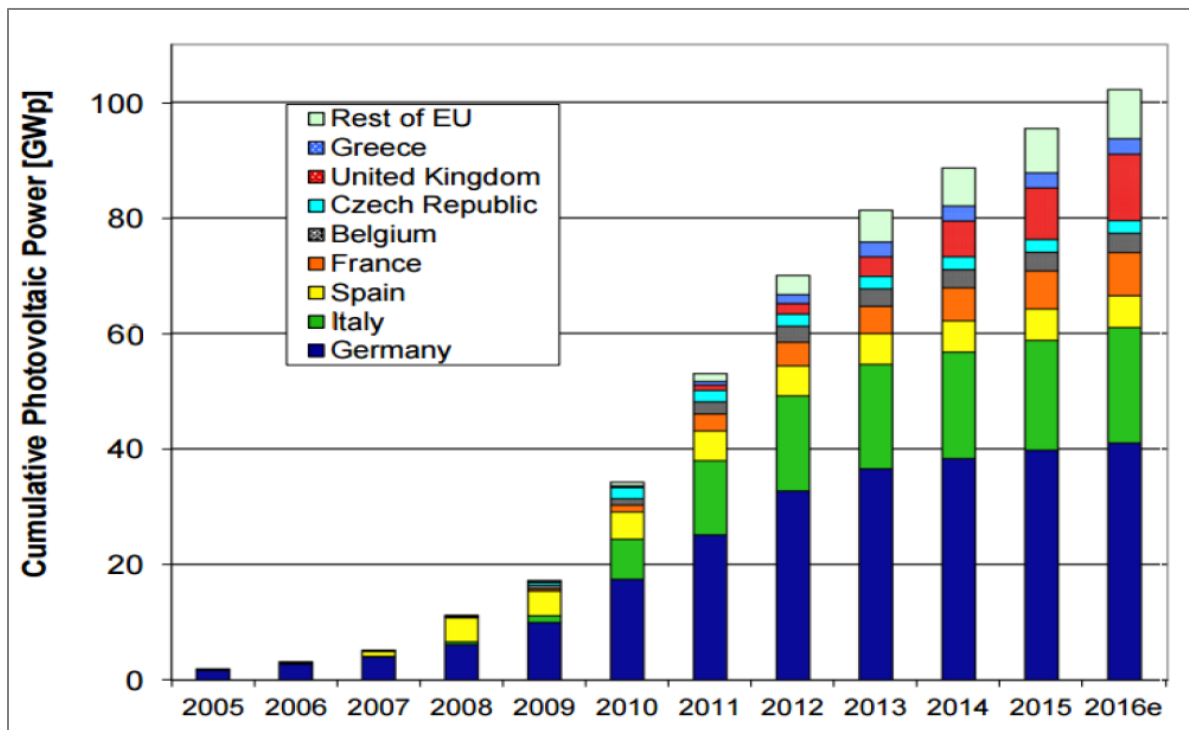
Some European countries already achieved grid parity, which is defined as the point in time where the generation cost of PV electricity equals the cost of conventional electricity sources. This can be consolidated in Figure 4, where a comparison between the Levelized Cost of Electricity (LCOE) from RES and the retail electricity price is outlined.



**Figure 4:** Comparison of European residential electricity prices with electricity generated by a PV solar system [Source: EUROSTAT]

Figure 5 shows the booming of the deployment of PV systems where the cumulative PV installed capacity for grid-connected systems in the EU has been constantly increasing over the last decade, reaching up to 105 GWp by 2016. Moreover, the favorable trend for the installation of small PV systems from the various incentives and attractive energy frameworks established by the EU countries aiming at reaching higher RES towards achieving their national energy targets in 2020.





**Figure 5:** Cumulative PV installed capacity (GWp) for grid-connected systems in EU countries between 2005 and 2016 [Source: JRC-PV status report 2016]

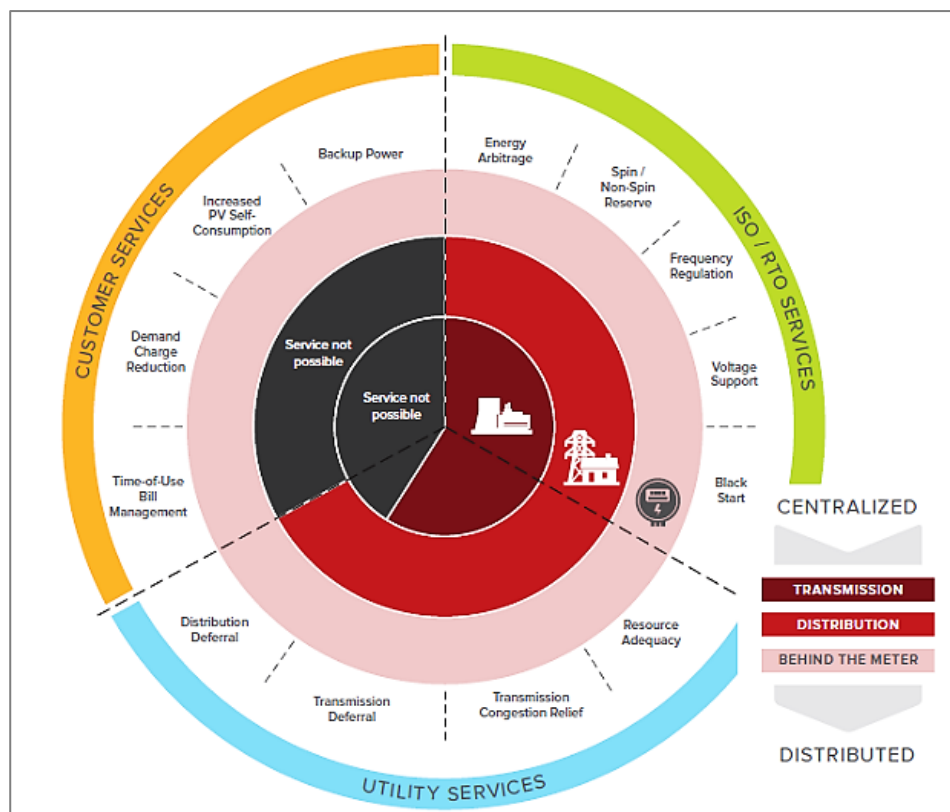
For example, the national FiT scheme in Germany was initiated in 2004 and modified in 2009 and 2014 (EEG modifications) encouraging the installation of small rooftop and large utility scale PV systems in return for attractive FiT. In addition to this, the establishment of net-metering and self-consumption schemes in other countries have stimulated the further utilization of PV, which is reflected in the sharply rising trend of the installed PV capacity over the last decade.

PV technology plays a significant role in the energy mix nowadays and this will intensify over the next few years. To promote and expand the deployments of solar PV systems towards restructuring the electricity grid, appropriate policy frameworks and governmental subsidies are needed. Incorporating technologies such as storage will lift off the barriers concerning grid stability issues and allow unobstructed deployment of RES.

## 5.2 Energy Storage Systems

The remarkable deployment of RES calls for the development of ESS since the decentralized and intermittent generation of RES poses significant risks for the stability and security of the grid. Energy storage is considered as a reliable solution that can provide the desirable resilience to the energy system. Storage systems are either centralized or distributed and can balance the generated electricity without risking grid security with the enhanced RES penetration. Furthermore, energy storage can dynamically supply demand response and other services

depending on the allocation level such as transmission, distribution or local. The deployment of storage technology offers several services (Figure 6). Specifically, for residential application, “behind the meter”, storage can offer important services to benefit the prosumer, for example the ability to self-consume and the back-up power operation in case of grid failure. Moreover, it can be used for optimal energy management in cases where Time-of-Use tariff management can be applied to increase consumer revenue. In addition, the stability of the electricity grid can be maintained by balancing the variable RES nature. Moreover, different services can be applied for grid support such as voltage support and frequency regulation because of active and reactive power compensation. Thus, the integration of energy storage to the electricity network can significantly reduce energy demand while improving the electricity system efficiency since energy dispatch and delivery can be locally achieved.



**Figure 6:** Energy storage technology can provide up to 13 different services.

[Source: R.M.I. The economics of Battery Energy Storage]

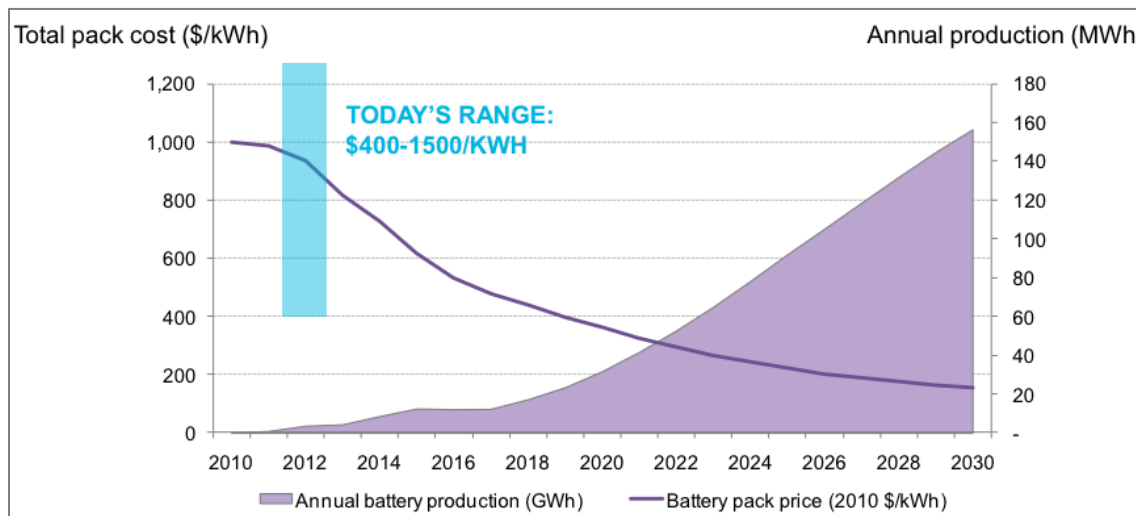
Different storage technologies are developed over the last years including batteries, compressed air and chemical, with pumped hydropower storage to be the most dominant and mature type. Through the years, other storage types are offering a range of services to the electricity grid. Specifically, electrochemical storage technology is emerging as a very competitive option for residential and community storage applications since it supports the growing need for an innovative and resilient energy system with integrated RES. However, the financial investment is required to achieve further technological progress and increase its cost competitiveness.



Furthermore, battery storage technology must overcome many barriers concerning security and financial compensation before it becomes a reliable and cost-effective solution. The lack of financial support and incentives in most of the European countries is the primary challenge to overcome.

The use of electrochemical batteries is beginning to become economically viable, especially in countries where grid parity is already achieved (EC, Best Practices on Renewable Energy Self consumption, 2015). The emerging utilization of energy storage has been promoted through different well-developed schemes established in several Member States including strategies on how to value prosumers' excess electricity. For example, the FiP model that was applied between 2009-2012 in Germany offered a premium tariff for self-consumed electricity generated from rooftop PV systems with capacity up to 500 Kw. On the other hand, the rapid decrease in generation cost of PVs has prompted the German Government to eliminate the premium tariff and value the self-consumer electricity at retail price. Specifically, the self-consumption limit was set to a minimum 10% since 2014 denoting that 90% of the annually generated electricity is allowed to receive the tariff (National policy and legal-administrative changes, available online). Additionally, a 40% surcharge on the electricity bill that finances FiTs has to be paid for the self-consumed electricity from new users with installations above 10 Kw. In UK, where small-scale PV systems (<30 kWp) were eligible to receive a Feed-in-Tariff and are given not only a generation tariff for the PV production (that is self-consumed) but also a bonus for the excess electricity fed into the grid.

The price difference between solar PV power production and residential electricity prices is decreasing and as result, the economic case to facilitate battery storage becomes viable (T. Strasser, IEEE, 2015). The aim of the adoption of storage systems is the balance of distributed generation and reducing peak power generated from decentralized RES installations. The deployment of energy storage in large-scale applications is becoming interesting for the case of isolated and not interconnected networks. Nevertheless, this is not financially possible for all technologies since the decreased unit price is not yet achieved for several storage types such as the battery storage technology. Many researchers show that Lithium-ion technology is a feasible solution and suitable for residential and utility storage applications. Figure 6 presents the forecasted price for Lithium-ion batteries, where a significant drop on the price is expected within the next decade.



**Figure 7:** Lithium-Ion battery pack cost and production [Source: Bloomberg New Energy Finance]

## 6 Renewable Energy Sources in Balkan Med region

RES deployment increases more and more over the years with solar PV systems to be the most famous solution for the Balkan Med region due to the reduction of PV systems' cost. For this reason, photovoltaics technology is becoming a viable alternative to conventional electricity generation and is contributing to the achievement of the very ambitious energy targets set by the EU Commission for 2020 and 2030.

Balkan Med countries have already started adopting new policies such as net-metering and self-consumption schemes, targeting to encourage prosumers to further utilize RES and thus reach higher RES penetration levels.

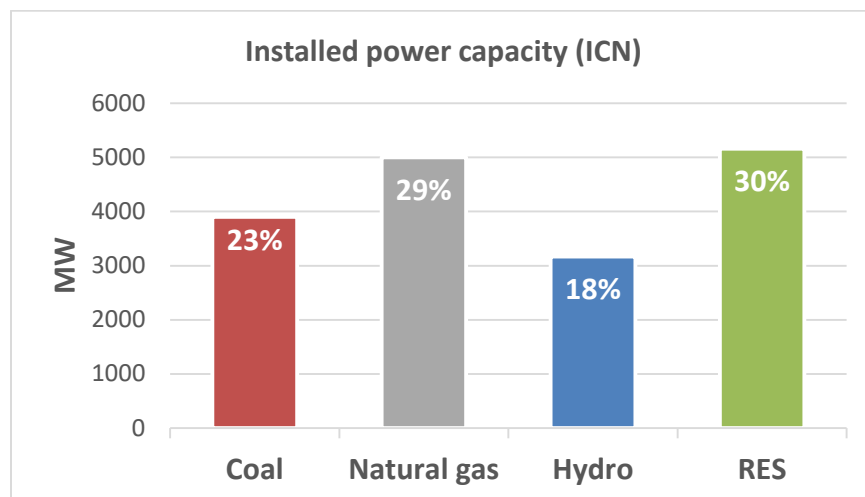
In this section, the existing situation regarding the evolution of RES over the last few years will be analysed for the Balkan Med countries participating in the PV-ESTIA project namely Greece, Cyprus, Bulgaria and FYROM. Emphasis is placed on photovoltaics due to the high solar resource of the Balkan Med region.

### 6.1 Renewable Sources

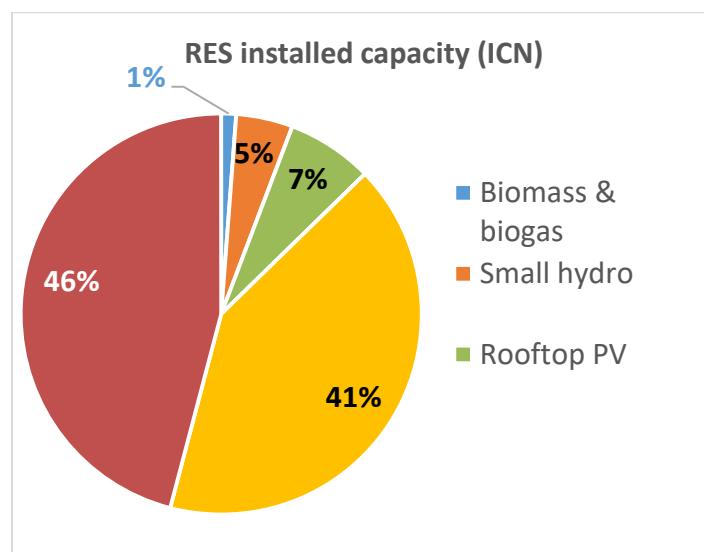
#### 6.1.1 Greece

The produced electrical energy in the region of Greece is characterized by a mix of conventional and renewable energy sources, with a total installed power capacity of 17,235 MW. Greece has many islands with autonomous electrical grids, dividing Greek electrical network in two parts, each one characterized by different energy mix: the interconnected network (ICN) and the non-interconnected network (nICN). The ICN delivers electricity to the mainland of Greece, whereas the nICN refers to small autonomous networks existing on the islands.

In Figure 8 Installed power capacity at Greek ICN by February 2018 , it can be observed that renewable energy sources hold the 30% of installed electrical power at the ICN, reaching at 5,160 MW, by February 2018 (HEP, 2018). Coal and natural gas power plants hold the half of installed power in Greece, i.e. 52%, while installed hydro power reaches the 3,171 MW (18%). Moreover, Figure 8 also presents the share of each different RES technology among total RES installed capacity. It can be noticed that almost the 50% of RES installed at NIC consists of ground-mounted PVs (2,094 MWp) and rooftop PVs (351 MWp).

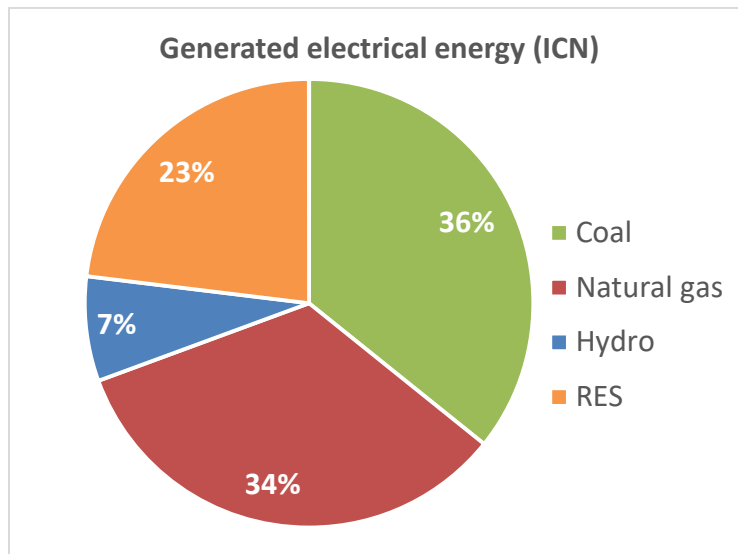


**Figure 8:** Installed power capacity at Greek ICN by February 2018 (HEP, 2018).



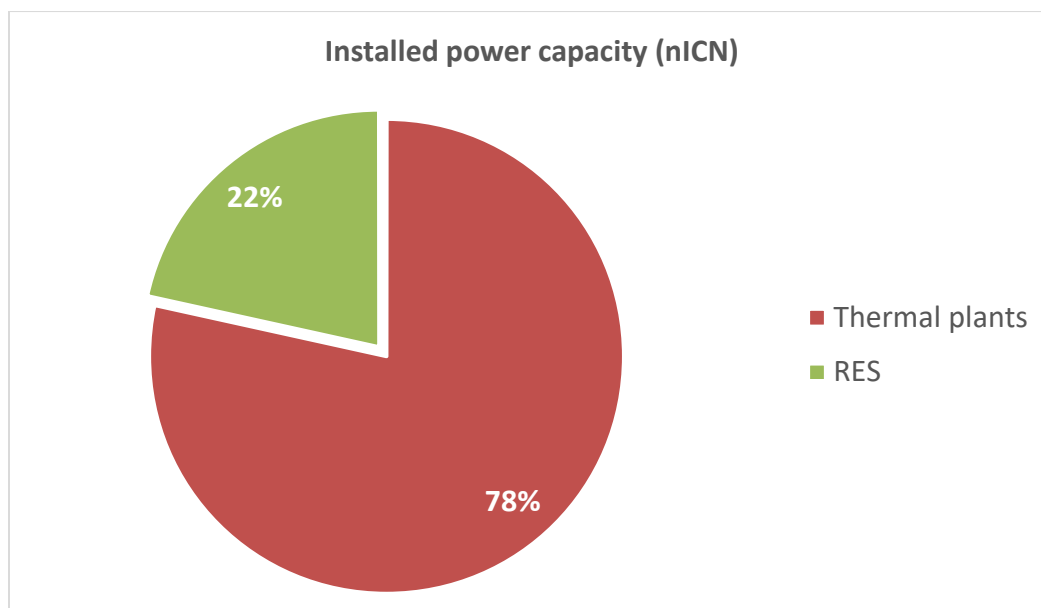
**Figure 2:** Installed capacity of different RES technologies at Greek ICN by February 2018 (ADMIE, 2018).

