StoRES

Promotion of higher penetration of Distributed PV through storage for all

Deliverable n°: **D3.2.1**

Deliverable Name: **Preliminary study, technical and policy barriers, current status and market**

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3. Contents

4. Project Summary

The project addresses the development of an optimal policy for the effective integration of Renewable Energy Sources (RES) and Energy Storage Systems (ESS). The primary challenge is to achieve increased penetration of RES and predominantly photovoltaics (PV), in the energy mix of islands and rural areas in the Mediterranean (MED) region without compromising grid stability. The main objective of StoRES is to boost self-consumption in the MED region with the integration of optimal storage solutions. Testing coupled PV-ESS solutions in different pilot sites and taking into account local particularities for optimization, current barriers concerning grid reliability with higher RES deployment will be eliminated. In addition to this, the development and integration of the proposed solution at both residential and community levels and the application of different policy scenarios will lift the barriers related to the grid integration of ESS and will extend the practical knowledge about this technology. It is expected that all the shortcomings regarding the intermittent nature of PV energy for increased penetration into the energy mix will be addressed whilst maintaining smooth operation of the grid.

The project started on the 1st of November 2016 and is expected to be completed within 30 months.

5. Introduction

In this report, the analysis of the current situation in the European Union (EU) and the participating countries is presented in terms of RES and mainly PV levels in each region towards achieving the 2020 energy targets. Further to this, the study focuses on the current relevant legislation in each country, highlighting the barriers for further RES promotion and storage deployment.

In addition to the above, the solar potential for each region is presented and also the different electricity tariffs are analysed. Finally, typical PV system prices are presented in order for valid comparisons between the electricity and the PV system cost in the different participating regions to be made.

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 the subsequent schemes to promote PV and storage in the MED countries.

6. State of the art in the European Union

Electricity demand is rapidly increasing thus putting pressure on utilities to expand generation. This coupled with socioeconomic and environmental concerns associated with climate change has brought electricity production from RES at the forefront. As a consequence, the EU has set very ambitious targets for the share of RES aiming at achieving a resilient Energy Union. The main objective is the decarbonisation of the distribution grid and the integration of higher shares of distributed generation through the deployment of innovative and flexible energy management strategies. This has led to increased RES deployment and price reduction, thus rendering RES a very competitive alternative to fossil fuel electricity generation.

However, increased RES deployment comes at a price and substantial restructuring of the electricity network with the adoption of new technologies is urgently needed in order to allow further RES penetration. This is highlighted in the strategic energy technology integrated roadmap for research in Europe, which 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) [1]. Responding to the above challenges and as part of the climate and energy framework, Europe has put forward the long-anticipated "Clean Energy For All Europeans" (Winter Package) [2]. In particular, the winter package paves the way towards achieving the clean energy transition and provides measures to promote the industrial competitiveness in the EU. As a consequence, various key stakeholders will benefit from the renewable directive. A good example is the renewable energy industry, since the various uncertainties for investors will be minimised. Further to the above, the new directive proposes the active engagement of the consumers, which constitutes an important objective of the strategic energy plan. The deployment of new and innovative technologies such as smart energy management systems and battery storage solutions to support RES into the new energy system will be established. In light of this and the significantly reduced prices of RES, consumers will be encouraged to further utilise RES with benefits such as the right to produce and self-consume electricity as well as feed any excess back to the grid.

On the other hand, the further unobstructed deployment of RES poses many challenges to the electricity system. For example, the variable and intermittent production of RES is a significant drawback that makes planning and dispatch of energy a very difficult issue to be dealt with. A suitable solution is the utilization of energy storage that can eliminate the barriers related to higher RES share. The deployment of storage is mainly focused 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 prime component capable of providing the desirable flexibility and reliability to the electricity system. Different energy storage technologies have developed rapidly over the last decades. However, electrochemical battery storage technology is emerging as one of the fastest growing storage technologies for grid-connected applications. Storage has an important role to play in the proposed energy transition, offering suitable services for several applications such as utility scale and households. On the other hand, the most significant barrier for electricity storage is its high unit price currently, and the lack of suitable financial compensation schemes. Therefore, important investments in innovation are needed to obtain significant cost reductions.

This section provides an overview of the existing situation regarding the evolution of RES in the EU towards achieving the energy targets for 2020 and beyond. Also, recognising solar PV as one of the most favourable RES technologies in the Mediterranean countries, the current status regarding its penetration in the energy mix in Europe is analysed. Finally, the appealing services of storage to the grid are presented, highlighting the need for financial support in order for its further deployment to the electricity grid.

6.1 Renewable Energy Sources

Owing to the very ambitious targets set for the 2020 energy plan, the share of RES in the energy mix of the EU countries is rapidly increasing. The EU has tuned its energy policy targeting the promotion of RES as a very competitive alternative to fossil fuel electricity generation. Recognising the benefits stemming from the different RES technologies, the target of 20% of the total gross energy consumption has been set by the EU to be reached by 2020. This translates into the doubling of the RES share in the EU countries over the last decades in order to reach the expected trajectory for the 2020 targets as depicted in Figure 1.

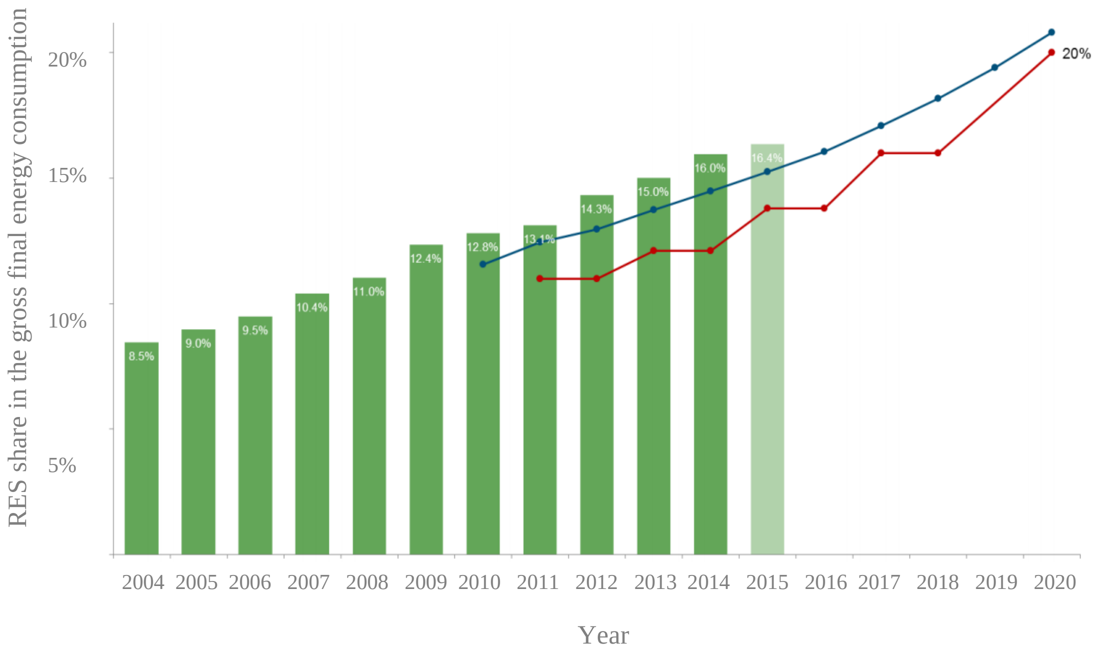

Figure 1: Renewable Energy shares in the EU versus Renewable Energy Directive (RED) and National Renewable Energy Action Plan (NREAP) trajectories based on EUROSTAT, Öko-Institut. [Source: EC - Renewable Energy Progress Report 2017]

In light of the above, 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 achieved 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 1, showing the share of RES in the gross final energy consumption for the countries of StoRES 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 1: Share of RES in the gross final consumption of energy (%) for the participating MED countries and the national targets by 2020.
[Source: Eurostat]

Member State	2010	2014	2015	EU Target 2020
Cyprus	6.0	8.1	8.9	13.0
France	12.5	14.6	14.9	23
Greece	9.8	15.3	15.4	18.0
Italy	13.0	17.1	17.5	17.0
Spain	13.8	16.1	16.2	20.0
Slovenia	20.4	21.5	22.0	25.0
Portugal	24.2	27.0	28.0	31.0
EU Average	**12.9**	**16.1**	**16.7**	**20**

An even more ambitious energy plan is set for the year 2030 which foresees the boosting of RES share to at least 27% of the EU energy consumption and also a reduction of greenhouse gas emissions by 40%. This acts as a drive 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. On the other hand, the possible unregulated deployment of RES poses serious barriers which are mainly connected to the distribution grid operation and must be taken into account through the currently undergoing power system transition. New grid strategies are urgently needed in order to maintain the grid operation stable and flexible.

In conclusion, the deployment of RES has seen a tremendous increase over the last few years. Taking into consideration the energy targets set by the EU for the upcoming decade, new and sustainable energy frameworks are needed for supporting the growth of RES systems. Among the different types of RES, solar PV is of particular interest to the MED countries due to the high solar resource. Therefore, in the next section the situation regarding PV technology in Europe is presented.

6.2 Photovoltaics

The growth of Solar Photovoltaic (PV) technology has been tremendous over the past few years in the EU, with Germany becoming a dominant player in the PV industry. Considering the ambitious targets set by the EU for 2020 and 2030, PV technology is an affordable and well established renewable source for the Member States to meet their energy targets. As a consequence of the increasing demand of electricity over the years, the competitiveness of PV systems is increasing thus rendering PV a very competitive alternative to fossil fuel electricity generation. This situation is reflected in the rapid decline of the PV system price over the last few years that is indicated in Figure 2 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. In light of the above, grid parity, which is defined as the point in time where the generation cost of PV electricity equals the cost of conventional electricity sources, is already achieved in some parts of the European region.

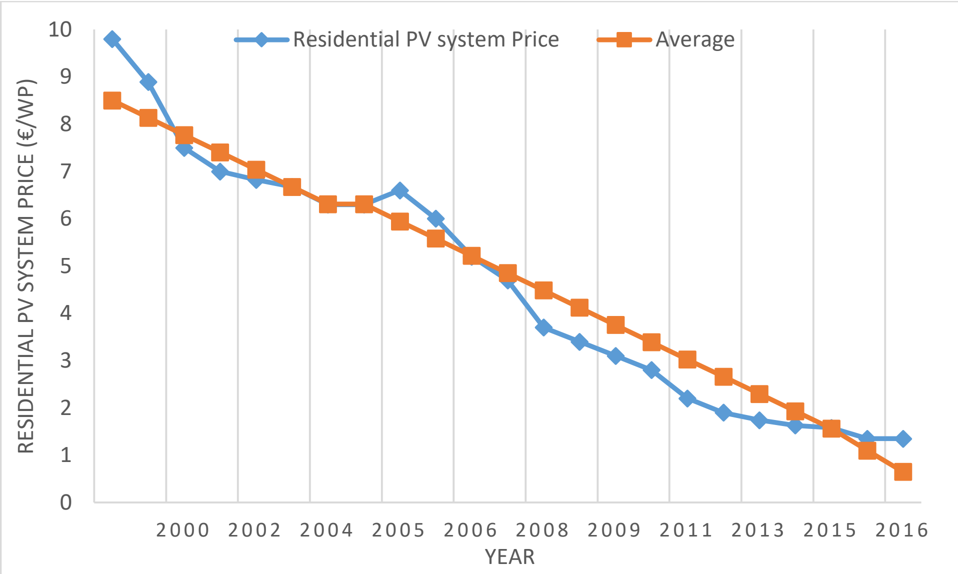

Figure 2: Solar PV system price for residential grid-connected applications in Germany up until 2016. Price includes PV modules, solar PV inverter, mounting systems and other Balance of System (BoS) components.
[Source: JRC PV Report 2016, IEA PVPS, Eurostat]