Furthermore, Figure 10 depicts how different energy sources contributed to electrical energy generation mix at the ICN during 2017. It should be noted that RES provided a total of 10,565 GWh, corresponding to the 23% of total electrical energy produced at ICN throughout the year.

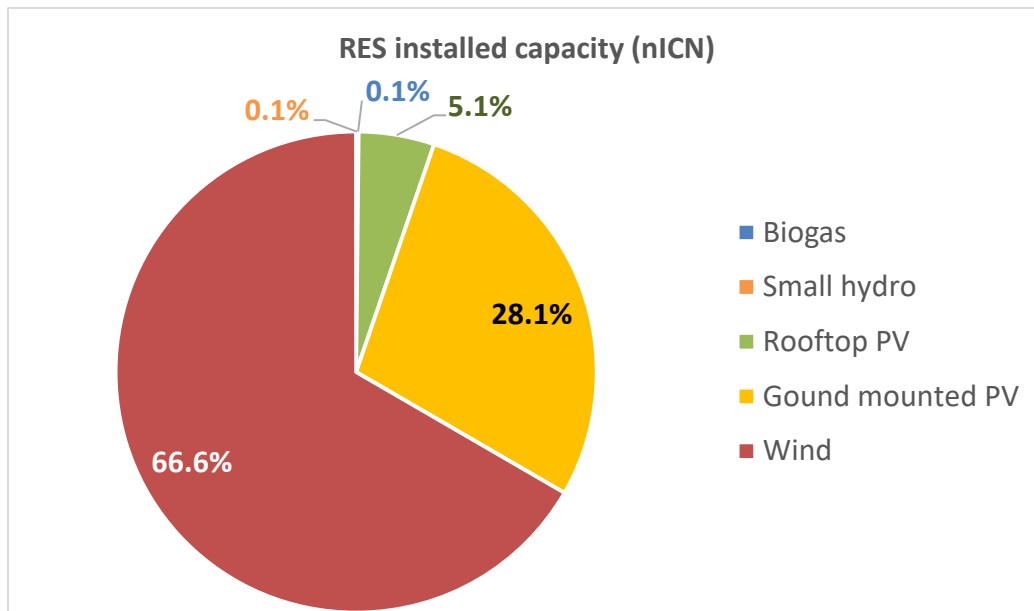


**Figure 3:** Total generated electrical energy in Greece during 2017 (ICN) (ADMIE, 2017).

On the other hand, nICN consists of 1,760.46 MW of thermal plants (78%) and 483.55 MW of RES generators (22%), as illustrated in Figure 11. Furthermore, the allocation of different RES technologies participating in the RES energy mix of the nICN is illustrated in Figure 12.



**Figure 4:** Installed power capacity at Greek nICN by November 2017 (DEDDIE, 2017).



**Figure 5:** Installed capacity of different RES technologies at Greek ICN by November 2017 (DEDDIE, 2017).

The growth of installed PV capacity in Greece is depicted in Figure 13, including PV installations both in the ICN and the nICN. It should be noted that from the beginning of 2012 until July 2013, installation of PV systems was increasing with a high rate, due to a high feed-in tariff compensation policy valid those years. In August 2012, the licensing for large PV installments was suspended. This fact eliminated the rate of PV increase in the summer of 2013, when the last licensed PV installations were placed. In April 2014 new FiTs were introduced by the Greek government, although they were not attractive enough for new investments, as it can be also realized by Figure 6. Considering the energy generated by PVs, Figure 13 confirms that during the summer, an amount higher than 400 GWh is generated by PV. Moreover, the PV share of total energy mix produced in Greece is illustrated in Figure 14 for each month of 2016 and 2017, whereas Figure 15 shows PV share throughout the last 6 years (2012-2017). It is seen that almost 7% of total produced energy in Greece comes from PVs, during the last 4 years.

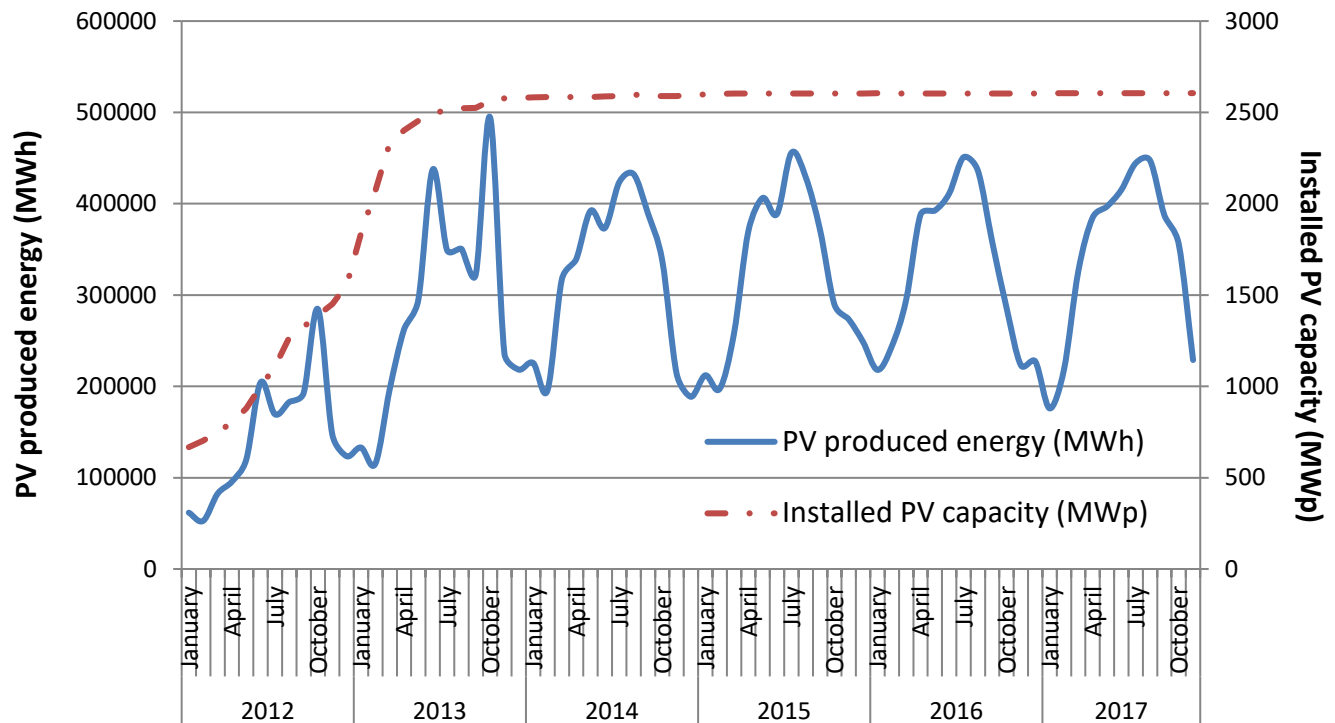


Figure 6: PV installed capacity and PV produced energy by November 2017 [(ADMIE, 2017) (HEP, 2018) (DEDDIE, 2017)]

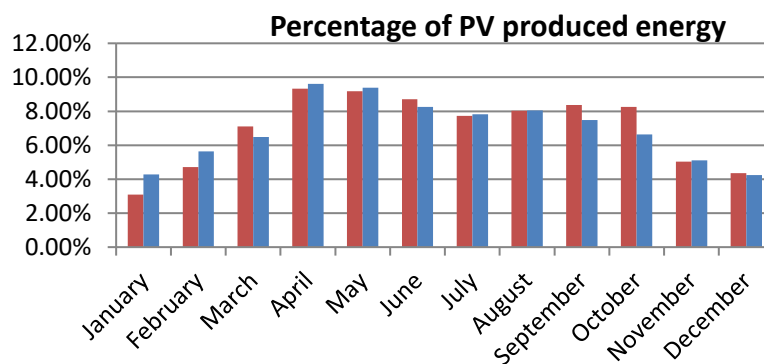
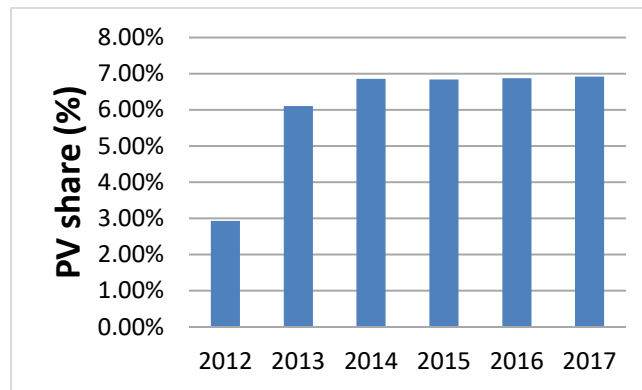
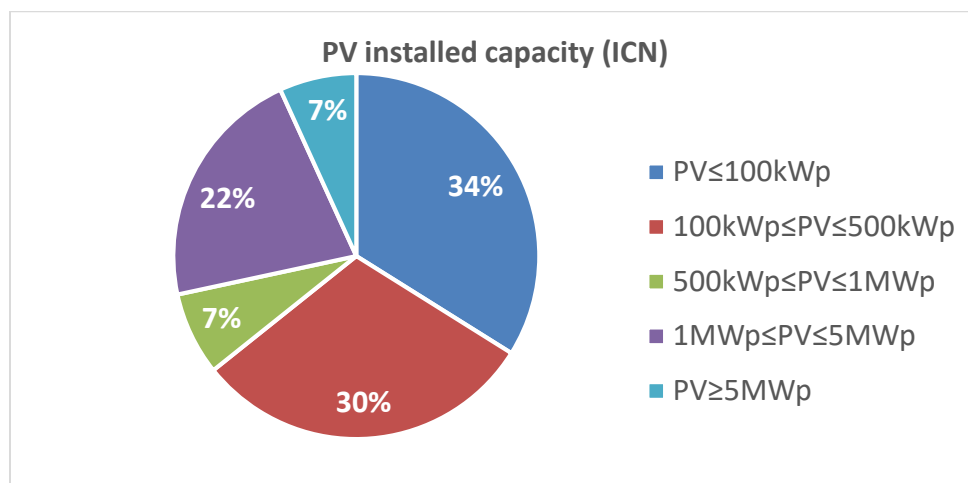


Figure 7: PV share of total produced energy in Greece for years 2016 & 2017 [(ADMIE, 2017) (DEDDIE, 2017) (HEP, 2018)]



**Figure 8:** PV share of total produced energy in Greece for years 2012 – 2017 [(ADMIE, 2017) (HEP, 2018) (DEDDIE, 2017)]

An analysis of the installed PV capacity in the ICN part of Greece is shown in Figure 16. The largest amount (64%) of PV installed power refers to PV installations smaller than 500 kWp, whereas 34% of PV power consists of instalments with PV capacity smaller than 100 kWp.



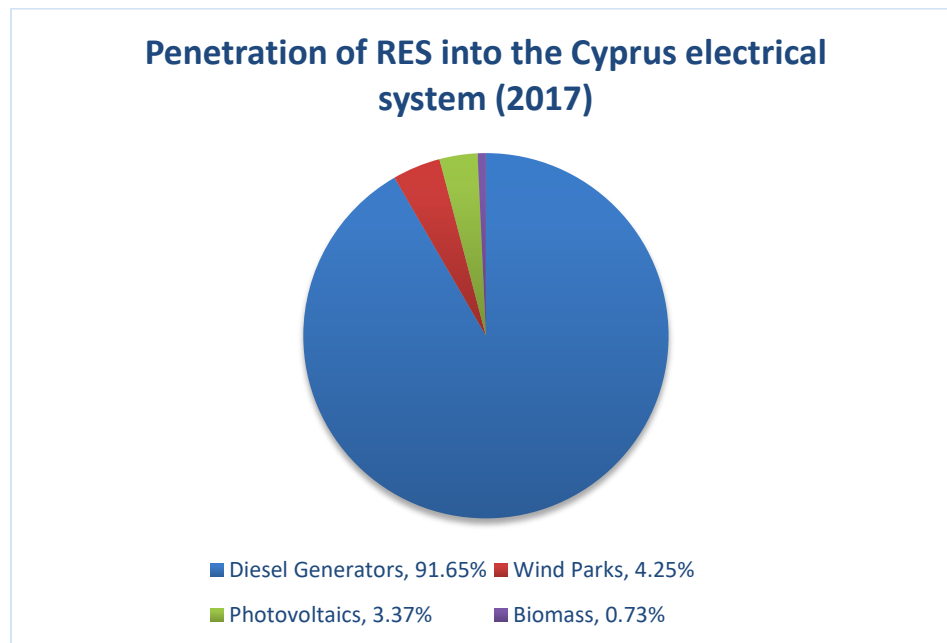
**Figure 9:** PV size classification among total PV installed capacity (ICN), (DEDDIE, 2017).

### 6.1.2 Cyprus

The integration of variable distributed generation sources in weak and isolated power networks such as the electricity grid in Cyprus poses several technical and financial concerns. The introduction of the RES to the Cypriot energy mix over the last decades is due to the generous subsidies offered and more recently because of the significant system price reduction. Considering the target of 20% of the total gross energy consumption set by the EU, Cyprus foresees to reach a RES share of 13% in the gross national consumption of energy in 2020.

Until today, the electricity generation mix in Cyprus relies heavily on imported fuels, mainly crude oil. Three main power stations with 1478 MW of total installed capacity provide the vast amount

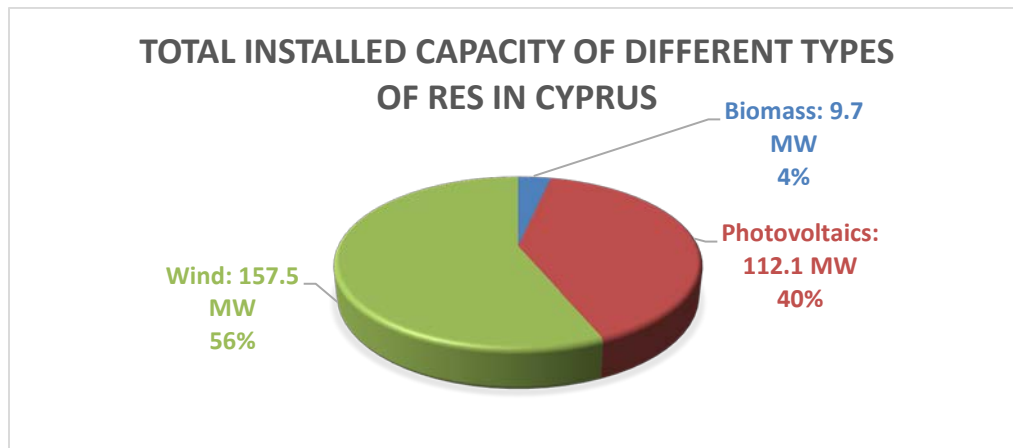
of the electricity generation (CTSO, 2018). Figure 17 presents the statistical analysis of the Cyprus Transmission System Operator (TSO), which shows that 91.65% of the country's total electricity demand in 2017 comes from diesel generators with the remaining 8.35% from RES. Specifically, wind parks constitute the primary renewable source of Cyprus reaching a share of 4.25% into the islands electrical system by the end of 2017. Additionally, the contribution of PV systems is of dominant importance since the country's solar energy potential is 2,000 kWh/m<sup>2</sup> of annual solar irradiation. PV penetration accounted for a share of 3.37% whilst biomass accounted for the remaining 0.73% of the total electricity consumption (CTSO, 2017).



**Figure 17:** RES penetration to the annual electricity demand in Cyprus for 2017 (CTSO, 2017).

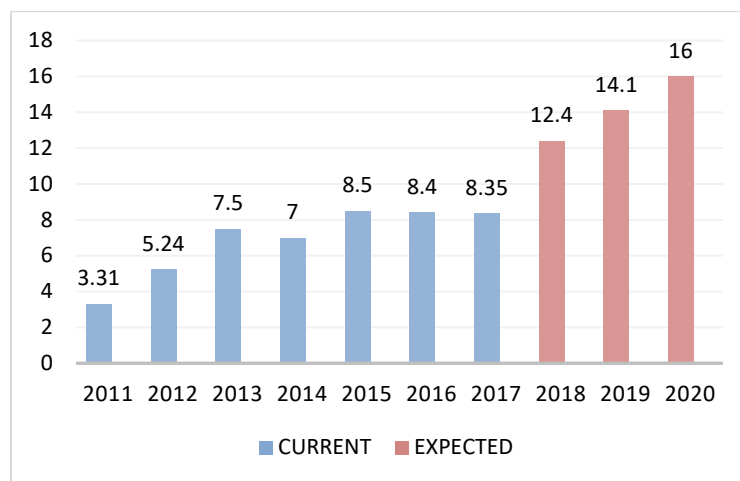
According to the data published by the Cyprus Transmission System Operator (TSO), the total installed capacity from RES has amounted to 279.3 MW by the end of 2017. The installed capacity and electricity penetration for different RES are depicted in Figures 18 and 19, respectively. Specifically, wind parks amounted to 65% of the total installed capacity or 157.5 MW. In addition, photovoltaic systems were having a share of 31% in the total installed capacity, which amounts to 75.04 MW. Finally, the total installed capacity for biomass reached 4%, having a total installed capacity of 9.7 MW by the end of 2017 (CERA, 2017) (CTSO, 2017).





**Figure 18:** Total installed capacity of different types of RES in Cyprus at the end of 2017 (CERA, 2017) (CTSO, 2017).

In response to the EU energy framework, Cyprus has put forwards very ambitious national targets to be met by 2020. According to the projections provided by the Ministry of Energy, Commerce, Industry and Tourism (MECIT) shown in Figure 21, RES contribution to the annual gross electricity demand is expected to double by 2020, reaching 16% in line with the national target (MECIT, 2010). This is a positive step towards energy sustainability, however this will give rise to the grid issues that will be exacerbated by the fact that Cyprus has a small isolated network if no mitigations actions are taken.



**Figure 19:** Electricity generation from RES (%) in Cyprus until the end of 2017 (TSO) and as expected by 2020 by the projections provided by the MECIT (CTSO, 2017) (MECIT, 2010).

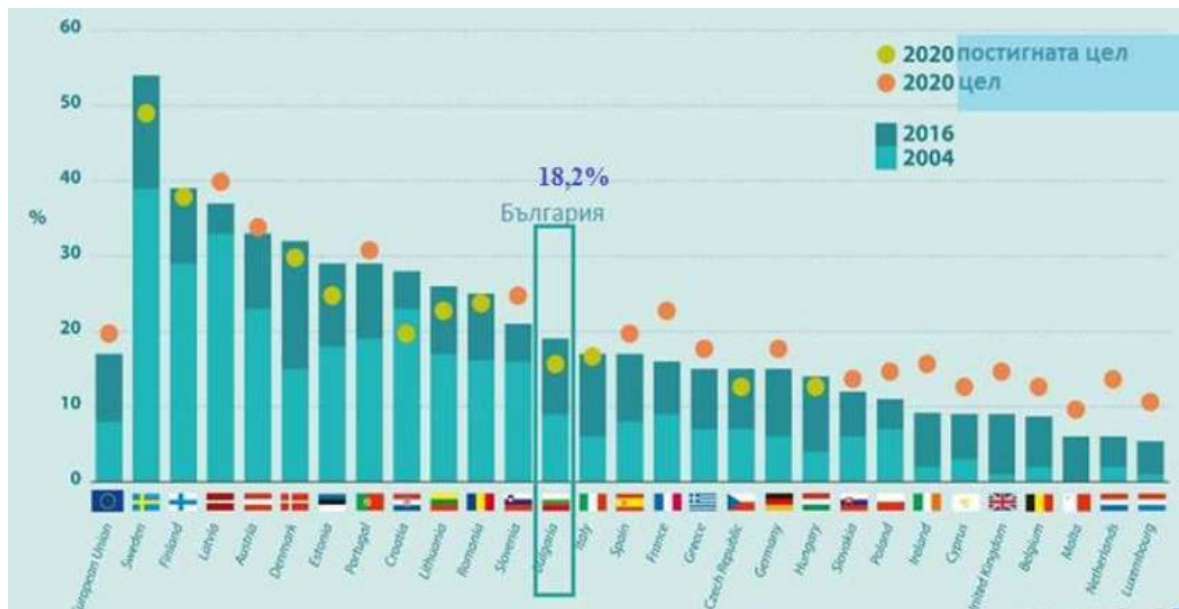
### 6.1.3 Bulgaria

The country's electricity consumption doubled between 2005 and 2014, however the growth is expected to stabilise by 2020. Currently Bulgaria is one of the EU countries with already achieved

renewable energy targets. The final RES energy consumption in the energy mix in 2017 represents 18,2 %, while the 2020 RES targets required 16%.

The total installed capacity in Bulgaria are 12,070 MW, while the total RES installed capacity is 5,026 MW. Specifically:

- Wind: 701 MW (6%)
- Solar: 1,043 MW (9%)
- Water: 3,204 MW (27%)
- Biomass: 78 MW (1%)



**Figure 20:** Bulgaria 2020 renewable targets (IRENA, 2018).

Because of the early achievement of the 2020 renewables target, and in the interest of reducing renewable energy support costs and stabilising household electricity prices, Bulgaria now grants almost no support to renewables.

The largest solar PV capacity increase took place between 2011 and 2012, when very high support levels were available. Some of the 843 MW were installed during a significantly short timeframe. This investment hype was caused by initially generous and non-capped FIT.

Regarding wind energy, Bulgaria was a highly attractive, emerging market, due to a generous FIT system. As a result, by 2014, 700 MW of wind generation had been installed.

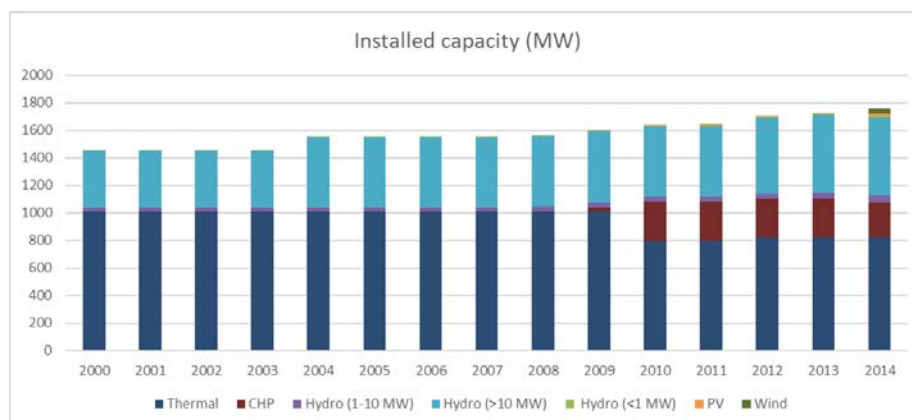
These developments, however, revealed problems in the inadequately designed and subsidised energy market, which led to a raising of electricity prices. An increase of 14% caused public resistance, ultimately leading to the resignation of the government in 2013. The strong limitation of support for renewables has led to a standstill over investments since 2012.

As of today, 3.69<sup>1</sup> MW is the total installed capacity of all PVs up to 30 kWp based on the official data available. Most of the installed capacity should be considered as a capacity from residential systems, although the official statistic doesn't divide the type of installations. The total PV installed capacity in the country is 1,043 MW.

Thus, the total PV residential capacity represents less than 0.01 % from the total capacity in the country (VEI, 2018).

#### 6.1.4 FYROM

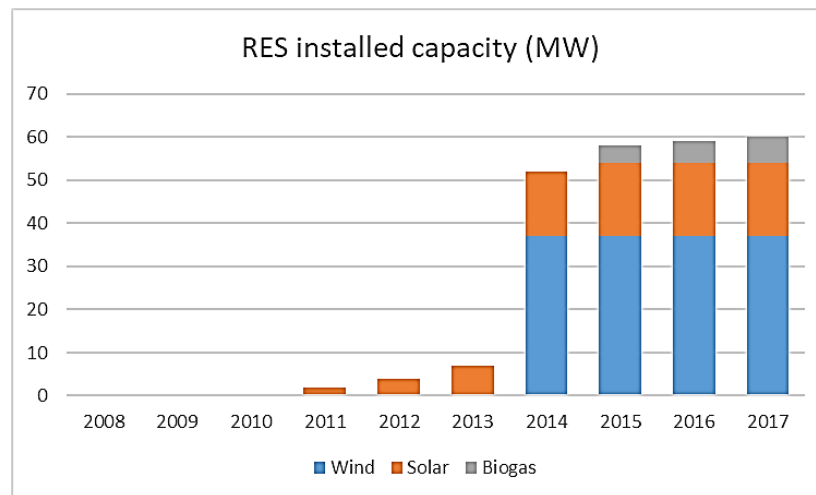
The official national data obtained from the State Statistical Office for the installed capacity of electricity generators covers the period until 2014. Figure 23 shows the dominant role of thermal power plants in the electricity production - around 46% of the total installed capacity in 2014 belongs to thermal power plants. The thermal power plants generated 44% of the total electricity in 2014. Hydro power plants are by far the largest source of renewable energy and they have installed capacity of 631 MW. Around 561 MW are large HPP plants with capacities over 10 MW. The integration of small hydro power plants appears to have an upward trend, mainly because of the supported schemes (FiTs) offered to the producers. The wind and solar generation could also be considered because of the feed-in tariff schemes. The only wind power plant has a total capacity of 36.8 MW and generates around 0.8% of the national electricity consumption.



**Figure 21:** Installed capacity of electricity generation.

Although the solar potential of the country is high, the integration of PV generators has been rather slow. According to the official statistical data, the total installed capacity of PV until 2014 is around 15 MW.

A more recent publication by IRENA - *Renewable Capacity Statistics 2018* provides data on the installed capacities of renewable energy sources for the period 2008 – 2017. The statistics shows that the total capacity of PV generators in 2017 was 17 MW (IRENA, 2018).



**Figure 22:** Installed capacity of renewable energy excluding HPP (IRENA, 2018).

The lack of official statistics makes it difficult to keep track of the penetration of PV technology in buildings. One reason for this lack of data is the limited number of installations nationwide. The existing installations are not connected to the distribution network and often include an ESS. For example, the SEE University in Tetovo has implemented a 100 kW PV system on top of the parking roofs. A PV generator with a rated power of 18 kW is installed at the elementary school “Snado Masev” in Strumica which production is used for lighting of the building. PV generators have also been integrated on the roofs of collective residential buildings to supply the lightning demand of the building halls. Some public institutions, for example the police station “Prolet”, the polyclinics in Bitpazar and Chair and the office building of the Association of the units of local self-governments (ZELS) have implemented photovoltaics and storage to reduce their electricity consumption. With regards to buildings in the industry sector, the foundry for aluminum and zinc in Resen has installed 41 kW generator. Other examples can be found in locations where the connection to the distribution system was not possible and a PV generator was implemented. Such systems have been implemented in the telecommunication stations in Lazaropole, Mavrovo and Dobrenoec, Kichevo. These are only a portion of the existing cases for PV+ESS in buildings and should give an indicative overview of where these systems have been installed so far.

## 7 Solar potential and Photovoltaics in Balkan Med Countries

### 7.1 Solar potential

It is widely known that the main and favourable RES type for buildings in the Balkan Med region is PV technology due to the high solar potential of its countries.

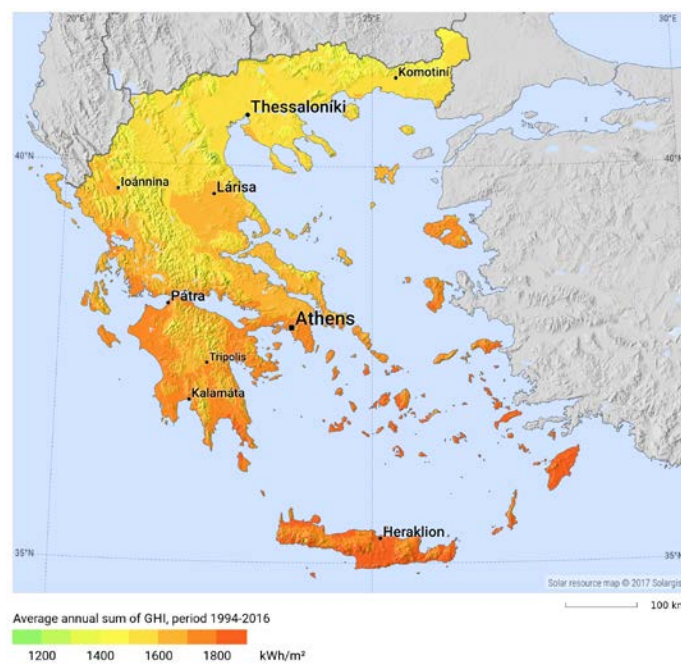
The table below shows the cumulative annual sum of global irradiation in each country (kWh/m<sup>2</sup>) along with the yearly sum of solar electricity generated by 1 kWp PV systems on the horizontal plane (kWh/kWp) with performance ratio of 0.75.

**Table 10:** Summary of the solar resource and generated electricity from PV in the participating regions. Data extracted from JRC-PVGIS tool.

	Greece (Thessaloniki)	Greece (Kozani)	Cyprus	Bulgaria	FYROM
Maximum Global Irradiation (kWh/m <sup>2</sup> )	1,720	1,620	1,980	1,520	1,520
Maximum Generated Electricity (kWh/kWp)	1,310	1,250	1,510	1,180	1,170

#### 7.1.1 Greece

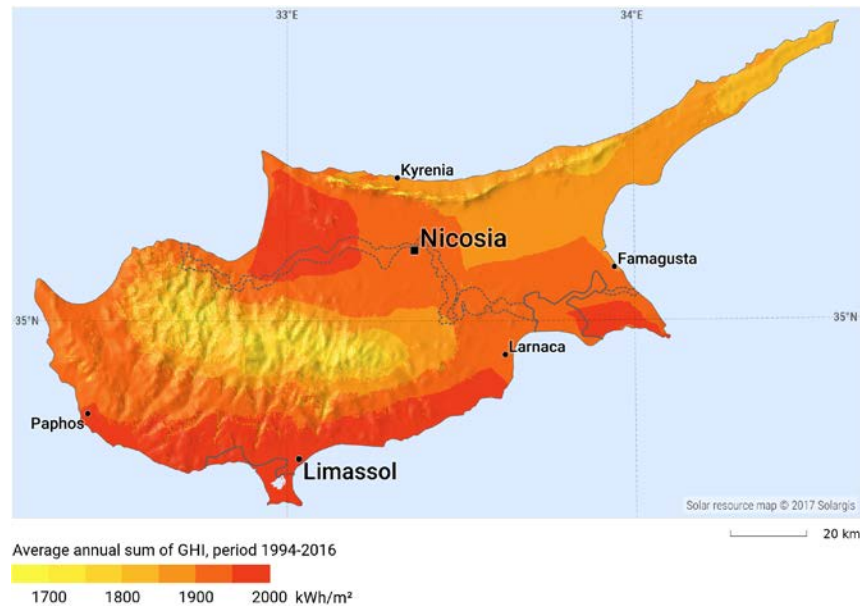
The yearly sum of the global irradiation for the Greek region is presented in Figure 23. Considering the northern part of the country, the solar energy potential is well above 1,400 kWh/m<sup>2</sup>. On the other hand, south parts of Greece as well as the Greek islands have solar power potential considerably higher than 1,600 kWh/m<sup>2</sup> (SOLARGIS, 2018).



**Figure 23:** Annual global irradiation in Greece on the horizontal plane form (SOLARGIS, 2018).

### 7.1.2 Cyprus

Figure 24 shows the annual global irradiation in Cyprus that reaches up to 1,800 kWh/m<sup>2</sup> in the mountainous regions where the expected generated electricity for horizontally mounted PV systems is 1,350 kWh/kWp. For the seaside and urban regions, the yearly sum of global irradiation is around 2,000 kWh/m<sup>2</sup>, which results in an approximated generated electricity greater than 1,500 kWh/kWp for horizontal inclination.



**Figure 24:** Annual global irradiation in Cyprus on the horizontal plane (SOLARGIS, 2018).

### 7.1.3 Bulgaria

Regarding the solar potential, the average solar radiation is 1,517 kWh/m<sup>2</sup> (1,410-1,600 kWh/m<sup>2</sup>) and the average annual sunshine period is 2,150 hours (2,100-2,500 hours). The total theoretical potential of the country is around 13x10<sup>3</sup> ktoe (Figure 25).

Bulgaria could be divided into three zones according to the solar insolation received, namely:

- Zone A: encompasses regions in the southeast, part of the southern Black Sea coastal region and the valleys of the rivers Struma, Mesta and Maritza. The amount of sunshine is over 2,200 h/yr and the total solar radiation received on a horizontal surface is greater than 1,600 kWh/m<sup>2</sup>.
- Zone B: encompasses regions in the Danube plain, the Dobrudja region, the Trace lowland, west Bulgaria, the Balkan hollow fields and Stara Planina mountain regions. The amount of sunshine ranges from 2,000 to 2,200 h/yr and total solar radiation from 1,500 to 1,600 kWh/m<sup>2</sup>.
- Zone C: encompasses the remaining parts of Bulgaria, mainly the mountainous regions, where sunshine is less than 2,000 h/yr and total solar radiation less than 1,500 kWh/m<sup>2</sup>.



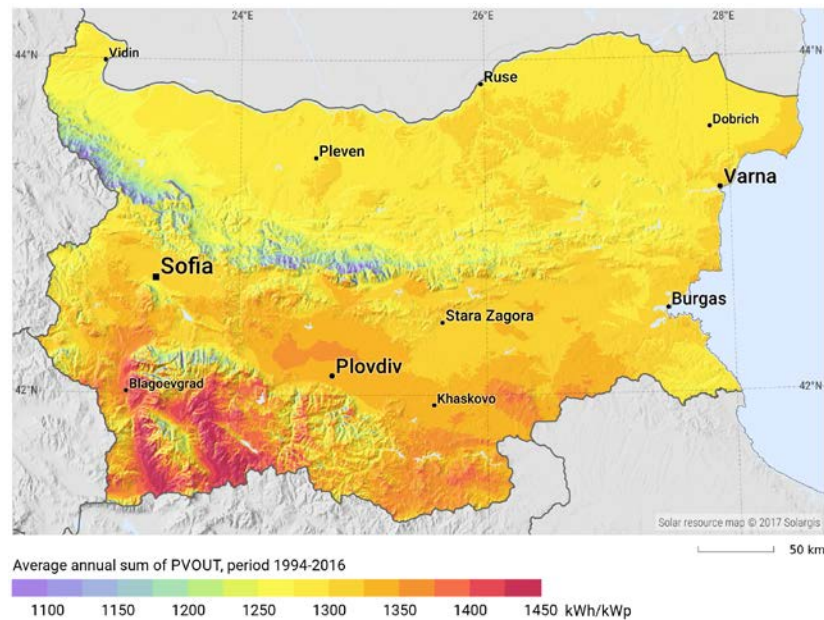


Figure 25: Annual global irradiation in Bulgaria on the horizontal plane (SOLARGIS, 2018).

#### 7.1.4 FYROM

As depicted on Figure 26, the total annual solar radiation varies from 1,250 kWh/m<sup>2</sup> in the north up to 1,530 kWh/m<sup>2</sup> in the south-western part amounting to an average annual solar radiation of 1,385 kWh/m<sup>2</sup>. The average daily radiation in the north, for instance in Skopje, is approximately 3.4 kWh/m<sup>2</sup>, while the southern part of the country has a larger daily solar radiation of 4.2 kWh/m<sup>2</sup>. As a result, the estimated PV output in different areas falls in the range 1,200 – 1,400 kWh/kWp.

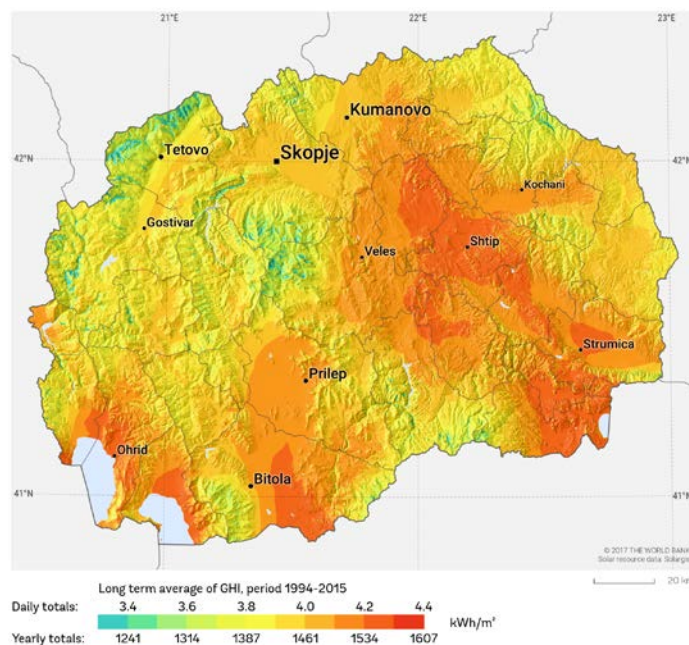


Figure 28: Global horizontal irradiation in FYROM (SOLARGIS, 2018)

## 7.2 Photovoltaics

The aim of this part is to present the PV related legislation that exists in each participating country with emphasis on the support schemes for PV systems. The current relevant legislation in each participating country for coupled PV- energy storage systems (ESS) installations are also presented.

Technology improvements, cost reduction and supported schemes have promoted solar technologies as viable alternatives to fossil fuels allowing solar PV module prices to plunge around 80% by 2016 compared to the 2009 prices.

In line with the falling cost of Balance of System (BoS) components, the total PV system price has seen the global weighted average installed cost of residential and utility scale solar plants fall by 65% in the EU between 2009 and 2016, which is shown in Figure 27 (IRENA, 2018).

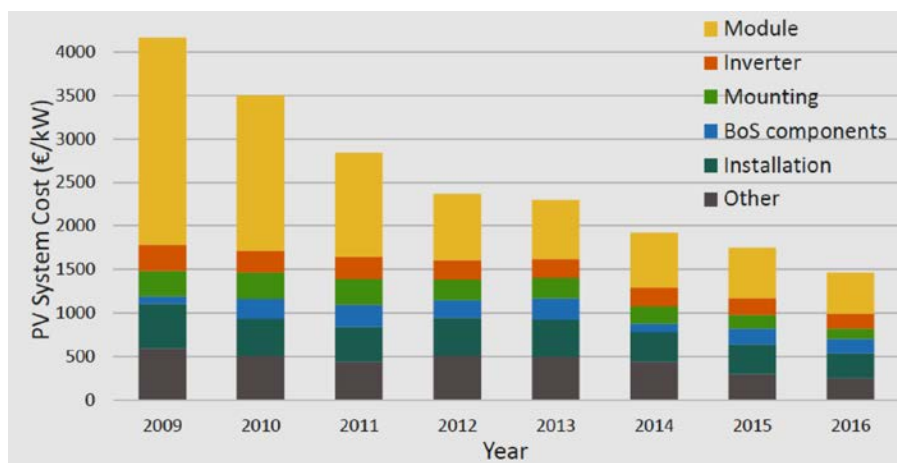


Figure 27: Retail price of PV systems in Europe (€/kWp) (IRENA, 2018).