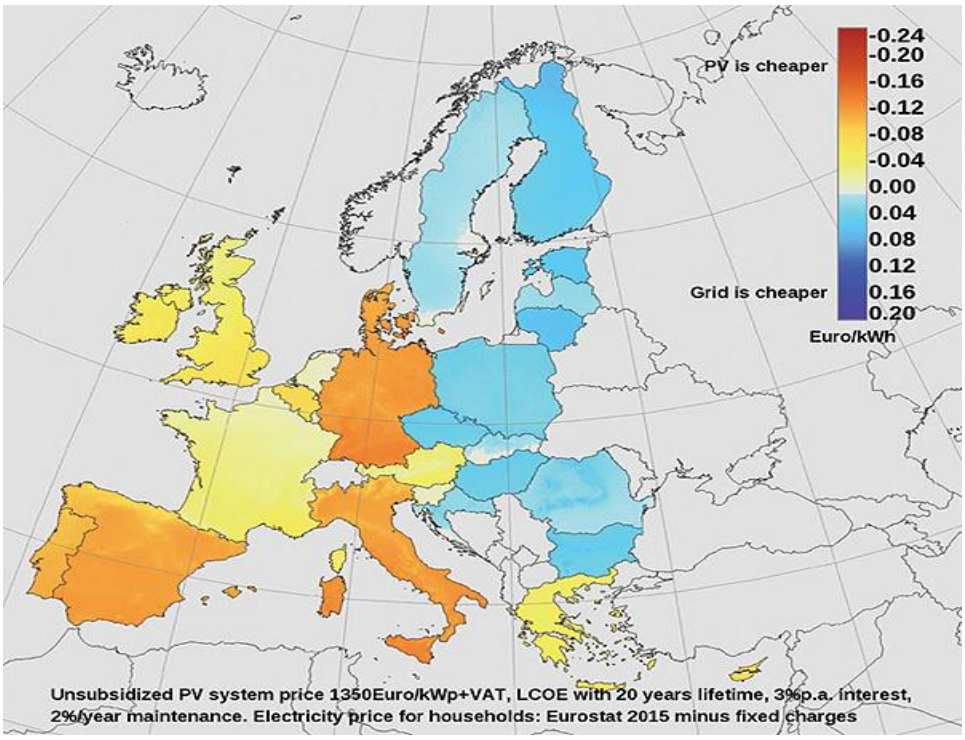

Figure 3: Global map with countries that have achieved grid parity in 2015.
[Source: Eurostat]

This can be consolidated in Figure 3, where a comparison between the Levelized Cost of Electricity (LCOE) from RES and the retail electricity price is outlined.
As a result of the above, the deployment of PV systems has boomed and this can be observed in Figure 4 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. In addition to this, the favourable trend for the installation of small PV systems stems from the various incentives and attractive energy frameworks established by the Member States aiming at reaching higher RES towards achieving their national energy targets in 2020. By way of illustration, the national FiT scheme in Germany was initiated in 2004 and modified in 2009 and 2014 (EEG modifications) encouraging the installation of small roof-top and large utility scale PV systems in return for attractive FiT. This situation and more recently the establishment of net-metering and self-consumption schemes in other countries have encouraged the further utilisation of PV, which is reflected in the sharply rising trend of the installed PV capacity over the last decade.

In conclusion, PV technology is beginning to play a significant role in the energy mix and this is expected to intensify over the next few years. Appropriate policy frameworks and governmental subsidies are needed in order to further promote and expand the deployment of solar PV systems towards restructuring the electricity grid. The barriers concerning grid stability issues with further RES deployment can be lifted off by incorporating technologies such as storage that will allow unobstructed deployment of RES. Next, the situation with energy storage in Europe is outlined.

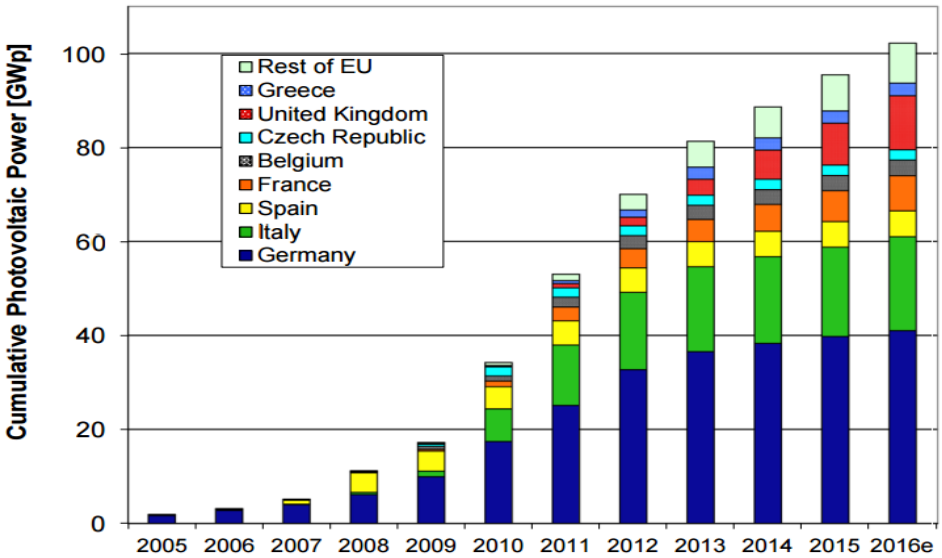

Figure 4: Cumulative PV installed capacity (GWp) for grid-connected systems in EU countries between 2005 and 2016 [Source: JRC-PV status report 2016].

6.3 Energy Storage Systems

The remarkable deployment of RES calls for the development and deployment of Energy Storage Systems (ESS). The decentralised and intermittent generation of RES poses significant risks for the stability and security of the grid. Energy storage is considered as a reliable solution capable of providing the desirable resilience to the energy system. Storage systems can be centralized or distributed and can balance the generated electricity without risking grid security with the further RES penetration. In addition to this, energy storage can dynamically supply demand response and other services depending on the allocation level such as transmission, distribution or local. A number of services can be offered from the deployment of storage technology as depicted in Figure 5. In particular, for residential applications, "behind the meter" storage can offer important services to benefit the prosumer, such as the ability to self-consume and the backup power operation in case of grid failure. It can also be used for optimal energy management in cases where Time-of-Use tariff management can be applied to increase consumer revenue. Finally, by balancing the variable RES nature, the stability of the electricity grid can be maintained. Further to this, different services can be applied for grid support with the most important being voltage support and frequency regulation as a result of active and reactive power compensation. Therefore, the energy demand can be significantly decreased by integrating energy storage to the electricity network whilst improving the electricity system efficiency since energy dispatch and delivery can be locally achieved.

Different storage technologies have shown significant development over the last years including batteries, compressed air and chemicals, with pumped-hydropower storage to be the most dominant and mature type. This situation is gradually changing with other storage types offering a range of services to the electricity grid. In particular, electrochemical storage technology is emerging as a very competitive option for residential and community storage applications. It is a suitable technology to support the growing need for an innovative and resilient energy system with integrated RES. Nevertheless, the need for financial investment is required in order to achieve further technological progress and increase its cost competitiveness. Further to the above, battery storage technology needs to 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.