### 7.2.1 Greece

The current legislation for PV installations can be classified into three main categories, summarized as follows:

- **Feed-in tariffs (FiTs):**

The price of the produced energy by the PV installations is compensated with a fixed price that is foreseen in the Greek Government Gazette 1103/02.05.2013. Nevertheless, the FiT policy is valid for PV systems with a capacity less than 500 kWp.

- **Net-metering:**

This policy was initiated on April 2015 by a Ministerial Decision published on the Greek Government Gazette B'3583/31.12.2014. The main concept of this policy involves the installation of PV systems by electricity consumers in order to cover own needs of electricity. Net-metering is a three-year offset between the energy produced by the PV system and the energy consumed on the installation of the prosumer. Energy production does not have to



occur simultaneously to the consumption. Net-metering can take place in both the interconnected (ICN) and non-interconnected (nICN) electrical networks, applying different rules in each occasion, as follows:

- Considering the ICN network, the maximum PV installed capacity is limited either to 20 kWp or to the 50% of the agreed power of consumption of the installation (in kVA), if it exceeds 20kWp. Nevertheless, in case of either governmental or non-governmental not-for-profit organizations, no limit is applied to the capacity of the PV installation that can reach up to 100% of the electricity needs.
- In the second case of the nICN network, PV system capacity is limited either to 10 kWp or to the 50% of the agreed power of consumption of the installation (in kVA), if it exceeds 10kWp. Especially for the island of Crete the above power quantities are double. In any occasion, the overall PV power cannot exceed 50 kWp for Crete and 20 kWp for the rest nICN network.
- PV systems must be placed at the same place of the installations that they supply. The net metering contract between the prosumer and the electricity supplier is valid for 25 years, starting at the date of the PV system connection.

- **Feed-in premiums and Virtual Net-metering:**

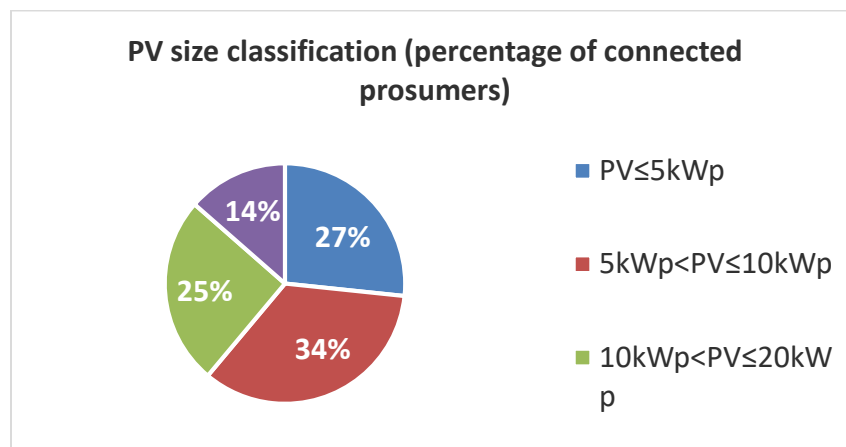
A new RES law (L.4414/2016) was voted by the Greek Parliament in August 2016. The purpose of this law is to develop a new support scheme for RES power plants, consistent with the Guidelines on State aid for environmental protection and energy 2014-2020 (Official Journal of the European Union 2014/C 200/01). It is foreseen that the new support schemes will boost up the PV installed capacity in the country. More specifically:

- The new policy framework abandons the FiT policy in favour of a feed-in premium scheme for systems over 500 kWp. In practice, this means that the new PV power plants participating in the energy market will be given a variable premium, on top of the standard market price for the generated green power. The amount of the premium for renewable power plants will depend on some market variables (e.g. the system's marginal price) and a tariff set via competitive tenders. The feed-in premium contract will be valid for 20 years. The new law does not apply to the nICN electrical network.

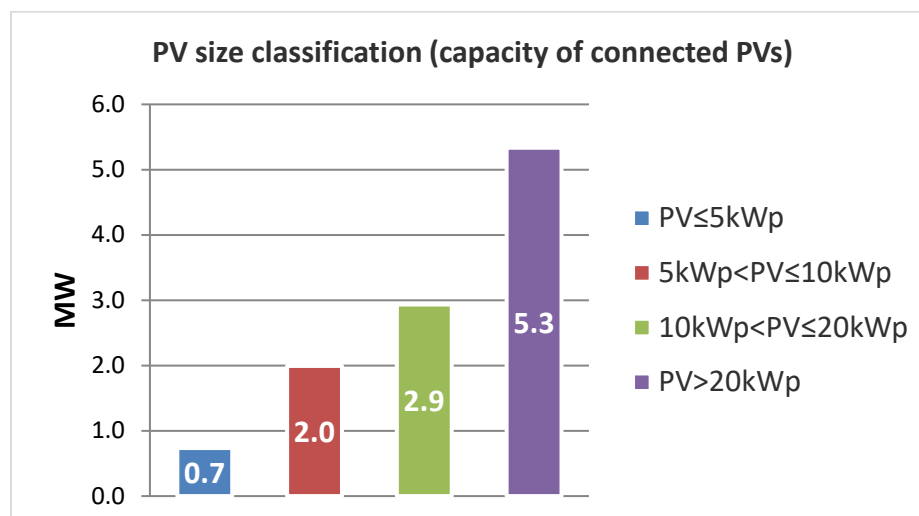
The aim of the net-metering compensation scheme that was launched in Greece on April 2015 was to enhance new PV placements on existing consumers' installations. This scheme was launched to move from older feed-in tariff policies to new policies that increase prosumers' self-consumption, giving new incentives to consumers for investment in PVs. The maximum eligible PV capacity operating under this scheme is 500 kWp for medium voltage network and 100 kWp for low voltage network (more restrictions may be applied, but this issue is further analysed in other section of this report. Since this scheme is eligible to already existing installations of consumers, a rise in PV integration in buildings is expected the next years. By the end of 2017, the total PV installed

capacity under Net-metering programme reached 11 MWp, installed on 694 different prosumers (Figure 28). The 61% of prosumers own a PV system smaller than 10 kWp, indicating the widespread of PVs integration in buildings, since such installations usually belong to residential prosumers. The installed PV capacity under net-metering programme is illustrated in Figure 29, classified by the PV size of the installation.

Finally, a virtual net-metering scheme was introduced in Greece. The first application for a PV installation under this scheme was placed on July 2017. Until the end of 2017, only two PV instalments were connected to the grid with a total capacity of 40 kWp. However, there are other applications pending for operation license already.



**Figure 28:** Percentage of connected prosumers classified according to their installed PV size, under net-metering programme by the end of 2017 (DEDDIE, 2017).



**Figure 29:** Total installed PV capacity classified of PV size, under net-metering programme by the end of 2017 (DEDDIE, 2017).

Virtual Net-metering is the netting of the produced electrical energy by a RES installation of the owner, with the total consumed energy by the installations of the owner, from which at least one is not at the same or neighbor place with the RES installation, or it is connected to a different supply. Thus, city and regional councils, schools, universities, farmers and farming associations will be allowed to develop solar PV projects up to 500 kWp (and other renewable projects) away from the place of the actual power consumption.

The installation of PVs in the building environment is foreseen in all the above-mentioned policies, apart from the feed-in premium scheme. Among them, the current FiTs are quite low. For example, considering rooftop PV systems with an installed capacity of less than 10 kWp, the current FiTs is 0.08 €/kWh. On the other hand, the Net-metering and the newly introduced Virtual Net-metering schemes are the most preferable policies for the prosumers, offering a viable solution.

Until recently, the only legislative attempt for the use of energy storage systems was included in hybrid stations, which are a combination of RES and storage system. More specifically, a hybrid station is a unit that:

- Uses at least one RES technology
- The annual consumed from the grid energy is not more than 30% of the total energy, which is consumed for charging the energy storage of the station.
- Maximum RES production capacity cannot exceed the 120% of the installed energy storage capacity.

Within this framework, the Greek regulatory authority for energy (RAE) issued in recent years several licenses of HS, with a total capacity of about 200 MW in some large islands (Crete, Rhodes, Lesvos), accompanied by detailed pricing produced energy, different for each island, depending on the average annual variable costs of conventional peak units.

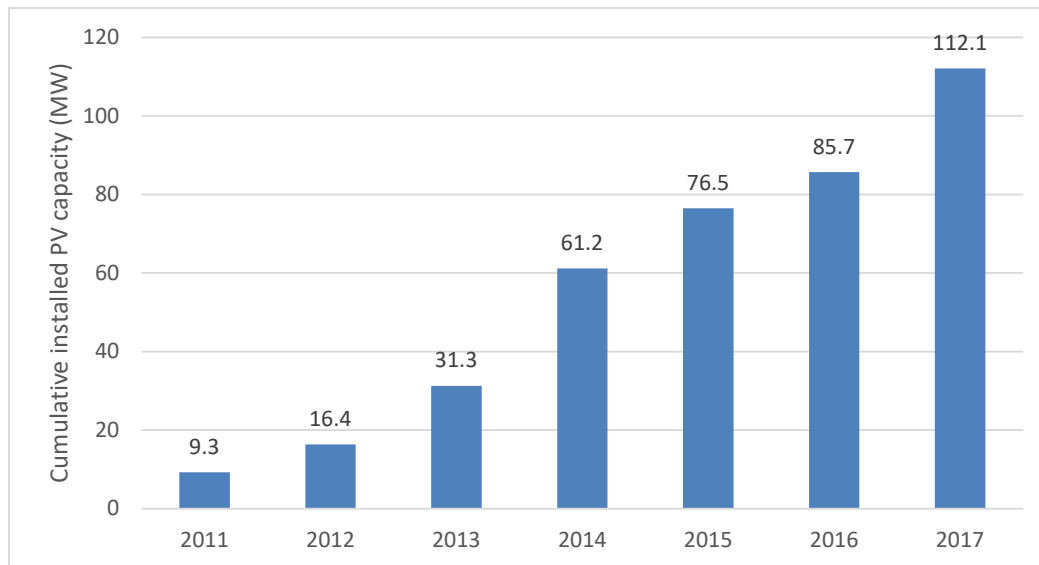
This situation is radically changed by the recently published law (28/01/2018) regarding the energy communities, where the implementation of electrical storage systems in PV prosumers with Net-metering is officially introduced. This is considered the first attempt set by the Greek Government for the wide integration of the energy storage systems in the grid.

### 7.2.2 Cyprus

Photovoltaic systems technology has been developed in Cyprus during the last ten years, with PV installed capacity almost doubling in consecutive years (Figure 30). Grid parity conditions combined with the implementation of favourable policies such as net metering have contributed to this trend of increasing PV system installation on the island.

In general, there have been several economic plans over the last years in Cyprus to encourage the further utilization of PV systems. The Cyprus Authorities launched the first support scheme in 2010

offering FiT incentives to promote PV penetration and to achieve the 2020 national energy targets. Incentives for small and large-scale PV systems (up to 20 kWp) were the most favourable and led to the installation of 1907 PV systems reaching 43 MWp installed capacity by the end of 2013.



**Figure 30:** Cumulative installed PV power capacity in Cyprus for the years 2011 till the end of 2017 (CTSO, 2018).

The same year a similar scheme was launched, supporting large-scale PV projects of capacity above 150 kWp by means of a competitive bidding process. The first tender was organized by the MECIT for a total capacity of 50 MWp. The high competitiveness of the tender in combination with the overall falling PV system component prices, led to an average tender price of 8.66 c€/kWh. Concurrently, the total PV capacity for installation under FiT incentives by the end of 2016 amounted to 53.0 MWp installed capacity.

The net-metering support scheme administrated by the MECIT under the “Solar Energy for all” program was established in 2013 under Law No.112 (I)/2013. Under this scheme. The installation of residential PV systems having maximum capacity up to 3kWp was allowed. According to the framework amendment released by 2015, the upper limit for net-metered systems has been increased to 5 kWp. This comprised the only available policy framework for residential PV installation in Cyprus and the total approved capacity cap for the year 2015 was 23 MWp. Governmental subsidies were launched for vulnerable prosumers (i.e. low-income families) who could benefit up to €2700 of the total system price in order to promote the further deployment of net-metered PV systems. The favourable conditions of net-metering scheme accelerated the utilization of small-scale PV systems, reaching a total number of installations close to 8000, corresponding to 28.5 MWp of total installed capacity at the end of 2016.

Apart from net-metering, the “Solar Energy for all” policy framework encourages self-consumption, paving the way for optimal integration between PV and energy storage technologies. Electricity Authority of Cyprus (EAC) defined the process of self-consumption allows the transition of passive consumers to active “prosumers”. The scheme allows the installation of grid-connected PV systems of 10-500 kWp with no incentive-based tariffs for any surplus power fed back to the grid. A first amendment of self-consumption policy was released in 2015 where the upper limit of the permitted capacity was increased to 10 MWp and an 80% capacity limit was set. Having in mind the need to encourage self-consumption through storage and increase the system flexibility, the 80% cap can be lifted to maximum peak in case where energy storage is installed. Over all, the total permitted capacity for new installations under self-consumption offered by the MECIT by 2010 was 5 MWp, whilst according the first amendment in 2015 the total limit was elevated to 40 MWp. Despite the governmental attempt to pave the way for energy storage and promote self-consumption, the absence of incentive frameworks coupled with the high cost of storage units has not yet resulted in any storage uptake.

The Feed-in-Tariff (FiT) support scheme promoted the installation of stand-alone and grid-connected PV systems for the first time in Cyprus with two different subsidy schemes having a duration of up to 20 years. Stand-alone PV systems were mainly installed in grid-isolated premises. Due to the high retail price of PV systems in 2010, prosumers under the specific scheme could benefit from 55% government subsidy of the total system cost including storage units, a total amount reaching up to €44,000. On the other hand, the policy framework for grid-connected PV systems was distinguished in two pillars. Specifically, producers could benefit a 55% subsidy (through MECIT) of up to €33,000 along with a FiT of 22.5c€/kWh for any excess PV energy fed back to the distribution grid. On the other hand, producers with no subsidy could receive a higher FiT of 38.3 c€/kWh as the overall PV production was fed back to the grid. Nevertheless, the low cost of electricity generation from PV systems prompted the government to reduce the feed-in tariff and finally eliminate the scheme in 2013. As a result, the net-metering framework as imposed in “Solar Energy for all” by the law N157 (I)/2015, consists of the existing policy for the installation of new PV systems. Grid-connected systems of capacity up to 5 kWp can be installed for three-phase homes and up to 4 kWp for single-phase homes. Moreover, a subsidy of €900/kWp for the first 3 kWp installed PV capacity was granted to vulnerable customers. Under this policy, PV generated energy is directly fed to the distribution grid and a bidirectional meter is placed to account for the imported and exported electricity. The billing period is two months with any excess kWh by the end of it being transferred to the next period up to a year.

The self-consumption scheme was also part of “Solar Energy for all” with the latest amendment published in 2015 to encourage self-sufficiency and promote storage through battery systems. The specific model is because grid parity has already been achieved from decentralized electricity generation of renewables and especially small-scale PV systems. Under grid parity, consumers can

save money by generating their electricity rather than buying it from the grid and high rates of self-consumption and self-sufficiency can result in several benefits for both prosumers and distribution system. The restriction for the total system capacity for each prosumer is 80% of the maximum power demand, a cap that can be exceeded if local storage is installed. Incentives for storage only exist for agricultural application where a governmental grant for up to 50% of the total storage cost is available. For the proposed, new Electricity market rules, storage is expected to play an important role in fading out the various imbalances of the electricity system and it is foreseen that suitable mechanisms will be applied to incentivize storage utilization.

By the end of 2012, Cyprus transposed the recast of EPBD Directive in national legislation by the Law 210(I)/2012, which amended the Law for the regulation of the energy performance of buildings. Based on this new legal framework, the cost-optimal levels of minimum energy performance requirements were calculated and revised, minimum requirements on thermal systems were implemented and measures to promote NZEB have been taken (D'Agostino D., 2017).

In August 2014, a ministerial order was issued defining the requirements that a building must fulfil to be NZEB and the cost-optimal calculation has shown that NZEBs are very close to the cost-optimal levels especially for some types of buildings (D'Agostino D., 2017).

In addition, during the last few years the Cyprus Government has put in place a series of energy efficiency legislations, including requirements for new construction and renovation, which are expected to reduce the energy consumption and overall energy dependence of the country in the forthcoming period (D'Agostino D., 2017).

After transport, the residential and services sectors are the second largest energy consuming sectors in Cyprus at 289.7 ktoe and 199.8 ktoe respectively. Moreover, Cyprus ranks the third most energy dependent EU Member State (D'Agostino D., 2017).

Cyprus is the European country with the higher share of recent dwellings (i.e. built after 2000). However, less than 10% of the residential buildings stock is equipped with wall, roof or basement insulation, while over 50% of the buildings. This makes Cyprus one of the worldwide leaders in this area (D'Agostino D., 2017).

The indicative target set by Cyprus requires that the primary energy consumption in 2020 should not exceed 2.2 million tons of oil equivalent (TOE). The Article 7 of Directive 2012/27/EU on energy efficiency estimates that end-use energy savings of 240 000 TOE should be ensured in the period 2014-2020. Also, in accordance with Article 5 of the above Directive, energy savings of 3.3 GWh per year should be ensured in the period 2014-2020 in buildings used by governmental authorities. Furthermore, Cyprus must ensure that the share of RES in final energy consumption is at least 13% by 2020 (MECIT, 2017).

Under Article 19 of the EED, Cyprus has notified the existence of the Special Fund for RES and Energy Savings (ES), established under the 2003 Law in Encouraging and Promoting the Use of Renewable Energy Sources and Energy Saving (Law 33(I)/2003). The grant schemes offered under the Special Fund support renewable energy and energy conservation measures available to households, public authorities and commercial companies. No specific design parameters for groups that face issues related to the split incentive barrier are currently offered by the grant schemes, so it is not possible to evaluate how successful they have been in practice tackling split incentive issues. Although, property owners can in theory apply for an upgrade of their rental properties, in practice the split incentive barrier remains an important obstacle. Moreover, each beneficiary can submit only one application, which means that landowners will likely choose to upgrade their owner-occupied property before upgrading their rented one. In terms of SMEs, a subsidy can be given to SMEs to upgrade a building that they either own or rent (D'Agostino D., 2017).

### 7.2.3 Bulgaria

Since 2015, the Bulgarian government limited the available renewable energy support to small-scale installations of up to 30 kW on buildings and biomass only. The early achievement of the 2020 renewables target, and the aim to reduce household energy prices, led to this broad phase-out of renewable energy support.

Thus, there is only one compensation policy for small-scale residential PV installations put on practise in the country, namely the FiT scheme. It is a policy mechanism designed to accelerate investment in renewable energy, where small-scale residential and non-residential PV installations are distinguished according to their capacity. Two different FiTs are available for PVs up to 5 kWp and for PVs from 5 kWp up to 30 kWp, with a compensation limit at the total yearly produced energy both limited to 1,261 kWh per kWp installed capacity. Most of the installed residential PV systems in Bulgaria are bound with long-term contracts (20 years) for directly selling and distributing renewable energy into the grid.

From September 2012 to June 2013, the owners of all renewable energy power plants commissioned between 2010 and 2012 were required to pay a grid access fee. Furthermore, in 2014, a fee of 20% of the monthly revenue was imposed. This was later declared illegal, but no back compensations have been provided.

All relations related to the PV systems are governed by the Law on Energy from Renewable Sources (3.05.2011, amended 18.07.2017). The law governs the public relations related to the production and consumption of electricity, heating and cooling energy from renewable sources, as well as biogas, biofuels and bioenergy for the transport sector. Its main goal is to promote the production and consumption of energy produced from renewable sources mainly through development of support schemes and financing project activities.

The State Energy and Water Regulatory Commission is the national regulatory body responsible for determination of preferential prices (Feed-in Tariffs) for the purchase of renewable electrical energy. The current PV FiT prices are set to guarantee each investor an average rate of return of 7%.

The current Law on Energy from Renewable Sources does not recognize energy storage, respectively energy storage systems. It addresses only the generation, purchase, transmission, distribution and taxation of energy from renewable energies, as well sets out the rules and the procedure about accession of a renewable energy production systems. Thus, ESS have not been set in any way in any official document. In addition, the permission process for establishment of any rooftop PV installation in a building already connected to the grid can be obtained only as a backup source. This option requires obligatory physical visits by the distribution company. No any Net-metering or Net-billing have been established in the country.

#### 7.2.4 FYROM

Despite its high solar potential, FYROM currently lags some of the neighbours in the Balkan Peninsula in creating an enabling environment for the deployment of PV systems.

FYROM did not establish the promotion instruments for NZEB retrofitting. The closest to promoting the NZEB are two different programs which promote energy efficiency by retrofitting of domestic buildings:

- **Feed-in-Tariff (FiT) related to renewable energy**

This financial initiative promotes adoption of renewable energy resources (such as photovoltaic generators, wind turbines, hydroelectricity, anaerobic digesters). The initiative is supported by the adoption of the Ordinance for Feed-in tariffs for electricity based on the Energy Law. Afterwards it was upgraded with the Strategy for Energy Development in FYROM until 2030 and the Strategy for exploitation of renewable energy sources in FYROM until 2020.

To increase the electricity generated by renewable sources and to stimulate the exploitation of the renewable potential, the regulation financially stimulates power plants by offering feed-in tariffs. The goal of this regulation is to encourage investments in renewable energy technologies, thus increasing the utilization of renewable energy potential. In line with the sustainable development goals, national targets have been set for the share of energy generated from renewable sources. Therefore, the feed-in tariff has been introduced as a mechanism for increasing the RES generation while ensuring an appropriate return of capital that financially will stimulate the investors. The FiTs in Table 11 have been set by the Energy Regulatory Commission of FYROM.



**Table 11:** Pricing – renewable energy

Category	Feed-in tariff (€cents/kWh)	Valid from
Wind power plants ≤ 50 MW	8.9	17.04.2013
Photovoltaic power plants ≤ 0.050 MW	16	17.04.2013
Photovoltaic power plants > 0.050 MW and ≤ 1 MW	12	17.04.2013
Hidropower ≤ 85,000 kWh	12	17.04.2013
Hidropower > 85,000 and ≤ 170,000 kWh	8	17.04.2013
Hidropower > 170,000 and ≤ 350,000 kWh	6	17.04.2013
Hidropower > 350,000 and ≤ 700,000 kWh	5	17.04.2013
Hidropower > 700,000 kWh	4.5	17.04.2013
Thermoelectric centrals on biomass	15	17.04.2013
Thermoelectric centrals on biogas	18	17.04.2013

The highly efficient CHPs got a granted status for preferential producers of electrical energy (as well as RES producers). They are eligible to apply for feed-in tariffs as well.

- **Renewable Subsidies Scheme (RSS)**

The renewable subsidies scheme is another financially stimulating program. Each year, the Government of the country approves a new program for subsidizing part of the cost for solar thermal panels in residential areas. The subsidies are approved by the Ministry of Economy. The details of the program and the obligations for the households for 2014 are available in the Official Gazette of FYROM (No. 7/2014). To stimulate the use of RES, such as solar panels, the Ministry of Economy issues subsidies scheme for households up to 30% of the purchased value for installed solar panels, for the first 500 purchases of solar panels. Additionally, an amendment was adapted to the Law on Value Added Tax (Official Gazette of FYROM no. 114/2007). This amendment promotes a VAT reduction from 18 percent to 5 percent for thermal solar panel systems and components.

This program has subsidized 2,415 household in the last 7 years and has contributed in the energy savings of around 2,400 kWh/year or 13,344 MKD/year for every household.

The current Energy Law addresses the topic of distributed generation in households. According to Article 37, if a household intends to participate in “electricity of heating energy generation for own consumption, when the relevant energy system is not used” that household is not required to own a license. Therefore, the administrative procedures favour consumers that choose to install PV generators that are not connected to the distribution system.

Evidently, under the current legislation the prospects for grid connected rooftop PV are unfavourable. There is no net-metering or net-billing scheme in place and households are not allowed to connect their PV installations to the distribution grid.

## 8 Analysis of the stakeholders' workshops and targeted meetings

The project aims to enhance the penetration of PV's in the built environment but first we need to alleviate the barriers and pave the way for an unobstructed NZEB development. To achieve the specific objective stakeholders' workshops and targeted meetings in each participating country organized to provide valuable input to the current policies situation in the BM region.

An analysis of these stakeholders' workshops and targeted meetings is presented. Representatives from the DSO, TSO, ministries, energy agencies, regulatory authorities, organizations and associations in the field of energy participated in the workshops and targeted meetings to learn about the objectives of the project as well as to answer important questions about the barriers related to NZEBs and PV integration. Questionnaires were disseminated as well to retrieve valuable inputs and a further insight in the existing regulatory framework in each participating country.

### 8.1 Greece

The way the stakeholders perceive the status, the barriers and the potential regarding the NZEB and PV integration, is expected to greatly affect the development of a regulatory, market and policy framework within which the NZEB implementation could be founded and expanded. The participation of several stakeholders to the national workshop under PV-ESTIA project, gave the opportunity to record their opinion about how they realize the current market status, what are the main barriers according to their opinion regarding the promotion of storage in buildings with PV towards the NZEB implementation, and to submit their proposals to allow the market growth and facilitate the NZEB development.

The list of the stakeholders involved in this procedure included the:

- Ministry of Environment and Energy (Directorates of Electricity, RES, and Energy Efficiency)
- Regulatory Authority of Energy (RAE)
- Hellenic Electricity Distribution Network Operator (HEDNO)
- Centre for Renewable Energy Sources and Saving (CRES)
- Hellenic Association of Photovoltaic Companies (HELAPCO)
- Greenpeace
- Hellenic Federation of Photovoltaic Electricity Producers
- Greek Industrial Development Bank
- Photovoltaic Electricity Producers of non-interconnected islands

Initially, it must be reported that all stakeholders agreed that electric energy storage is a necessary requirement to further increase the penetration of PV systems. Moreover, the general belief was that limited support schemes may be needed for incentivizing the installation of energy storage systems in residential PV applications. Among the most suitable support policies for promoting the penetration of electric energy storage systems in buildings were reported to be the low interest loans and after that the provision of tax exemptions.

Based on the answers in the completed questionnaires by the stakeholders, the first and most important barrier for the widespread of energy storage in PV installations in buildings was reported to be the high capital cost of the energy storage system. High importance was given also to other costs like the need to replace battery system more often than other PV system parts (panels, inverter, etc.), since this reported difference could not allow the installation of PV system along with storage to be fully considered as a joint investment. Lower importance was assigned to the lack of a clear and specific regulatory approach to energy storage, to the considered complicated, expensive, and uncertain process for the installation of energy storage in PV systems, and to the lack of appropriate recognition/compensation for the benefits that a storage system can provide to the grid. Although the stakeholders recognize the impact of these three factors to the development of the PV and storage in buildings towards the NZEB implementation, they do not think that they constitute insurmountable barriers. Finally, the lack of markets or inadequate market design along with the increased bureaucracy that could lead to longer licensing times, are not perceived as serious barriers that could not significantly delay the widespread storage penetration in buildings with PV already installed.

When the stakeholders were asked to prioritize various billing schemes according to their suitability for application to prosumers with PVs and storage, the PV producers stated that the full Net-Metering coupled with Time of Use scheme was the most favourable. Also, the Increased FiT compared to non-storage PV system owners and the partial Net-Metering/net billing gained the attraction of almost half of the stakeholders. The other schemes, like pure self-consumption without compensating excess energy to the grid and self-consumption with compensation for excess energy to the grid was not favoured. Finally, one of the basic concerns was related to the basic role of the storage systems and the potentials of alternative ancillary services. The contribution of storage systems to the increase of self-consumption along with peak shaving were found as the most important roles, while less importance was assigned to energy arbitrage and ancillary services (e.g. voltage support, frequency regulation).

It is worth mentioning that some questions raised by the Regulatory Authority of Energy (RAE) constitute important issues that should be considered before the regulatory and legislative framework regarding the building storage system installation is finalized and released. These questions are summarized as follows:

- Will the storage systems (i.e. battery) absorb energy from the grid?

- Will energy be injected into the grid from the battery? Will this be a maximum power limit?
- Will consumers with storage systems be compensated if they offer power quality and local back-up services?
- Should the pricing policy on regulated charges change?
- What about Demand Side Response mechanisms and distributed storage to provide ancillary services through dynamic pricing and other financial incentives?
- Is there a need to promote the development and installation of smart meters for the participation of prosumers in the wholesale energy market?
- Should special treatment be considered in isolated systems?

Such questions remain open for discussion among stakeholders and policy makers in Greece. The finalization of specific targets for RES by 2030, and the extensive dialogue that has already started, will provide answers to such questions. PV-ESTIA comes in the correct time in this discussion, and the findings will provide valuable insights to policy makers.

## 8.2 Cyprus

An international workshop as well as targeted meetings with important stakeholders of Cyprus were organized and provided valuable input for the further deployment of the project. The project's targets, challenges and opportunities were presented to different stakeholders and to the PV and grids community. In addition, feedback was received about the barriers, which may affect the penetration of PV systems in the built environment of the BM region. This feedback was obtained through a questionnaire that was effectively disseminated to several attendees to retrieve useful data of how to tackle the barriers of energy storage systems (ESS) increased penetration as well as through the Q&A section of the workshop.

The participant list includes representatives from the Scientific Community, the Distribution System Operator in Cyprus, Universities and Private Companies, the Cyprus Regulatory Authority of Cyprus, Technical Staff of the University of Cyprus and other interested parties.

It was clearly pointed out that photovoltaic technology with storage is an important part of the evolution of the NZEBs. However, there are several constraints that must be addressed. It is also undeniable that there is not enough knowledge about the stress real building with PV and storage systems impose to the electrical grids. Moreover, regulatory authorities must design policies considering macro-economic implications in the interests of both the consumers/prosumers and PV companies as well as the DSO.

An important barrier that must be considered is the high initial and future running costs and lack of capacity for example of the special equipment and expertise that offers PV and ESS installations

opportunity as well as after sales maintenance. Information workshops to the public, architects, civil and electrical engineers regarding NZEBs, PV and ESS would enhance storage penetration in buildings with PV.

In addition to the necessity of building information campaigns, designing policies, the high initial and future running costs of the ESS, another important aspect is the necessity of examining the size and characteristics of the battery and its life cycle as well as the environmental consequences of the excessive use of PVs and especially batteries area after some years. The importance of focusing on barriers of joint PV-storage and not on PV barriers only was also mentioned by several parties.

Regarding the benefit from forecasting capability, this is subject to the available tools at residential and grid-level storage systems. Moreover, extensive knowledge of the market products is required to mark the constraints of existing battery technology.

Interesting though is the answer of the representative of the Ministry of Energy, Commerce, Industry and Tourism of Cyprus about the definition of an NZEB. It stated that the NZEB definition given by the Ministry is based on national methodology for calculating energy performance of buildings. This methodology calculates energy performance of building on annual basis and it does not consider the time of electricity produced or used. As a result, buildings are not credited for storing electricity produced from RES. This applies probably to all Member States as national methodologies are based on a set of CEN standards issued to better implement the EPBD. Thus, including storage in NZEB definitions requires as a first step a methodology that will give credit to buildings that use batteries combined with PV or CHP. Further steps are to reexamine support schemes for electricity production i.e. net-metering, regulatory regimes, the capabilities of the grid and the cost benefit analysis. Storage is going beyond the requirements of EPBD, which only promotes energy efficiency of building, while storage (in very energy efficient buildings) promotes “autonomous energy buildings”, which sounds ideal if other infrastructure is available i.e. smart grids, smart buildings, and electric vehicles charging points. Finally, they believe that a minimum of self-consumption requirement to be imposed to an NZEB definition without considering the above will be of no benefit.

Our research also showed that academia and industry must collaborate to disseminate the concept of NZEBs with storage systems to the public, scientific community and more importantly to the RES companies. The staff of these companies is important to participate in local workshops, trainings and conferences organized by the research and academic sector to communicate the idea of the project and the main conclusions retrieved as soon as the pilot systems are tested thoroughly and gain the technical expertise, which is important for the installation as well as for the maintenance of the batteries. Finally, the investment on storage systems needs the introduction of incentives such as ToU tariffs, rewards from the ancillary services that a battery will offer and financial aids since the high initial costs of the batteries are high.

Many people consider electric energy storage as a requirement to further increase the penetration of PV in our country. The majority of the people asked are not aware if there are any incentives regarding electric energy storage systems installation alongside PVs for private investors. In addition, support schemes are needed for incentivizing the installation of energy storage systems in residential PV installations.

The questionnaires analysis revealed that direct subsidies for the installation of electric ESS and tax exemptions are the most suitable support policies for promoting the penetration of the ESS in buildings. Moreover, peak shaving ancillary services and especially incentives of self-consumption are important for the ESS in buildings with PVs. It is obvious that the lack of a clear and specific regulatory approach to energy storage, the high capital cost, the lack of appropriate recognition/compensation for the beneficial services that a storage system can provide to the grid and lack of markets or inadequate market design are the most important barriers for the widespread of energy storage in PV installation in buildings. Finally, it seems that the billing scheme most suitable for application to prosumers with PV and storage is the net-metering coupled with ToU tariffs and the least preferred is the increased FiT compared to non-storage PV system owners.

### 8.3 Bulgaria

The main conclusions of the stakeholders' workshops and targeted meetings are the following:

- General harmonised regulations on EU level are missing

The distribution grid system will require more flexibility if higher shares of renewable energy are integrated and energy storage is one of the available flexibility options. However, the present situation discourages potential investors because there is uncertainty with respect to the future development of energy systems and European market design. Definite regulations are needed that specify questions of ownership of storage and taxation.

*A harmonised way across the EU on how to adapt energy storage system schemes in a way that energy storage at end-user level is stimulated by the EC is recommended.*

- Definite energy storage regulations and policies should be introduced

Energy storage and energy storage systems are a new innovative technology, not yet proven among policy makers, design engineers, construction and engineering companies and to individual households. Energy storage and energy storage systems are not defined, neither stimulated in anyway in current legislation. *Definite storage regulations are needed that specify questions of ownership, taxation and implementation.*

- Policy makers are not aware of energy storage

Policy makers and regional authorities have very important role in raising awareness of the importance of integration of PV-and-storage in buildings, as a step that helps to reach long-term RES targets. However, due to the innovative aspect of the energy storage technologies and especially PV coupled with ESS, their awareness on the topic is quite limited. *There is, therefore, a need to ensure that national and local public representatives are fully informed about benefits from*

*coupled PV + ESS and are fully committed to take the expected lead in shaping a positive intelligent energy future. This can be done through demonstration projects.*

- Low penetration of household PVs in general

Currently the total residential capacity of all PVs up with installed capacity up to 30 kWp equals to 3,69 MW, which represents less than 0,01 % from the total capacity installed in the country. This is extremely low number and one of the main reasons is that residential PV systems can be financially supported only through only scheme - the FiT scheme. However, the scheme is introduced in a way that doesn't stimulate investment. The strong limitation of support for renewables has led to a standstill over investments since 2012.

Residential PV systems should be stimulated in a better way, preferably through delivering new market adequate schemes.

- Low electricity costs for households

In general Bulgaria is among the EU countries with the lowest electricity prices for residential users, where there are only two tariffs available - daytime & night time tariffs. The average electricity price in 2016 in Bulgaria is considered 0,0956 euro/kWh, compared to an EU average price of 0,240 euro/kWh. Thus, the low electricity prices compared to the high investments currently required for implementation of PVs are making them still unattractive solution. *This, coupled with the non-working PV schemes available, represents one of the major barriers in PVs and PVs+ESS penetration in the country.*

- Storage is economically not attractive option for households

Although energy storage enables the optimisation of production and consumption 'behind-the-meter' (storage could increase the percentage of self-consumption of locally produced power from some 30% to 65-75% for households), and also lowers household electricity bills by avoiding electricity supply, transport fees and taxation for electricity, there is currently no "real value" for Bulgarian prosumers as proper mechanism for facilitating increased self-consumption are missing. This is also due to the high investment costs required for deployment of PVs coupled with energy storage and due to the low electricity costs currently marketed.

- There are no incentives for stimulating energy storage or increased renewable self-consumption

At current stage of the art the deployment of storage in households is strongly connected with direct financial support or other financial mechanism. However, large numbers of end-users turning to self-production and local storage could result in load defection or even grid defection, however this could seriously affect the revenue models of network operators and traditional power generators. *Thus, schemes for renewables in such a way that energy storage at the end-user level is stimulated are required. Currently there is also lack of appropriate compensation for the beneficial services that a storage system can provide to the grid.*



- Avoiding restrictions to renewable energy self-production restrictions

Avoiding restrictions of any kind to renewable energy self-production and consumption with or without decentralised storage and establishing simplified authorisation procedures for small-scale renewable energy projects with or without storage components should be targeted.

- General NZEB uncertainty

There is general uncertainty, due to the innovative aspect of the scheme, which renewable technologies will be facilitated in order a building to meet the 55 % renewable goal set in the NZEB definition. Firstly, there is uncertainty on how the market will prioritize the renewable technologies to be implemented in order a building to become NZEB in Bulgaria. Bulgaria is characterised as a country where the largest share in the building consumption represents the heating (usually the dominance of the heating varies between 40 to 50 % of the total energy consumption of a residential building). The NZEB definition is designed in a way that if solutions like biomass boiler and/or any type of a heatpump (A2A, A2W, W2W) with SCOP higher than 350 (also considered as a renewable energy source within the national legislation) are implemented, these would practically cover most of the renewable energy share required by the current NZEB legislation. Another possible renewable interaction/ measure would be solar thermal collectors for DHW. An example for an already realised nZEB solution (good practise) is published on the BuildUp portal (BuildUp, 2015). The case study is the University Research Centre at the Technical University of Sofia, where a VRF/VRV heatpump with COP = 4 (or similar) is realised and some measures are applied to the building envelope. The good practise case concludes that with the VRF/VRV system the building is provided by 63% renewable energy of its final energy consumption and is already considered as NZEB. *Such solutions, as shown with the example above, and/or combination of solutions in the design of a NZEB building would significantly decrease the necessity and the capacity of any PVs, unless proper legislation facilitating PVs is introduced. Thus, considering the possible resistance of suppliers/builders and building managers to change the local building tradition and unless proper regulations containing targets for minimum share of renewable electricity are implemented, PVs will most probably remain out of the scope of the NZEB designers, at least for the few first years.*

Moreover, currently there are no strict regulations on the verification procedure if the buildings really meet NZEB criteria once established and under operation. Some technical calculations are only made on design stage and after implementation of the building, where the technical designer is setting some cumulated values for SCOP and SEER of the heating/cooling systems, but no further control or measurements are implemented. Thus, stricter policies and measurement about if the building really meet NZEB criteria should be implemented into the national legislation.



It should be also noted that public institution, as they have been given the chance to be the first to apply the NZEB rule, should be the facilitators of the green solutions in the building environment and thus pave the way towards good examples of NZEB buildings.

## 8.4 FYROM

In order to address how stakeholders, perceive the barriers related to NZEB and PV integration four meetings were organized. The targeted national stakeholders were the Distribution System Operator (DSO) EVN Macedonia, the Transmission System Operator (TSO) MEPSO, the Macedonian Academy of Sciences and Arts and the Municipality of Karposh. In addition, a workshop focusing on the policy barriers and opportunities related to NZEB and PV+ESS integration was organized on 11.4.2018. Representatives from academia, industry, municipalities and financial institutions attended the workshop and contributed to the discussions.