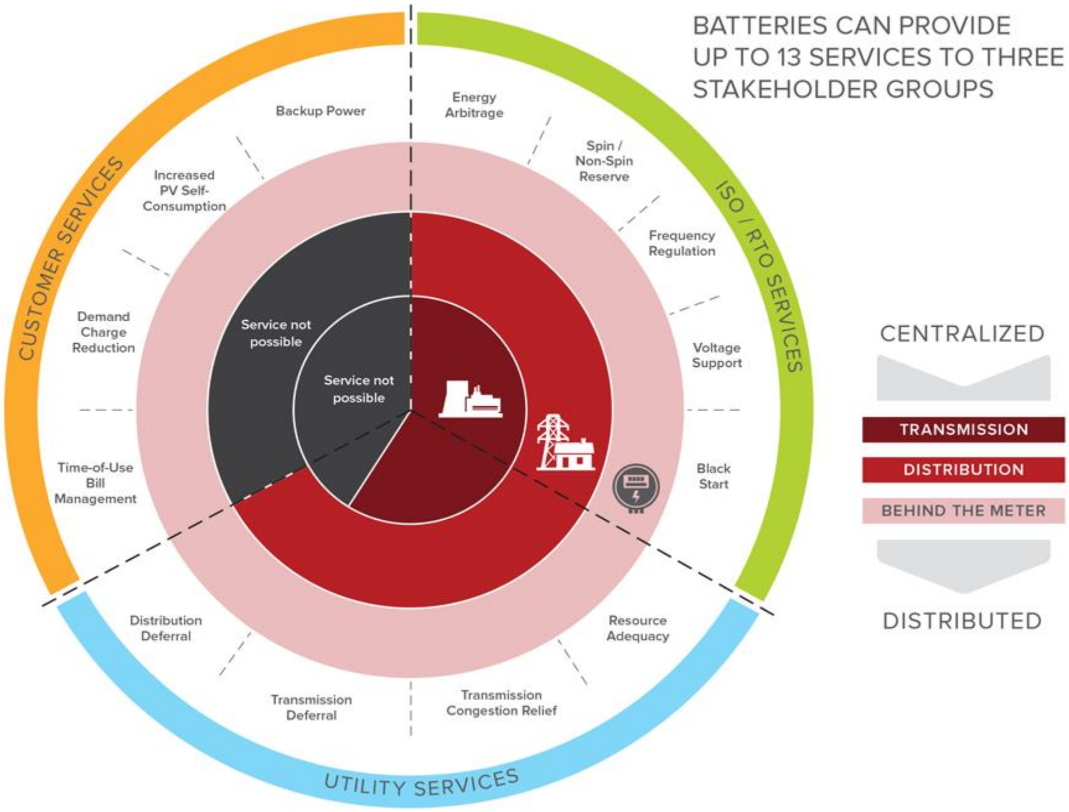

Figure 5: Services provided by energy storage technology.
[Source: R.M.I The economics of Battery Energy Storage]

On the other hand, the use of electrochemical batteries is beginning to become economically viable, especially in countries where grid parity is already achieved [3]. In particular, the emerging deployment of energy storage has been promoted through different well-developed schemes established in several EU countries including strategies on how to value prosumers' excess electricity. By way of illustration, the Feed-in Premium model that was applied between 2009-2012 in Germany offered a premium tariff for self-consumed electricity generated from roof-top PV systems with capacity up to 500 kW. However, the rapid decrease in generation cost of PVs has prompted the German authorities to eliminate the premium tariff and value the self-consumed electricity at retail price. More 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 [4]. Additionally, a 30% (or 40% since 2017) 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. Another example is the UK where smaller-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.

As the price difference between solar PV power production and residential electricity prices is decreasing, the economic case to facilitate battery storage becomes viable [5]. The adoption of storage systems is mainly for balancing distributed generation and reducing peak power generated from decentralised RES installations. The utilisation of energy storage in large-scale applications is becoming interesting for the case of isolated and not interconnected networks. However, this is not financially feasible for all technologies since the decreased unit price is not yet achieved for several storage types such as the battery storage technology. In particular, many studies show that Lithium-ion technology is a viable solution and suitable for residential and utility storage applications. The forecasted price for Lithium-ion batteries is presented in Figure 6, where a significant drop on the price is expected within the next decade.

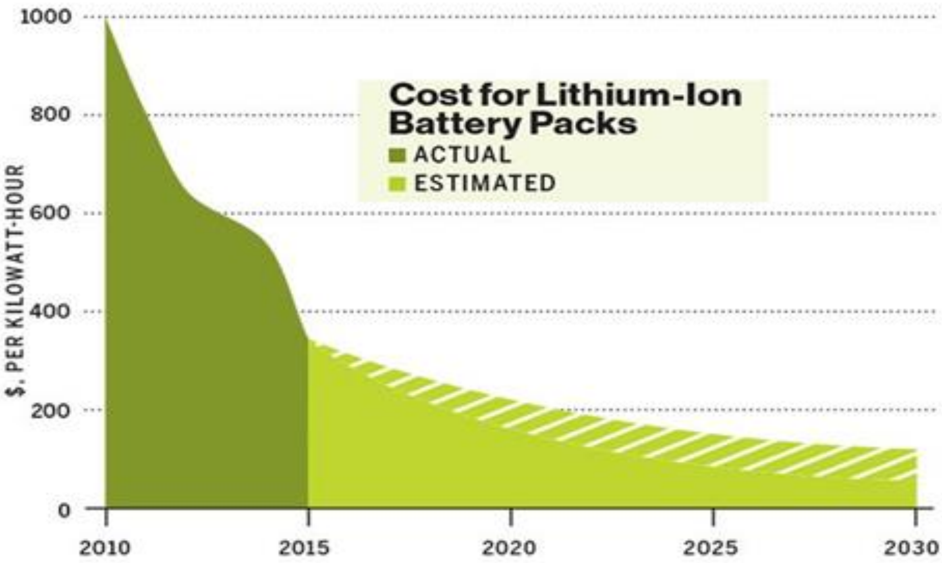

Figure 6: Forecasted price of Lithium-ion batteries.
[Source: Bloomberg New Energy Finance 2016]

7. State of the art in MED regions

The deployment of RES has been increasing over the last few years with solar PV systems to be the most favourable option for the MED countries due to the significant cost reduction of PV systems. As a consequence, solar PV technology is becoming a viable alternative to conventional electricity generation and will contribute to the achievement of the very ambitious energy targets set by the EU for 2020 and beyond. To this end, MED countries are moving away from costly Feed-in Tariffs and have started adopting policies such as net-metering and self-consumption schemes, targeting to encourage prosumers to further utilise RES and therefore achieve higher RES penetration levels. In particular, the existing situation regarding RES penetration in the MED countries is outlined in Table 1 by the end of 2016 along with 2020 energy targets in each MED country.