For instance, DSO expects the energy storage to enhance the penetration of PV's in low voltage networks, especially if it is used primarily for increasing the self-consumption of prosumers. Nevertheless, a detailed analysis is needed in order to determine the optimal storage capacity in the network, as well as its economic and technical feasibility. It is the opinion of the DSO representatives that there is an opportunity for allowing batteries to discharge in the grid, if it partly reduces investments in the grid and increases the efficiency of the system, thus providing maximum benefits for the grid and consumers. That cannot be accomplished without technical and regulatory barriers however. The existing meters are not fully capable of meeting the technical requirements of TOU tariffs which creates a significant barrier for the widespread of TOU tariffs. A definition of the most appropriate tariff design providing fair treatment of consumers and enabling System Operator to recover costs is always a challenge. Under volumetric grid tariffs, as is the national case, prosumers with PV+ESS would pay less for the final grid costs since they consume less electricity. Hence, it might be argued that they will be cross subsidized by other consumers. Partly supplementing volumetric tariffs with capacity-based tariffs was proposed by the DSO as a possible solution to this problem. In accordance with the proposal for the Directive of the European Parliament and the Council on common rules for the internal market in electricity from the European Commission, from 23.02.2017, especially article 36, the Distribution System Operator shall not be allowed to own, develop, manage or operate energy storage facilities. However, Member States may allow DSOs to own, develop, manage or operate energy storage facilities if several conditions are met:

- Other parties, following the transparent tendering procedure, have not expressed their interest to own, develop, manage or operate energy storage facilities,
- Such facilities are necessary for the DSO to fulfil their obligation under the Directive for the efficient, reliable and secure operation of the distribution system,

- If the regulatory authority has assessed the necessity of such derogation considering that first two conditions it will issue its approval.

By the opinion of the DSO, if storage facilities are introduced, the ability to own, develop, manage or operate them should be granted to the DSO, at least in the beginning of their implementation, in order to enhance and support their further development. At the same time, it has to be assured that allowing such possibilities must be in compliance with the unbundling requirements.

The Transmission System Operator MEPSO did not reflect on the technical aspects of integrating PV+ESS in buildings. However, the importance of storage for integration of variable renewables was discussed. MEPSO has conducted a study for the integration of renewable energy sources showing that the frequency and power regulation could be improved. It currently purchases ancillary services from the national electricity generation company ELEM by paying a fixed amount regardless of whether the services are provided. Additionally, it does not monitor the realization of these services. Furthermore, not all actors in the electricity sector are held responsible for causing imbalances. With the aim of improving the balancing mechanisms, storage facilities and virtual power plans might play a role in the future. On that account, possible synergies with MEPSO exist, having in mind their active participation in other ongoing research on storage and TSO interaction.

The Research Centre for Energy and Sustainable Energy of the Macedonian Academy of Sciences and Arts (MASA) has worked on several national strategies in the field of energy and has extensive experience with energy modelling. According to its representatives, there is a low likelihood of integration of substantial energy storage behind the meter. It was argued that under a net-metering or net-billing scheme battery storage is economically infeasible, if no additional revenues are provided to the prosumer. This does not imply that storage cannot play a role in future energy systems. However, it would currently make more sense to tap into the potentials of energy storage integration and utilize other forms of storage, generally on a larger scale. The coordination of centralized larger storages would be easier than that of distributed battery units. One option is large scale thermal storage, since the unit costs of thermal storage are significantly lower than those of batteries. Moreover, it was argued that it is more efficient to regulate the balancing of variable renewables through market mechanisms and by providing “virtual storage” to consumers, as is the case of the supplier E.ON.

The Municipality of Karposh is considered a pioneer for supporting energy efficiency and for integration of renewable energy in buildings. The office building of the Association of the units of local self-governments (ZELS), which has implemented a PV and storage system, is located in the Municipality of Karposh and the energy efficiency department of Municipality of Karposh has offices in ZELS. From their point of view, storage is technically beneficial for increasing self-consumption. In their opinion, there should be a national subsidy scheme for supporting the

deployment of rooftop PV, ideally in the form of a fixed grant. Although batteries are expensive, the national legislation needs to create an enabling environment for prosumers by further reducing administrative procedures and introducing one-stop shops for all necessary documentation. In addition, Municipality of Karposh states that public institutions should lead the way by transforming their buildings into NZEBs, not only as a good practice, but also as economically efficient solution.

The workshop on the policy barriers and opportunities related to NZEBs and PV+ESS integration provided extensive debate on the topic, but also broadened the discussion to the cost-effectiveness of hybrid PV and solar thermal generators. The following barriers were identified:

- High cost of battery technology;
- No appealing services for storage to the grid;
- Lack of a definition of nearly zero energy buildings (NZEBs)
- Cross subsidizing prosumers because of volumetric grid tariffs;

To summarize, the country is in the early phase of adopting PV generation in buildings and has a long transition ahead. The dramatic reduction in investment costs have contributed but are not enough to stimulate the adoption of PV integration in buildings. That is why changes in the national legislation are necessary. Most national stakeholders agree that a net-metering scheme would be most financially encouraging progress for prosumers. As the penetration of PV increases, the problems that the DSO faces when assuring a safe and reliable system operation will increase as well. In order to reduce the stress that distributed generation creates to the grid, a maximum installed capacity of the generators should be defined. However, in cases of significant PV penetration, energy storage systems could play an important role by making buildings with PV more grid friendly. In addition, the national legislation needs to accommodate a more elaborate definition of energy storage in the electricity sector with a focus on energy storage behind the meter, its role and the services that it can provide.

## 9 Barriers and challenges related to NZEBs and PV integration in Balkan Med area

The Balkan Med (BM) region is facing the challenge of sustaining and increasing the growth of PV systems that is endangered by several barriers and their unpredictable nature especially in the built environment.

### 9.1 Greece

The first and one of the most important barriers refers to the lack of a legislative and regulatory framework since it makes quite difficult to estimate the feasibility and sustainability of relative

investment plans. Moreover, the lack of a national strategy to create an infrastructure for NZEB implementation fails to contribute to NZEB development. Local authorities are not in so close contact with research centres and universities to understand in depth the NZEB concept and their implementation requirements. Thus, many building professionals could be considered not fully qualified to lead the NZEB implementation process from the initial stage of design to the final of construction to meet the expected market demand. The market penetration for technologies and products used in NZEB for each country is relevant to the numbers of qualified NZEB professionals and accreditation schemes in place. The general training courses for energy auditors in the country may not be enough to meet the needs for skilled engineers in the NZEB sector, so it is expected that new training courses, focused on NZEB design and retrofit, will be offered by academic institutions or Vocational Training Centres. Thus, the gaps between current educational NZEB related programs and market requirements exist and they should be filled to facilitate NZEB efficient development.

Additionally, one basic problem is that until now no indicators for the use of RES in NZEB are set in Greece. The Greek Regulation for Energy Efficiency of Buildings, issued as the Ministerial Decision Official Gazette Bulletin B' 407/09-04-2010 defines 4 different climate zones (A, B, C and D) based on heating degree days (HDD) dividing the country in 4 regions. Climate Zone A corresponds to regions in South Greece, whereas Climate Zone D to regions in Northern Greece. The other 2 regions are classified respectively to Climate Zone B and C. The status of NZEB adaptation in Greece is at an early stage and currently there is no definition of NZEB Standard in Greece. Thus, no performance thresholds and concrete definitions for NZEB are set. In central/southern Greece, it is most likely that the heating demand is relatively low in NZEB compared to the cooling demand due to country's climate (Shady, 2017). The minimum energy efficiency threshold regarding NZEB has not yet been defined while no thresholds have been defined for CO<sub>2</sub> emissions as well. The construction guidelines and the full renovation of existing buildings are developed based on European standards. They are defined in the Regulation for Energy Efficiency of Buildings, which was issued in 2010. The respective legislation on thermal comfort is based on the European standard EN 15251, which includes the adaptive comfort model for the design and construction of NZEB. The comfort levels as defined by the respective legislation in Greece concern the combination of temperature and relative humidity during summer and winter time. The levels are different based on the use and function of the building (Shady, 2017).

Due to solar irradiance values, solar energy dominates, and it is considered as the most effective RES technology. However, the main barrier that could enable higher penetration of PV systems in urban areas is basically the lack of space for solar access; especially in multi-family buildings. A major concern for the development of NZEB in Greece is the construction quality, while the construction material market lacks high-tech components and new construction technologies. More importantly, building professionals lack the know-how of the design and construction of

NZEB [1]. If the latter is combined with the limited storage technology market in Greece, then the development of NZEB is subject to relative barriers. This is due to the fact that NZEB concept is, or should be, related to storage solutions implementation along with RES utilization.

Another crucial aspect is in direct relation with the economic recession and the problems in the banking sector that deprive the market of the financial tools and means which could allow investments in new technologies towards the widespread development of NZEBs. Fear of investment costs upfront combined with unforeseen costs and problems with financing an energy efficient building project are viewed as barriers as well. A national strategic plan under financial or other kind of incentives (such as “Exikonomo” programme) could initially boost the whole effort for NZEB development across the country, while the government and public buildings should be considered the pioneers towards this direction. Recently, such a program was launched, i.e. the Home Saving Program II, and is currently running considering the integrated energy saving intervention in the residential building sector.

For the private building owners, the availability of economic incentives or flexible financial tools are highly welcomed and appreciated. For example, the large subsidies along with the high feed-in tariff rates in the recent past facilitated the PV penetration and the respective national targets were easily and quickly met. Therefore, policy makers should adapt to the current economic situation and focus on raising public awareness for private investments by the public that are related to environmental concerns and sensitivities.

A usual barrier that is related to all new and innovative ideas and technologies refers to lack of proper knowledge and amount of information about the advantages of these new ideas. For example, energy storage technology and its advantages have not been sufficiently known to public. People should more easily embrace innovative technologies that contribute in energy savings and fall in with their environmental sensitivities and concerns because that way the willingness to support and participate will increase. For example, the public do not know what the storage of electricity is or is not enough aware of available storage technologies, recent technological achievements, but also the multiple benefits that can be derived by them for the energy system. This can prevent timely and efficient design and development of the necessary storage units, causing considerable delays in achieving the objectives of high penetration and participation of varying generation of RES (wind, photovoltaics) in the system. Moreover, special attention should be given to analyze the potential ancillary services that could be provided under high storage penetration in NZEB. The latter could facilitate the integration of storage technology within the NZEB context since the related ancillary services could be somehow compensated.

## 9.2 Cyprus

To begin with, to alleviate the barriers and enhance the penetration of NZEBs we should consider the challenges in relation to the decision-making process towards NZEBs. Firstly, existing building

structure and technical system limit the choice of technical solutions that can be used but where technical solutions can be found, they are often costly and not financially viable. The investment cost of a nearly zero energy building or to renovate a building to nearly zero energy performance is too high. There is lack of knowledge and interest for energy efficiency among residents and building owners, often due to lack of awareness combined with challenges with architectural and cultural values. From the environmental point of view, we should introduce criteria for materials and waste and the mix between comfort and efficiency. Finally, the ownership structure and need for consensus among several homeowners can hinder NZEB renovations (D'Agostino D., 2017).

A disconnection can be identified between developing innovative technologies from the building industry and the lack of take up due to budget constraints. Awareness of how users consume energy in residential buildings should be increase. Furthermore, it is widely recognized that energy targets are challenging for cultural and historic buildings (D'Agostino D., 2017).

The continuously increasing PV penetration in the energy mix combined with the intermittent nature of RES impose significant challenges to the electricity system operation. The adoption of new technologies is urgently needed to achieve further RES deployment and eliminate the barriers related to grid stability. Energy storage is considered as a technology that will bring higher rates of self-consumption from RES electricity and potentially solve the issues related to high PV penetration. However, technological and safety issues arise with the integration of ESS to the distribution grid. In addition, the lack of financial compensation mechanisms along with high capital costs are the main obstacles to ESS deployment (Kempener R., 2015).

In relation to NZEBs renovation, the existing building structure sets limits to what extent the existing technical solutions can be implemented. This limitation is more relevant where the architectural value of the building needs to be conserved, making the retrofit processes more challenging. Moreover, existing technical solutions for NZEB are perceived as expensive adding to the main financial challenge of having high investment in NZEB renovation projects. A return of the investment appears often as difficult apart from considering savings through the life-cycle of the building; in this case the initial investment costs are lower than those of the overall operational costs. The payback period for NZEB renovation may take between 15 – 30 years and often residents do not benefit from this payback period. Furthermore, a landowner cannot, or do not want to, raise rents and becoming uncompetitive in the market as the difference between non-NZEB and NZEB is not considered by the tenants (D'Agostino D., 2017).

It is also usual that lack of knowledge about NZEBs renovation is spread among professionals and residents. Communication of best practices in NZEBs renovation is important to increase the knowledge among professional and public in general on energy efficient renovation and technical solutions. A follow up is important to ensure that residents use buildings. Communicating with

residents and end-users has been noted as important. End-user behaviour after a completed renovation is also a challenge in the retrofitting process (D'Agostino D., 2017).

There is also need of specific retraining for the experts already authorized to issue Energy Performance Certificates (EPC), to tackle the new challenges that may arise with the introduction of NZEBs. This is a specific issue within a more general challenge on developing training modules and programs focused on NZEBs. The retraining of qualified experts recognized based on Directive 2002/91/EC to make them sufficiently trained to interact with owner, to deal with real energy consumption and to make reliable recommendations for energy efficiency investments is needed as well. This must be importantly considered since it is part, together with information and dissemination activities, of a broader and more ambitious goal of knowledge and capacity building, which goals to link the experts' training with the public in general (e.g. building owners), public authorities and other relevant stakeholders not directly involved in the construction process.

Another point of weakness is the lack of employers' engagement in the education of students and professional training course. The economic crisis and the slowdown in the construction area contributed in a negative way this aspect. The Cyprus economy and the build sector specifically consists predominantly of small and medium-sized and micro-enterprises for which providing work-based learning and apprenticeships to students of vocational education and training programs is challenging. The same applies to many self-employed in the construction sector, which have very limited, if none, subsidies for the cost of their training and specialization. In a time when also public finances are constrained, the most important training programs developed and implemented are those financed through European funds (D'Agostino D., 2017).

Regarding the financial barriers, public authorities have a leading role in setting up financing schemes for the national or local contexts. The level of ambition of financial programs rises to have greater impact and unlock further private investment for NZEB renovation. Legislation and financial incentives have a strong influence in developing NZEBs projects. Finally, communication and information between involved actors and organizations of the renovation project, as well as with the residents, are among the factors that can provide a successful NZEB renovation (D'Agostino D., 2017).

The further unobstructed deployment of RES poses many technical barriers as well. Firstly, the variable and intermittent production of RES makes planning and dispatch of energy a very difficult issue to be dealt with. An ideal solution is the utilization of energy storage to eliminate the barriers related to higher RES share. The deployment of storage focuses on balancing the variable generated electricity from RES depending on its allocation level, which can be either centralized or distributed. It is considered as the major element able to provide the desirable flexibility and reliability to the electricity system. Although, different energy storage technologies have developed rapidly over the last years, the electrochemical; battery solution is emerging as one of



the fastest growing storage technologies for grid-connected applications. Storage is extremely important in the proposed energy transition, which offers suitable services for several applications such as utility scale and households. On the contrary, the most significant barrier for electricity storage is its high unit price and the lack of suitable financial compensation schemes. Thus, there is a huge need for important investments in innovation to obtain important cost reductions.

To conclude, there is an urgent need to alleviate the barriers and enhance the penetration of PV's in-built environment through the developing of a sustainable management scheme that will render PV-ESS systems as a viable and cost-effective solution.

### 9.3 Bulgaria

The first and important barrier for the further enhancement of coupled PV and ESS in NZEBs is that there is only one scheme available for facilitating PV residential installations – the FiT scheme. Currently two different FiTs are available for PVs - up to 5 kWp and from 5 kWp to 30 kWp, with a compensation limit at the total yearly produced energy both limited to 1261 kWh per kWp installed capacity. Although, residential PV systems in Bulgaria, part of the FiT scheme, are bound with long-term contracts (20 years), they are considered with low Internal Rate of Return, as their payback period is estimated for at least 10-12 years. The scheme has been established in such a way that doesn't encourage small scale PV projects to be implemented. Finally, since energy storage infrastructure remains in a conflict with the scheme a design of a proper new scheme is highly recommended and required.

In addition, household PV implementation is accompanied with bureaucratic and time-consuming procedures. In order a household to implement a residential rooftop PV system it should meet a number of national requirements and also clear a number of procedures before actual pilot implementation takes place. An important step in the process represent the DSO application procedure, which aims to examine the accession conditions of the requested PV system. The final decision, where a PV system would be able to be implemented or not, not matter its size, ability to charge or discharge energy to the grid, relies on the DSO side.

All required steps to be implemented before installation process are described below:

1. Pass Law on Condominium – obtain documented approval from other condominium owners within the building stating that owners of at least 50 % of the ideal parts of the building agree on establishment of a PV installation
2. Implement a DSO application in order to examine the conditions for accession of the requested PV system – the application briefly describes the project concept and includes number of documents
3. Obtain official construction assessment stating that the building will withstand the load that has to be implemented



4. Technical design project of the planned PV system
5. Building permission application and official construction permission from the Regional municipality and Installation implementation.

Another important step is to avoid restrictions of any kind to renewable energy self-production and consumption with or without decentralised storage and establishing simplified authorisation procedures for small-scale renewable energy projects with or without storage components should be targeted as a national legislation.

Moreover, the current Law on Energy from Renewable Sources (3.05.2011, amended 18.07.2017) doesn't recognize energy storage, respectively energy storage systems. It only addresses the generation, purchase, transmission, distribution and taxation of the renewable energy, as well as the accession rules of an energy production system. The official legislative recognition and definition of the ESS is an important first step. *Although, there is no law prohibiting Electric energy storage in buildings with PVs, however there is also no clear signal whether is permitted.* There is no framework for rewarding potential contributions from storage to system stability. There is also lack of a clear and specific regulatory approach to energy storage

Finally, energy storage is an alternative to provide more stability, reliability and resilience to transmission and distribution grids. The use of storage by grid operators is not allowed at present because unbundling requirements do not allow transmission and distribution operators to directly own or control energy storage infrastructure. Thus, the position of storage in different steps of the electricity value chain should be clarified to allow transmission and grid operators to invest, use and exploit energy storage services for purposes of grid balancing and other ancillary services.

## 9.4 FYROM

The current Energy Law of the Republic of Macedonia (Energy Law (Official gazette of Republic of Macedonia No. 16/2011, 136/2011, 79/2013, 164/2013, 41/2014, 151/2014 and 33/2015), Ministry of Economy of the Republic of Macedonia - in Macedonian) and the national legislation of the Republic of Macedonia still hasn't introduced the definition of nearly zero energy buildings (NZEB), neither the numerical requirement for the mandatory share of RES concerning NZEBs. Therefore, the NZEB targets are not compulsory, because there is no transposition of NZEB definition in the national legislation and Macedonia have not specified numerical requirement for mandatory share of RES concerning NZEBs. The national definition of NZEB is not introduced in the existing Energy Law of the Republic of Macedonia and the national legislation of the Republic of Macedonia. The Rulebook for Energy Performance of Buildings, Article 136 although already put in to law, does not mention the NZEB definition. Therefore, no targets are set for having buildings with almost zero energy consumption.

For instance, the current Energy Law of the Republic of Macedonia, actively in power since 2011, only slightly and indirectly addresses the topic of rooftop PV installations. According to Article 37, if one intends to participate in “electricity of heating energy generation for own consumption, when the relevant energy system is not used” he is not required to own a license. This shows that the administrative procedure is in favor of those who choose to put up an isolated PV installation and, surely enough, should not be considered an enabling mechanism for rooftop PV installations.

Another factor that has contributed to this state is the lethargic attitude of the DSO with respect to the support of rooftop PV. As indicated by the interviewed representatives from the national DSO in the study Net Metering in the Republic of Macedonia, Possibilities, Perspective, Examples – Pathways to Cleaner Energy, the main concerns for allowing the connection of PV installations on building to the distribution grid are disturbances in the power quality, the effects of the policies and mechanism on the electricity price and potential problems with balancing as the load covered by the suppliers in Macedonia is not big enough to cancel out abrupt changes in demand or production. They, nevertheless, state that net-metering policies would be effective only in a fully liberalized electricity market.

Finally, although there is significant solar potential, the low electricity price for households is a barrier that slows down the uptake of rooftop PV installations. As the electricity market is not been liberalized, households are regulated consumers subject to a two tariffs billing scheme. The low tariff of 4.52 €cents/kWh is effective in the periods of 14:00 – 16:00 h and 22:00 – 07:00 h in work days and for 24h in Sunday, while the high tariff of 9 €cents/kWh is valid for the rest of the time. These values do not include VAT of 18%.

## 10 Policies and measures for the promotions of NZEBs in new buildings and buildings undergoing major renovation

Since NZEBs are a brand-new concept not only for professionals in the building industry but for building owners, both in terms of design and construction as well, most Member States did not describe in a detailed way policies and measures that would lead to enhance NZEB penetration in the built environment (D'Agostino D., 2017) (MECIT, 2017). However, apart from the minimum energy performance requirements, further measures are also required to improve the skills of building designers and developers and to introduce NZEBs to the public. Therefore, it is important to increase NZEB-related awareness among professionals and consumers through incentives, training measures, information measures and research programs (MECIT, 2017).

The best practices for the transformation of the existing building stock towards NZEB include technology awareness, incentive schemes, financial instruments, taxation mechanisms. Among the economic instruments are energy saving obligation schemes, market instruments such as public

private partnerships to stimulate building renovation or one-stop solution centres giving advice on energy renovation (D'Agostino D., 2017).

In most Member States a wide range of policies has been selected to increase NZEB penetration (e.g. awareness raising and information, education and training, strengthening building regulations and energy performance certificates, chose by Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, Poland, Portugal, Sweden, Slovenia, United Kingdom). However, policies sometimes seem rather general and addressed to “all buildings”. Their specific support to NZEB is not always sufficient clear or to what extent they contribute in practice to achieving the NZEB target in a country. Therefore, a stronger connection between policies, measures and NZEB is recommended. Reported policies appear in line with the EPBD requirements, but rarely do these legislative and normative measures explicitly refer to a clear definition of an NZEB renovation (D'Agostino D., 2017).

Restoration into NZEBs means a restoration of a magnitude that allows the meeting of NZEB energy performance requirements. This does not prevent having different timelines and financial support for existing buildings, in recognition of the longer period required for NZEB levels to be cost-optimal in the case if existing buildings (D'Agostino D., 2017).

The following aspects are identified as crucial in the transition toward NZEBs, both for all new buildings to be NZEB by 2020 and for increasing the number of buildings that are refurbished to NZEB:

1. Design of financial and other incentives
2. Identifying regulatory and non-regulatory barriers and ways to overcome them
3. Information to consumers and stakeholders
4. Training of professional of the building industry

JRC has addressed the following points which were translated into sub-activities:

1. Analysis of existing financial incentives for the NZEBs
2. Identification of the regulatory and non-regulatory barriers for the transformation of the building stock towards NZEBs, including the assessment of the barriers for the adoption of renewable energy sources in buildings, and proposal for policies and measures to remove these barriers
3. Identification of stakeholders relevant to the transition toward NZEB, preparation of communication and dissemination material for effective information to the stakeholders about the concepts, cost and benefits and technologies related to NZEBs
4. Support for the training of the professional in the building industry and identification of the main training needs in the Cyprus construction industry.

After the first phase of the BUILD UP Skills Initiative, a comprehensive Intelligent Energy Europe initiative to increase the number of qualified workers in the building workforce in European countries, some specific training programs and schemes have been developed and implemented in Cyprus, especially within the framework of EU-funded projects (D'Agostino D., 2017).

Some data sources also exist for the effective support of deep and NZEB renovation. These are the following:

- 1) The ODYSSEE-MURE database, which includes around 2000 energy efficiency policy measures including their impact
- 2) The GBPN on-line Policy Tool for Renovation, which captures the performance of current best practice in some EU countries and enables their comparison
- 3) The third NEEAPs provided by Member States in mid-2014, which include descriptions of the new measures adopted
- 4) The first renovation strategies in line with Article 4 of the Energy Efficiency Directive.

Successful policy measures can be selected from ODYSSEE-MURE, which includes about 225 measures explicitly related to the renovation of the residential and non-residential existing building stocks (D'Agostino D., 2017).

Lithuania runs since 2008 a financial scheme supporting the renovation of residential buildings whereas bonuses are paid for deeper renovation since 2012. The GBPN analysis focused on six countries (Germany, Denmark, France, Netherlands, Slovenia and United Kingdom) identified: i) key themes and elements that support the development of policy packages that drive the existing building stock towards deep renovation; ii) current best practice elements of policy packages for the residential building stock. The selection of each package based on two main criteria: a demonstration of their policies including elements that cover energy renovations; and a reduction of residential energy consumption (D'Agostino D., 2017).

Some Member States link financial support for building restoration to the achievement of high-energy classes' equivalent to NZEB level. This approach can be considered a good practice to stimulate the transformation of European building stock towards NZEB. To overcome the energy efficiency potential of the building sector different policy actions can be taken including regulatory measures, information tools, financial models, and voluntary approach. In the last decade, different EU countries introduced measures addressed to the existing building stock and new forward-looking perspectives have been recently defined within the national renovation strategies developed in accordance with Energy Efficiency Directive Article 4. In countries with limited solar potential (e.g. northern Europe), policies that support alternative measures are needed (e.g. biomass) (D'Agostino D., 2017).

The section below presents some measures taken by Cyprus authorities to increase the number of NZEBs in the country to help the other Balkan Med countries of the partnership to launch policies and measures to promote NZEBs in the built environment as well.

### 10.1 Incentives

Upon discontinuation of the aid schemes for the implementation of energy savings measures in buildings through the Special Fund for RES and ES in 2013, a new aid scheme was launched in 2014 to encourage households and small and medium-sized enterprises (SMEs) to adopt energy efficiency and renewable energy measures. The “Save & Upgrade” program finances major renovation of homes and buildings owned or used by SMEs, which has requested a building permit before 21 December 2007, i.e. before the entry into force of the energy performance requirements. The program has a budget of 15.3 million euros for the period 2014-2020 for SMEs and 16.5 million euros for households. It is co-financed by the European Regional Development Fund (ERDF) for SMEs or by the Union’s Cohesion Fund (CF) for households.

As opposed to the previous aid scheme for individual intervention measures, the new scheme provides financial support for a set of measures aimed to upgrade the building to a minimum increased energy efficiency level. The largest aid amount is granted to buildings undergoing renovation to become NZEBs, i.e. those that achieve conformity to RAA 366/2014. An estimated 106 existing homes will be upgraded to NZEBs from the date of the initial call issued under the “Save & Upgrade” program. Based on the assessment of the results, of the first call to be issued by the Directorate-General for European Programs, Coordination and Development, the plan will be revised, and a second call will follow.

Another incentive is Order No 1 of 2014, as issued by the Minister for Interior based on the Town and Country Planning Law. In accordance with the Order, in the case of new buildings and buildings undergoing renovation, it is possible to increase the building rate by 5% for energy class A buildings, and at least 25% of their total energy needs will be covered from RES, i.e. at least two of the criteria laid down for NZEBs must be met (Order No 1 of 2014: Use of RES; according to the Article 6 of the Town and Country Planning Law). To date, seventeen publications have been submitted to the Energy Service of the Ministry of Energy, Commerce, Industry and Tourism to verify conformity to the requirements laid down in the Order. Most of the cases relate to new large buildings.

### 10.2 Information measures

The energy performance information available to building users and professionals in the building sector has significantly improved due to the measures taken in recent years, such as the minimum energy performance requirements and the energy performance certificates. However, NZEBs are a new topic for the build environment, let alone for the public.

In recognition of the fact that architects and engineers are responsible for the implementation of NZEBs, the Energy Service has issued a “Technical Guide on nearly zero-energy buildings”. The guide aims to facilitate the project design team in looking into the most important NZEB design parameters. Plans are also being made to revise the “Guide on the thermal insulation of buildings”, which sets out the method used to calculate U-values and the specific heat capacity, also referring to thermal insulation techniques. The revision will include clear-cut references to NZEBs.

Regarding the public, the Energy Service of the Ministry of Energy, Commerce, Industry and Tourism has published an information leaflet, promoted both in hard copy and in electronic format by the Energy Services as well as through other related stakeholders, such as the Technical Chamber of Cyprus and the Cyprus Energy Agency. In the context of its overall effort for more effective communication with the public the Energy Service has been using the social media to promote NZEBs and is setting up a new website on NZEBs. At the same time, the Service is organizing or participating in information workshops on NZEBs intended for specific target groups, such as consumer associations.

The Energy Service of the Ministry of Energy, Commerce, Industry and Tourism has secured technical assistance from the JRC including proposals for providing consumers and stakeholders with information on NZEBs. There is also technical assistance obtained from the Gesellschaft für Internationale Zusammenarbeit (GIZ) for planning an information campaign on energy efficiency. The aim is to provide appropriate and timely information, adapted to each specific target group, such as households, undertakings, local authorities, etc. NZEBs are an integral part of that information campaign. The results of the study will be used as a criterion for the information measures to be implemented afterwards.

### 10.3 Training measures

Providing training on NZEBs to all professional groups involved in the construction industry and the real estate market such as energy services providers, energy audits, energy managers and installers of energy-related building elements is a fundamental measure for promoting NZEB principles in new and existing buildings (D'Agostino D., 2017) (MECIT, 2017).

Focusing on the qualitative characteristics of the labour force is significant to ensure that workers in the building sector have the necessary knowledge and skills to effectively contribute to the achievement of the national targets for 2020 and 2030. Generally, investments in the training of experts is crucial in both developing new knowledge and skills and in ensuring the transition of this knowledge to practice in several issues related to the EPBD and Energy Efficiency Directive (D'Agostino D., 2017).

On the other hand, the Renewable Energy Directive (RED) establishes an overall policy for the production and promotion of energy from renewable sources in the EU, including schemes for

accreditation of training and certification of installers of small scale RES systems in buildings such as biomass boilers and stoves installers, solar photovoltaic installers, solar thermal systems installers and geothermal installers (D'Agostino D., 2017).

The level of knowledge of engineers and architects regarding the energy performance of buildings has improved significantly thanks to the training and examination of qualified experts, heating system inspectors, air-conditioning system inspectors, air-conditioning system inspectors and energy auditors. In the effort made to integrate NZEBs in the field of knowledge of the independent experts concerned, the syllabus on which qualified experts are examined was modified in 2015 to include NZEB topics. In addition, in the context of the training and examinations of energy auditors and heating system inspectors, reference is made to the legislative framework for NZEBs.

Moreover, in the context of the “SouthZEB” research program, the Department of Mechanical Engineering and Materials Science and Engineering of the Cyprus University of Technology organized ten seminars under the general theme of NZEBs. The “SouthZEB” program aims to support engineers and architects in the Southern European countries, based on the experience of front-runner countries in central and northern to design and implement training and assessment programs, especially focused on the transfer of successful practices and knowledge for NZEBs. The Cyprus University of Technology has undertaken to train a small group of instructors, who will in turn be able to train other engineers/architects in this respect. So far, there are 14 instructors who have trained 120 engineers and architects in NZEB design, 82 of whom were granted a certificate of successful attendance following an examination. The seminars are organized under the auspices of the Energy Service of the Ministry of Energy, Commerce, Industry and Tourism. It is important to provide many and different technical skills required by professionals involved in the NZEB building process in a modular training way (National Plan, JRC, SouthZeb website).

The MENS project was financed by the EU Framework Program Horizon 2020, which aims to provide professionals in the building sector (architects, civil engineers, electrical engineers, etc.) with NZEB training, with the emphasis placed on the renovation of existing buildings. The MENS project aims to increase the NZEB-related knowledge and skills of 1800 professionals in 10 countries, including Cyprus. Fifty-percent of those persons should be women or unemployed. The aim of the 30-month-long project was to set up an interdisciplinary training program focusing on actual cases of buildings. The training activities of the project include a (postgraduate) university course, e learning and webinars, as well as training meetings and workshops for the actual case study of buildings. Since, January 2016, more than 60 persons have been trained in Cyprus and total more than 120 persons, all professionals in the building sector, were informed by taking part in project activities. The training course is available at the University of Cyprus. The Cypriot body responsible for the implementation of the “MENS” project in Cyprus is the FOSS Research for Sustainable Energy of the University of Cyprus, which is also a member of this consortium (MENs, 2015) (D'Agostino D., 2017) (MECIT, 2017).



Professionals engaging in the installation of building elements, technical systems and RES systems in buildings are also very important for the implementation of NZEBs. In accordance with the roadmap developed in the context of the “Build up skills – Pillar I” initiative, there is a need to provide “green” training to at least 4500 workers for 13 different skills until 2020, to achieve the national targets for the energy performance of buildings (IEC, 2014). Having regard to the roadmap, the bodies responsible for the implementation of the project “WE-Qualify: Improve skills and qualifications in the building workforce relating to the energy performance of buildings” completed the planning and trial implementation of five training courses for three different skills: (i) installation of thermal insulation, (ii) installation of frames and sunlight protection systems, and (iii) installation and maintenance of biomass systems. The main objective of the WE-Qualify project is to assist the construction sector in Cyprus to address the lack of skills among the workforce in relation to the construction of energy-efficient buildings, and to contribute towards the attainment of the targets for promoting renewable energy technologies.

The WE-Qualify project, which is co-financed by the “Intelligent Energy Europe” program through the “Build-up skills – Pillar II” initiative, started its operations in November 2013 and was completed in October 2016. The following pilot training courses were implemented under the program: three courses for thermal insulation installers, one course for frame and sunlight protection system installers, and one course for installers of small-scale biomass boilers and heaters.

Concerning the legislation and in the context of implementing Directive 2009/28/EC on the promotion of the use of energy from renewable sources, a certification system has been established for installers of small-scale RES systems. These installers will carry out the installation and/or maintenance of small-scale biomass boilers and heaters and/or photovoltaic and solar thermal systems and/or shallow geothermal systems and heat pumps. So far, a training provider for photovoltaic system installers (provided by the Photovoltaic Technology Laboratory of FOSS Research Centre of Sustainable Energy) and another one for installers of small-scale biomass boilers and heaters has been authorized. In addition to that, the Energy Service has prepared regulation setting out the qualifications and obligation of installers of heating, air-conditioning, major ventilation and hot water production systems after consultation with stakeholders. Both the existing arrangements and those planned aim to improve the skills of installers and, therefore, the quality of the installations in buildings, as this is essential in NZEBs.

Therefore, training of professionals is recognized as an essential part of any national plan to reach energy efficiency targets. The actions and projects undertaken go in the right direction and all present success stories, which correctly address key issues related to training of professionals to meet energy efficiency goals for building. However, efforts are still needed to convert these measures into a stable, systematic, coherent and long-term policy for training.



#### 10.4 The role of the public sector

Energy upgrade works have started since 2013 in buildings owned and used by the central government, under the “ENERGEIN” project. The project included the major renovation of two buildings and the implementation of individual energy savings and renewable energy measures in another two buildings. By the Decision of the Council of Ministers of 14 April 2016, a Committee was set up for upgrading the energy performance of buildings used by central government authorities. Representatives of the Department of Public Works, the Department of Electrical and Mechanical Services, the Directorate of Control of the Ministry of Transport, Communications and Works and the Energy Service of the Ministry of Energy, Commerce, Industry and Tourism comprise the Committee. The mandate given to the committee includes both the energy upgrading of existing buildings owned and used by the central public administration, with a view to complying with the obligation under principles in public buildings in a financially and technically optimal way. The committee should prepare an annual report to inform the Minister for Transport, Communication and Works and the Minister for Energy, Commerce, Industry and Tourism on the progress made in achieving the national target for energy savings in public buildings (except from the minutes of the Council of Ministers meeting of 13 April 2016, Decision No 80 534).

#### 10.5 NZEB Research in Cyprus

Universities and other research centres in Cyprus have been carried out significant work on the NZEB area and, on how the relevant principles can be implemented in an optimal way in the country. The Energy Service supports such initiatives, mainly by issuing opinions on the policy implemented by the Cyprus Government in the energy sector, as well as on the dissemination of the results. The results of these projects are used as a feedback to improve the existing NZEB arrangements and incentives. Following are some NZEB research projects, while we should do also stress that other research programs relating to the energy performance of building are being, or have been, implemented.

Efforts to secure research programs are still being made by stakeholder organizations, and additional research projects may be implemented by 2020.

The European research project IEE EPISCOPE (Energy Performance Indicator Tracking Schemes for the Continuous Optimization of Refurbishment Processes in European Housing Stocks) aims to consider the most effective methods for the energy upgrading of residential buildings, including scenarios for major renovation into NZEBs. Seventeen (17) Member States take part in the project including Cyprus, its partner being the University of Cyprus (IEE Project EPISCOPE, n.d.).

The research project “Geothermal energy systems in NZEBs” investigated the possibility of using a combination of a soil heat pump and photovoltaic systems in the Cypriot building sector from an energy, environmental and financial point of view, as well as on how these can contribute towards

the achievement of NZEB targets. The project was implemented by the University of Cyprus and was financed by the Research Promotion Foundation.

The project “Nearly Zero-Energy Sports Facilities – n0e Sport Facilities”, which is implemented in Cyprus by the Cyprus Energy Agency, aims to assess the current state of play in terms of energy in 18 sports facilities in the EU and to determine and implement innovative technological solutions for energy savings, aiming to save more than 50% of the current energy consumption. As a result, the “n0e Sport Facilities” project promotes the creation of nearly zero-energy sports facilities through the design and the promotion of an integrated renovation package for sports facilities, including all the available energy savings methods/measures and utilizing renewable energy technologies. Three of four pilot sports facilities have been chosen in each country participating in the program, to propose and implement energy efficiency improvement measures. The municipal swimming pool in Aglantzia, the sports facilities of the Chalkanoras Idaliou Club, the municipal swimming pool of Nicosia and the Sports Centre of Kition in Larnaca were chosen in Cyprus.

The ZERO-PLUS project is financed by Horizon 2020 and started on 1 October 2015, while it is expected to be completed by 30 September 2019. The Cypriot participants in the project are the Cyprus Institute and Cyprus Vassiliou Ltd. It relates the development and implementation of integrated energy-efficient agglomerations, including NZEBs. These agglomerations will be developed in four areas in Europe, one of them in Cyprus. The system will consist of innovative solutions for both the building envelope and the production and management of energy at building and agglomeration levels. The project aims to reduce the total use of energy by an average of 0-20 kWh/m<sup>2</sup>/year (compared to the current average of 70-230 kWh/m<sup>2</sup>), as well as to migrate from NZEBs to nearly zero-energy agglomerations, in which energy loads and resources are optimally managed. Furthermore, 50 kWh/m<sup>2</sup>/year is expected to be produced from renewable energy sources using innovative energy generation technologies. The goal is that the costs of the above system are reduced at least by 16% compared to the current costs.

Despite not being directly linked to NZEBs, other NZEB promotion measures are also taken contributing indirectly towards enhancing the penetration of them in the built environment.

One such important measure is the “Solar energy for all” program started in 2013 where its main purpose is to promote photovoltaic installation for meeting own electricity needs. By the end of 2015, it was possible to install a photovoltaic system with a maximum capacity of 3Kw in homes. In December 2015 though, the program was revised to include all types of buildings and to increase the maximum permissible capacity of the photovoltaic system to 5Kw. Where these systems are installed, the electricity consumed by the building is offset against that generated by the photovoltaic system (net metering). It is also possible to install larger photovoltaic systems (10kW to 10MW), in which offsetting takes place every 20 minutes. The “Solar Energy for all” program is a strong energy for the promotion of NZEBs, as it helps fulfil the obligation for renewable energy

production in a building. Until now, more than 11000 photovoltaic systems have been installed in buildings using the net metering method and the goal is to have another 70 MW installed by 2020, which corresponds to 15000 buildings.