In this section, the existing situation regarding the evolution of RES over the last few years will be analysed for the MED countries participating in the StoRES project namely Cyprus, France, Greece, Italy, Portugal, Slovenia and Spain. Particular emphasis is placed on photovoltaics due to the high solar resource of the MED countries.

7.1 Renewable Energy Sources in MED Countries

7.1.1 Cyprus

The integration of variable distributed generation sources in weak and isolated power networks such as the distribution grid in Cyprus comes with numerous technical and economic issues. Renewable sources have been introduced to the Cypriot energy mix over the last decades due to the generous subsidies offered and more recently as a result of the significant system price reduction. Considering the ambitious 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 now, the electricity generation mix in Cyprus relies heavily on imported fuels, mainly crude oil. The bulk of the electricity generation is provided by three main power stations with 1478 MW of total installed capacity [6]. According to the statistics published by the Cyprus Transmission System Operator (TSO) shown in Figure 7, an enormous share of 90.6% of the country's total electricity demand in 2016, is covered by diesel generators with the remaining 9.4% from RES. In particular, wind parks constitute the primary renewable source of the island, reaching a share of 4.9% into the Cyprus electrical system by the end of 2016 [7]. Additionally, the contribution of PV systems is of paramount importance considering the island's solar energy potential having 2000 kWh/m^2 of annual solar irradiation. PV penetration accounted for a share of 3.7% whilst biomass accounted for the remaining 0.8% of the total electricity consumption.

Based on data published by the Cyprus Energy Regulatory Authority (CERA), the total installed capacity from RES has amounted to 252.9 MW by the end of 2016. The installed capacity and electricity penetration for different RES are depicted in Figure 7 and Figure 8, respectively. In particular, wind parks amounted to 62% of the total installed capacity or 157.5 MW. Additionally, the significant increase of PV installations over the last few years is reflected on the PV deployment growth, having a share of 34% in the total installed capacity which amounts to 85.7 MW. Finally, the total installed capacity for biomass reached 4%, having a total installed capacity of 9.7 MW by the end of 2016.

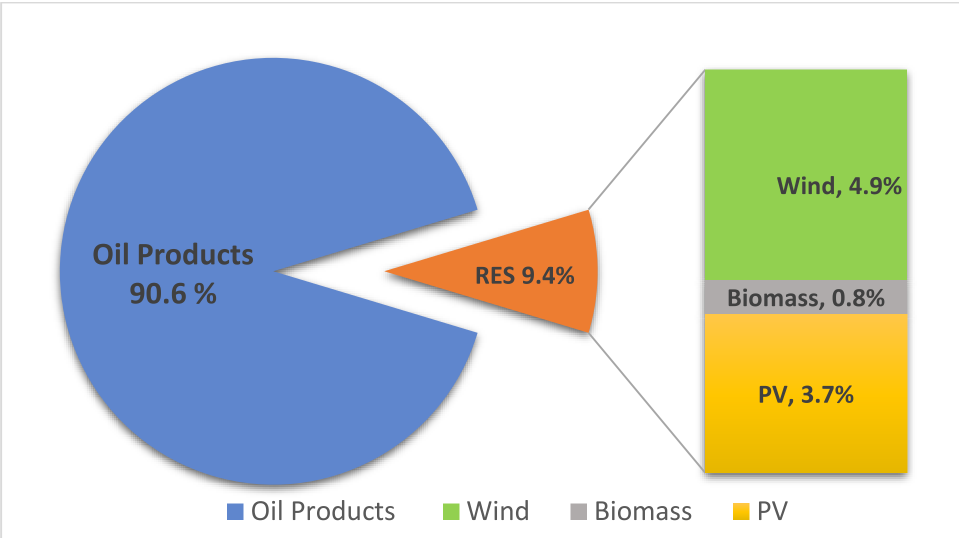

Figure 7: RES penetration to the annual electricity demand in Cyprus for December 2016. [7]

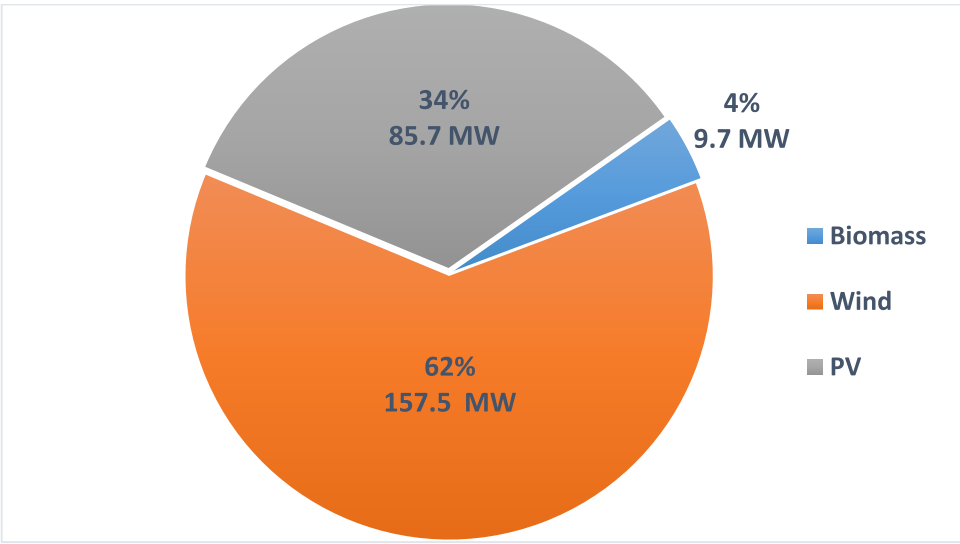

Figure 8: Total installed capacity of different types of RES in Cyprus at the end of 2016. [7]

In response to the EU energy framework, Cyprus has put forward 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 9, RES contribution to the annual gross electricity demand is expected to double by 2020, reaching 16% in line with the national target [8]. This of course, is a positive step towards energy sustainability, however this will give rise to grid issues that will be exacerbated by the fact that Cyprus has a small isolated network if no mitigation actions are taken.

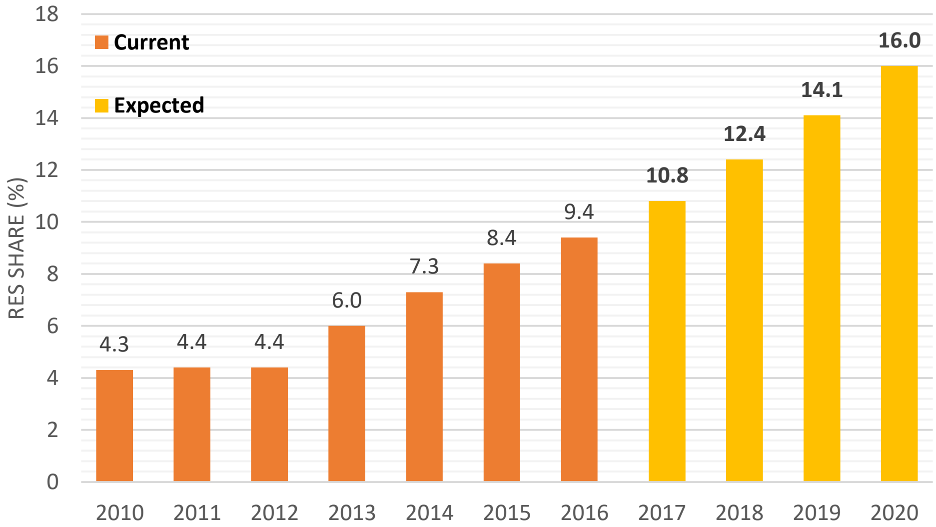

Figure 9: Electricity generation from RES (%) in Cyprus towards 2020. [8]

7.1.2 France

Electricity generation in France represents 570 TWh, mainly provided by nuclear power plants (76.1%) as depicted in Figure 10. In particular, electricity generation from RES was 89.5 TWh in 2015 (without the overseas territories which account for 2 additional TWh), mainly achieved through large hydro power plants (61%) as shown in Figure 11 [9, 10]. PV represents a share of 8% of the final gross electricity generation from RES, which has significantly increased during the past five years thanks to national incentives.

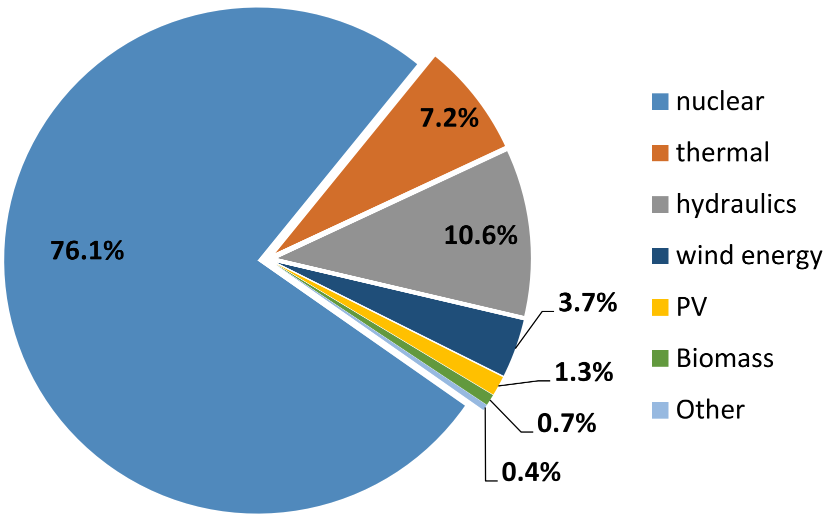

Figure 10: RES penetration to the annual electricity demand in France, 2016.

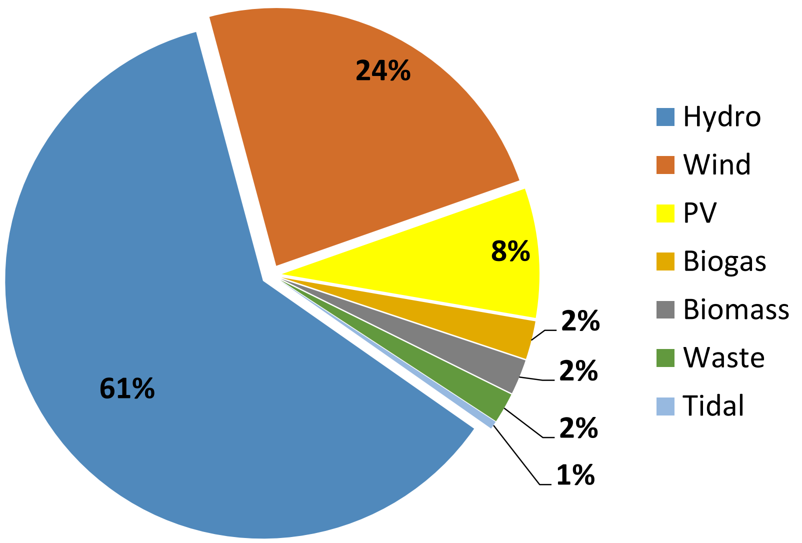

Figure 11: Share of different RES types in France, 2016.

The French government finely tuned various objectives for the development of RES. The last National Law on Energy Transition (2015) aims at reaching 27% of RES in electricity generation in 2020 and 40% in 2030 (previous targets were lower). During these last years, RES only represented between 14% and 17% of electricity generation, the variations being mainly correlated to the variations of hydro production. More detailed targets are also defined per type of energy generation technology.