A significant development is the progress made in the field of energy audits and energy services. Based on regulations adopted in 2012, the training and authorization of energy auditors started in the second half of 2013. Energy auditing offers a more integrated approach than that of the three other independent experts in the field of the energy performance of buildings (qualified experts, air-conditioning system inspectors and heating system inspectors), as it must be based on updated measurable operating data regarding energy consumption in the building and must include a detailed overview of the characteristics of that consumption. This enables building owners and would-be investors to consider the energy upgrade options available, including renovation into NZEBs. Periodic energy audits are mandatory for large undertakings, as an energy audit must be carried out by 5 December 2015 and must be repeated every four years thereafter. As large undertakings represent only a small part of Cypriot activities, the number of energy audits to be carried out mainly depends on demand and supply on the market. The regulations on energy service providers (ESPs) were adopted in April 2014 to increase confidence in energy audits among stakeholders as well as in the alternative ways of financing energy savings measures resulting from energy audits, by means of energy performance contracting (EPC). So far, there are 61 energy auditors for buildings and 24 ESPs.

To further enhance energy efficiency in companies, and private and public organizations, the Energy Service of the Ministry of Energy, Commerce, Industry and Tourism is promoting the institution of “energy manager”. Energy management training has been provided to individuals since 2014 through the “European Energy Managers” (EUREM) training program. For the further strengthening and dissemination of energy management, the Energy Service repeated, following consultation with the stakeholders, a decree specifying the training and duties of energy managers. As provided by the decree, an energy manager’s duties include, among other things, proposing actions and making recommendation to an organization’s management for reducing energy consumption. This helps promote increase energy efficiency on a voluntary basis, also promoting NZEBs, through a company’s, organization’s or government authority’s own procedures too.

Choosing appropriate technical systems in a NZEB may entail a greater challenge than in a conventional building, as the needs to be met are relatively small and this must be done in the most efficient manner without compromising comfort. To partially comply with Article 8 of Directive 2010/31/EU, the Energy Service has issued technical guides on energy performance requirements and the adjustment and control of the technical building systems which are installed in existing buildings. Despite the guides’ primary aim being to lay down requirements for existing buildings only insofar as this is technically, functionally and economically feasible, they may also

serve as standards of good practice, providing solutions for streamlined design, installation and use of technical systems in NZEBs.

**Table 12:** Summary of the most important measures already taken and planned to be taken to promote NZEBs between 2012 and 2020 (MECIT, 2017).

Measure	Type of measure	Year of implementation	Intended primarily for:
Study on the definition of NEZB for different types of house (EXERGIA S.A., Provision of consulting services for the definition of Nearly Zero Energy Residential Buildings in Cyprus, Contract No MCIT/ES/01/2011, May 2012)	Research	2012	Ministry of Energy, Commerce, Industry and Tourism (Energy Service), Building designers
Determination of the qualifications, training and the duties of energy auditors (RAA 184/2012)	Legislation/Training	2012	Architects and engineers
Calculation of cost-optimal levels of minimum energy performance requirements  (Ministry of Energy, Commerce, Industry and Tourism, Calculations for setting minimum energy performance requirements at cost optimum levels according to Article 5 of Directive 2010/31/EU on the energy performance of buildings (recast), April 2013)	Legislation/Research	2013	Ministry of Energy, Commerce, Industry and Tourism (Energy Service)
“Geothermal systems in NZEBs” research project	Research	2013-2015	Architects and engineers
Renovation of buildings owned and used by central government authorities in the context of the “ENERGEIN” project	Exemplary role of the public sector	2013-2015	Central governmental authorities, public

“Solar energy for all” program to promote photovoltaic systems	Incentives	2013-2015	Owners of new and existing buildings
Revision of minimum energy performance requirements	Legislation	2013	All stakeholders
Increasing the building rate for energy efficiency class A building, which meet at least 25% of energy consumption from RES	Incentives	2014-2020	Owners of new and existing buildings
Determination of the responsibilities of ESPs and of the procedure used for enrolment thereof in a register (RAA 210/2014)	Legislation	2014	Undertakings
Definition of NZEB by decree of the Ministry of Energy, Commerce, Industry and Tourism (RAA 366/2014)	Legislation	2014	All stakeholders
Inclusion of NZEBs in the syllabus on which qualified experts are examined (RAA 419/2015)	Legislation/Training	2015	Qualified experts
Determination of the qualifications, training and duties of small-scale RES system installers (RAA 374/2015)	Legislation/Training	2015	RES Installers
Technical guide on nearly zero-energy buildings	Information/Training	2015	Building designers, qualified experts
“Save & Upgrade” program for upgrading existing homes and buildings used by SMEs into NZEBs (first call)	Incentives	2015	Households and SMEs
Document on NZEBs	Information	2016	Public
Revision of minimum energy performance requirements (RAA 119/2016)	Legislation	2016	All stakeholders

“Save & Upgrade” program for upgrading existing homes and buildings used by SMEs into NZEBs (first call)	Incentives	2016	Households and SMEs
Revision of the “Guide on the thermal insulation of buildings”	Legislation/Information/Training	2017	Building designers, qualified experts
Guide laying down requirements for technical systems installed or upgraded in residential buildings and building units, and guide laying down requirements for technical devices installed or upgraded in non-residential buildings or building units	Legislation/Information/Training	2016	For technical building system designers and installers
Website of the Energy Service concerning NZEBs	Information	2017	Public
Determination of the qualification, training and duties of technical building system installers	Legislation/ Training	2017	Technical system installers
Determination of the training and the duties of energy managers	Legislation/ Training	2016	Executives of undertakings and public organizations
EPISCOPE research program	Research	2013-2016	Ministry of Energy, Commerce, Industry and Tourism (Energy Service), architects and engineers
“WE QUALIFY” project	Training	2013-2016	Installers of building envelope elements, technical system and RES
“Nearly Zero Energy Sports Facilities” research program	Research	2014-2016	Sports facility owners and

			managers, such as local authorities and sports clubs
“SouthZEB project”	Education/Research	2015-2017	Building designers
“MENS” project	Education/Research	2016-2017	Building designers, qualified experts
Renovation of buildings owned and used by central governmental authorities in the context of applying Article 5 of Directive 2012/27/EU	Exemplary role of the public sector	2016-2020	Central governmental authorities, public
“Save & Upgrade” program for upgrading existing homes and buildings used by SMEs into NZEBs (second call)	Incentives	2017-2020	Households and SMEs
Second calculation of cost-optimal levels of minimum energy performance requirements	Legislation/Research	2018	Ministry of Energy, Commerce, Industry and Tourism (Energy Service)
Review and revision of minimum energy performance requirements	Legislation	2018-2020	All stakeholders
“ZERO-PLUS” research project	Research	2015-2019	Architects and engineers

## 11 Potential Improvements

The current financial support policy for improving the energy performance of buildings and promoting NZEBs largely depends on State subsidization since certain deficiencies in the previous aid scheme of the Special Fund for RES and ES are addressed in the “Save & Upgrade” program. For instance, the “Save & Upgrade” program provide for major renovation financing, meaning that the buildings included in the current scheme are not at risk of “blocking” the entire energy savings potential of the buildings. Moreover, the provision for participation of the qualified experts and energy auditors in the scheme boosts energy efficiency in the market and promotes a holistic and

cost-effective approach when measures are chosen for intervention in each building (Economidou, 2016).

However, ensuring maximum investment requires a higher share of private financing and solutions that are based on market mechanisms. Thus, NZEB projects must meet the different criteria that are mandatory for financing from the financial sector. Also, the banking sector must become acquainted with the concept of NZEBs and the economic parameters of the buildings. The technical report entitles “Financing energy efficiency in buildings in Cyprus, Status across the EU and recommendations, JRC Reports”, as prepared by the JRC for the Ministry of Energy, Commerce, Industry and Tourism, provides details on the existing financial incentives and assesses their financial and technical efficiency to date. A greater mobilization of private capital is very important, also in line with said technical aid, and proposals for improving the situation are being made. This parameter will be recognized in the impending restructuring of the “Save & Upgrade” program in view of the second call to be issued.

The Energy Service and professional in the field of the energy performance of buildings organize events for key figures of commercial banks to exchange views and find solutions to satisfy all stakeholders, including building owners.

Until today, training and information on NZEBs are provided primarily to architects and engineers, as well as to installers to a lesser extent. However, a contribution can be made towards the promotion of NZEBs by other groups of professionals too, which are currently receiving no or very little information on the subject. The most important groups are real estate agents, property evaluators and construction material and technical system suppliers. The technical assistance received by the Ministry of Energy, Commerce, Industry and Tourism from the JRC and the GIZ is also expected to contribute towards finding appropriate communication channels for better informing these groups.

NZEBs require higher levels of thermal insulation and possibly, in many cases, the implementation of sunlight protection measures, such as external shades, cantilevers, etc. These measures tend to reduce the amount of usable space available in a building or the distance from adjacent buildings. As building construction is subject to town planning restrictions, discussing the issue with the direct stakeholders, i.e. the Department of Town Planning and Housing and architects, will stress the extent of the problem and point to the implementation of corrective measures as appropriate.

Conformity to the NZEBs requirements laid down in RAA 366/2014 can only be achieved through the methodology used to calculate the energy performance of buildings. Various case studies and surveys have indicated that the actual energy consumption is lower than calculated where the largest deviation being observed in cooling. This is because of various reasons with the most important one being that the current methodology used to calculate the energy performance of buildings does not consider measures that help reduce cooling needs, such as roof-mounted fans



and a building design that favours natural cooling. The contribution of such measures towards reducing the energy spent on cooling cannot be calculated at this stage, as the calculation procedures concerned are not specified in the relevant EU standards. Furthermore, EU standards do not allow the calculation of the renewable energy derive from high-efficiency heat pumps. As a result, there are certain savings measures which are not adequately encouraged, and it may be impossible to effectively implement an overall requirement concerning energy demand for cooling like that in place for heating. Cyprus looks forward to a solution to the problem through the new standards prepared by the European Committee for Standardization (CEN).

In Cyprus for example, consistent mixtures of policy instruments (policy packages) should be designed depending only partially on public budgets. Reliable data to monitor also policy impacts, including actual energy performance and indoor environment are required above all for building stock refurbishment. The adoption of roadmaps and indicators is a good option to address specific needs and monitor implementation (D'Agostino D., 2017).

## 12 Conclusion

The improvement of the energy performance of buildings, through the promotion of NZEBs, is deemed necessary to achieve the targets for the reduction of energy consumption, since almost one third of the final energy consumption is due to the buildings.

The report provides information on NZEBs definitions in Europe with a focus on the Balkan Med countries as well as best practices measures, and policies related to buildings' renovation that can be considered in the Balkan Med framework. The study identifies barriers towards NZEB implementation especially for the consortium countries.

The main conclusion of the report is that the current policy framework has made relatively little progress towards providing effective solutions to the barriers of storage integration in NZEBs as little attention has been drawn on how to solve them. After the analysis of the situation, possible recommendations, policies, and measure to overcome these barriers have been suggested. Best practices are identified in other EU Member States though to help us highlight the good case studies that could be applicable to the Balkan Med context.

Training of professionals is identified as essential to meet challenging energy efficiency. The assessment of the current situation in the involved countries highlighted some areas with potential for improvement (e.g. modular training, engagement of building owners, employers and other stakeholders, interdisciplinary training), which could be addressed in the future. Specifically, the conception and development of a comprehensive and long-term strategy is recommended, rather than a set of specific isolated pilot projects to build competences and being ready for the challenged posed especially by NZEBs requirements (D'Agostino D., 2017).

Although several efforts have been made to fill the skill gaps already identified, some other gaps though mainly longer-term sustainable schemes still need to be further developed. The development and implementation of a national broad and long-term framework strategy, broader and more articulated is extremely recommendable.

It is necessary to adopt a definition of NZEB in the countries where this legislation is still pending, to promote these building, specifying the energy performance level of all new building after 2020 and providing all people currently engaged in the construction and renovation business with a standard for increased energy efficiency in relation to the mandatory minimum energy performance requirements.

This report is considered as the baseline of the subsequent work to be carried out in the project. The existing legislation and current electricity billing policy for each participating region, as reported in this study will be used as input to develop an innovative management scheme and a set of country specific policy recommendations, related to PV and storage integration in NZEBs. The goal is to propose roadmaps, identifying how enhanced integration of PV and storage in buildings will help to reach 2030 RES targets.

This report presents also the current energy status for the European Union with an emphasis on the Balkan Med countries. A detailed analysis of the RES development and PV penetration at both European and Balkan Med level was carried out, which focused on the installed RES and PV capacity until today. Concurrently, a valid comparison between the existing penetration levels and the regional targets for 2020 was performed, pointing out that new technologies are mitigating the barriers emerging by the steadily increasing share of RES in the energy mix of the countries.

Another important study was performed to analyse the legislation and incentive schemes currently in place to support the deployment of PV systems. A range of energy policies and incentives including FiT, net-metering and self-consumption schemes, with different upper capacity limits apply in different regions. Generally, the report concludes that there exist many challenges regarding the financial and technical aspects for energy storage integration in the electric power distribution grids and that there is an urgent need for new policy frameworks to allow the effective deployment of coupled PV-ESS technology in the Balkan Med region.

This report also presents the high solar potential of the Balkan Med countries following an analysis of the solar resources of each participating country. Furthermore, a detailed breakdown of the conventional electricity billing schemes in each region was performed, which indicates that a major contributor to the relatively high tariffs across the Balkan Med region is the high cost of generation and network utilization. Finally, typical PV system prices have been collected and analysed for each country with the PV modules constituting the most expensive component.

The contribution of key stakeholders in all participating countries on the identification of barriers and of the potential for NZEB deployment for the implementation of electric energy storage with PV installations in the Balkan MED region has been valuable for the conclusion of this Deliverable and is highly acknowledged.

## References

ADMIE, 2017. *Independent Power Transmission Operator: December 2017*. [Online]

Available at:

[http://www.admie.gr/fileadmin/groups/EDRETH/Monthly\\_Energy\\_Reports/Energy\\_Report\\_2017\\_12\\_v1.pdf](http://www.admie.gr/fileadmin/groups/EDRETH/Monthly_Energy_Reports/Energy_Report_2017_12_v1.pdf)

ADMIE, 2018. *Independent Power Transmission Operator: February 2018*. [Online]

Available at:

[http://www.admie.gr/fileadmin/groups/EDRETH/Monthly\\_Energy\\_Reports/Energy\\_Report\\_2018\\_02\\_v1.pdf](http://www.admie.gr/fileadmin/groups/EDRETH/Monthly_Energy_Reports/Energy_Report_2018_02_v1.pdf)

BPIE, 2015. *Nearly Zero Energy Buildings Definitions across Europe*, Brussels: Buildings Performance Institute Europe.

BuildUp, 2015. *The European Portal for Energy Efficiency in Buildings*. [Online]

Available at: <http://buildup.eu/en/practices/cases/university-research-centre-technical-university-sofia-bulgaria>

[Accessed 2018].

CERA, 2017. *Cyprus Energy Regulatory Authority: RES Statistics*. [Online]

Available at: <https://www.cera.org.cy/el-gr/ilektrismos/details/statistika-ape>  
[Accessed 2018].

CTSO, 2017. *Cyprus Transmission System Operator: Electricity Generation Records*. [Online]

Available at: <http://www.dsm.org.cy/en/cyprus-electrical-system/electrical-energy-generation/energy-generation-records/yearly/res-penetration>  
[Accessed 2018].

CTSO, 2018. *Cyprus Transmission System Operator: Cyprus Electrical System*. [Online]

Available at: <http://www.dsm.org.cy/en/cyprus-electrical-system>

CTSO, 2018. *Cyprus Transmission System Operator: RES Penetration*. [Online]

Available at: <http://www.dsm.org.cy/en//cyprus-electrical-system/electrical-energy-generation/energy-generation-records/yearly/res-penetration>

D'Agostino D., Z. P. P. D., 2017. *Transition towards NZEBs in Cyprus (D2.5)*, s.l.: Joint Research Centre (JRC).

DEDDIE, 2017. *Hellenic Electricity Distribution Network Operator, HEDNO: Monthly Reports of RES & Thermal Units in the non-interconnected islands*. [Online]

Available at:

[http://www.admie.gr/fileadmin/groups/EDRETH/Monthly\\_Energy\\_Reports/Energy\\_Report\\_2017\\_12\\_v1.pdf](http://www.admie.gr/fileadmin/groups/EDRETH/Monthly_Energy_Reports/Energy_Report_2017_12_v1.pdf)

DEDDIE, 2017. *Hellenic Electricity Distribution Network Operator, HEDNO: Prosumer applications for net-metering programme in the mainland and non-interconnected islands*. [Online]  
Available at: <https://www.deddie.gr/el/upiresies/fwtovoltaika-kai-alles-ape/fv-apo-autoparagwgous-me-energeiako-sumpsifismo-ne/arxeia-aitisewn/energeiakos-sympsfismos-arxeia-aitisewn-noemvrios>

Economidou, 2016. *Financing energy efficiency in buildings in Cyprus*, s.l.: JRC.

EPBD, Directive 2010/31/EU, 2010. DIRECTIVE 2010/31/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 19 MAY 2010 ON THE ENERGY PERFORMANCE OF BUILDINGS. *Official Journal of the European Union*.

HEP, 2018. *Operator of Electricity Market*. [Online]

Available at:

[http://www.lagie.gr/fileadmin/groups/EDRETH/DAS\\_Monthly\\_Reports/201802\\_DAS\\_Monthly\\_Report.pdf](http://www.lagie.gr/fileadmin/groups/EDRETH/DAS_Monthly_Reports/201802_DAS_Monthly_Report.pdf)

Hermelink A., S. S. B. T. P. L. Z. P. A. R. V. K. M. E., 2012. *Towards nearly zero-energy buildings: Definition of common principles under the EPBD*, s.l.: ECOFYS Germany GmbH.

IEC, 2014. *Intelligent Energy Europe: Build Up Skills Cyprus*. [Online]

Available at: <https://ec.europa.eu/energy/intelligent/projects/en/projects/build-skills-cy>

IRENA, 2018. *IRENA: Renewable Power Generation Costs 2017*. [Online]

Available at: <http://www.irena.org/publications/2018/Jan/Renewable-power-generation-costs-in-2017>

IRENA, 2018. *Renewable Capacity Statistics*, s.l.: International Renewable Energy Agency.

Kempener R., B. E., 2015. *Battery Storage for renewables: market status and technology outlook*, s.l.: IRENA.

Kurnitski J., et al., 2011. How to define nearly net zero energy buildings. *REHVA*, pp. 6-12.

LAGIE, 2017. *Operator of electricity market: RES and CHP Monthly Statistics*. [Online]

Available at:

[http://www.admie.gr/fileadmin/groups/EDRETH/Monthly\\_Energy\\_Reports/Energy\\_Report\\_2017\\_12\\_v1.pdf](http://www.admie.gr/fileadmin/groups/EDRETH/Monthly_Energy_Reports/Energy_Report_2017_12_v1.pdf)

MECIT, 2010. *National Renewable Energy Action Plan 2010-2020*, s.l.: Ministry of Energy, Commerce, Industry and Tourism.

MECIT, 2017. *2nd National plan for increasing the number of nearly-zero energy buildings*, s.l.: s.n.

MEnS, 2015. *MEnS – Meeting of Energy professional Skills*. [Online]  
Available at: <http://www.mens-nzeb.eu>  
[Accessed 2018].

Shady, A., 2017. Overview and future challenges of nearly zero energy buildings (NZEB) design in Southern Europe. *Energy and Buildings*, pp. 439-458.

SOLARGIS, 2018. *SOLARGIS*. [Online]  
Available at: <https://solargis.com/maps-and-gis-data/overview/>

VEI, 2018. *VEI-BG.ORG*. [Online]  
Available at: <http://vei-bg.org/en>

Zingheri, P., 2016. *Building Stock in Cyprus and Trends to 2030*, s.l.: JRC Technical Reports.

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