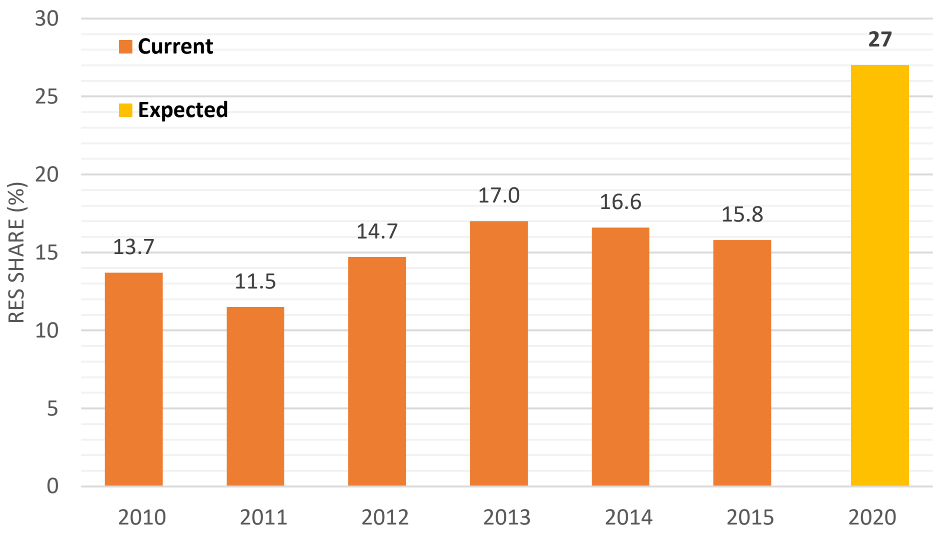

Figure 12: Electricity generation from RES in France towards 2020.

7.1.3 Greece

The electrical network in Greece consists of the interconnected (IC) network, supplying the mainland and some Greek islands, and the non-interconnected (NIC) network, which includes most of the Greek islands. The overall installed capacity of power generation is 17.086 MW for the IC network and 2.262 MW for the NIC network. The installed RES capacity share for the IC network is presented in Figure 13, while the corresponding share for the NIC network is depicted in Figure 14. It is observed that the RES installed capacity constitutes almost 28% of the overall installed capacity of power generation in the IC network, whereas this percentage is less in the NIC network and is equal to 21%. Furthermore, the overall RES installed capacity of Greece is equal to 5250.3 MW [11, 12, 13].

The mix of RES in Greece consists of wind power plants, photovoltaics, small hydroelectric power plants, and biomass/biogas technologies. The installed capacity of the aforementioned RES types for the IC and the NIC network is depicted in Figure 15 and Figure 16 respectively. It is worthy to mention that PV installations are categorized into rooftop PVs and ground mounted PV systems (PV parks). The installed capacity of PV installations is greater than the corresponding wind power installations in the IC network. On the other hand, wind power installations are double the installed capacity of the PV installations in the NIC network, mainly due to the large wind potential of the Greek islands. Considering PV installations, 14% consists of rooftop PVs while the remaining 86% corresponds to ground mounted PV systems. This situation applies for both the IC and NIC networks, as shown in Figure 17. Finally, Figure 18 shows the share of RES in Greece over the last years towards achieving the 2020 national targets.

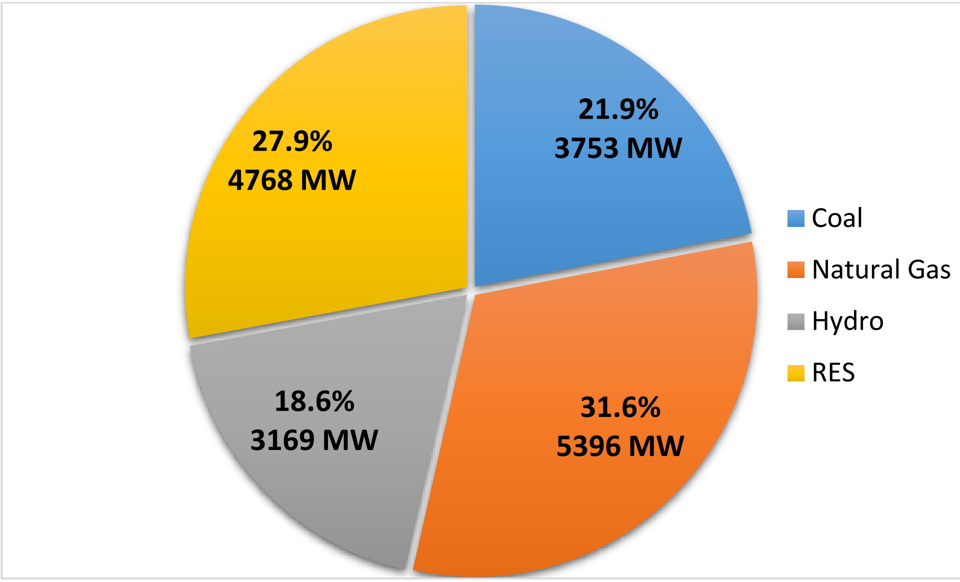

Figure 13: Overall installed capacity of power generation in the Greek IC by the end of 2016.

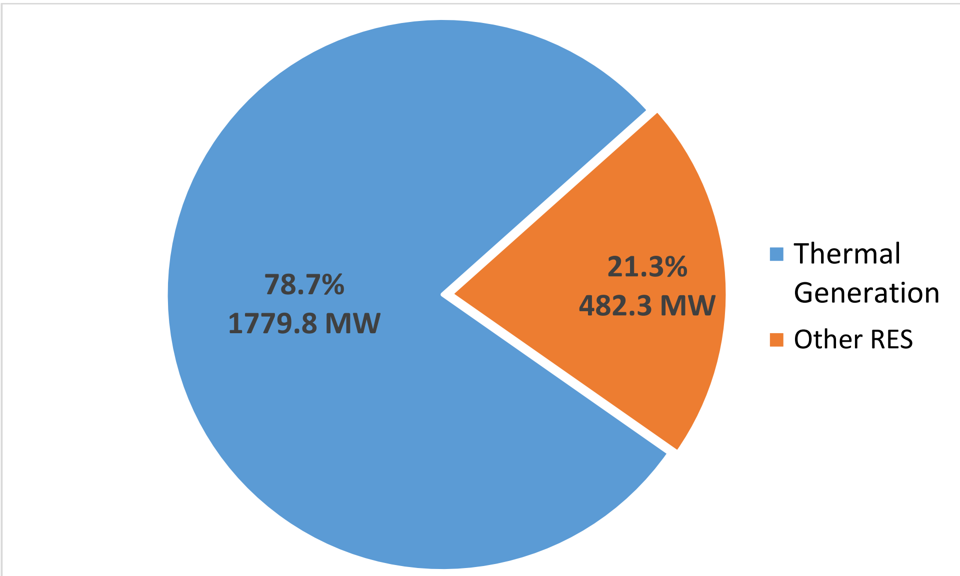

Figure 14: Overall installed capacity of power generation in the Greek NIC by the end of 2016.

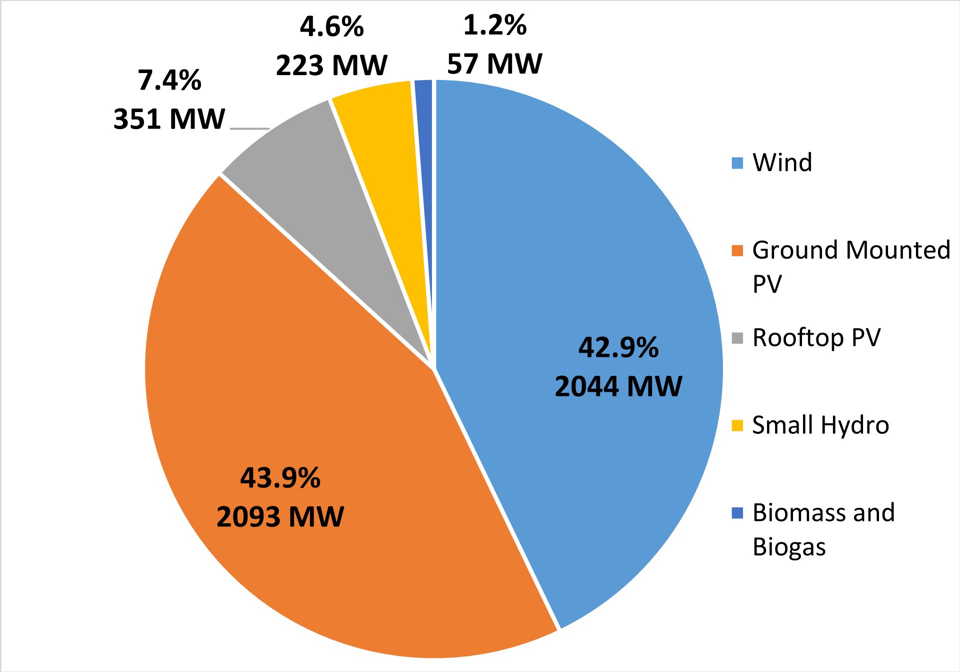

Figure 15: Installed RES capacity of the Greek IC network by the end of 2016. Source: [11, 12, 13].

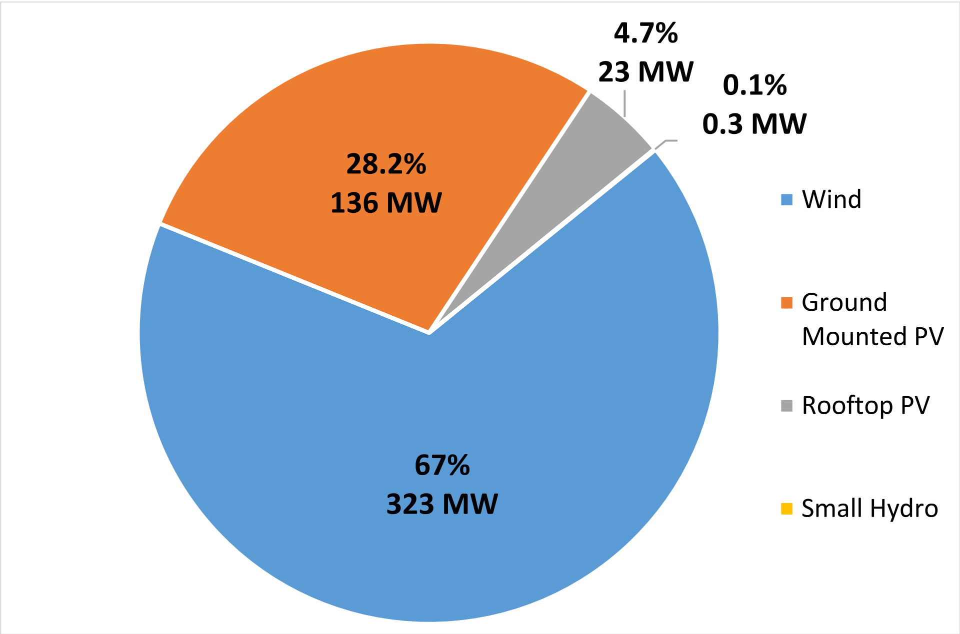

Figure 16: Installed RES capacity of the Greek NIC network by the end of 2016. Source: [11, 12, 13].

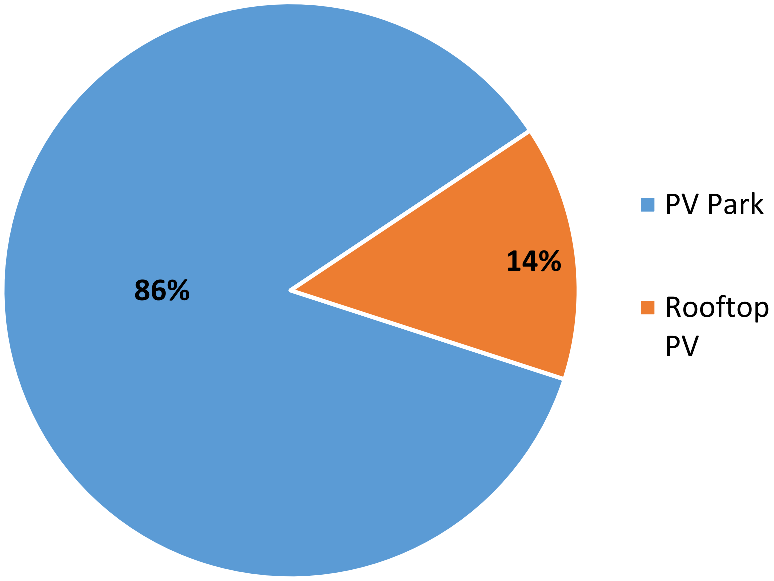

Figure 17: Percentage distribution of the installed PV capacity of the Greek IC network by the end of 2016. Source: [11, 12, 13].

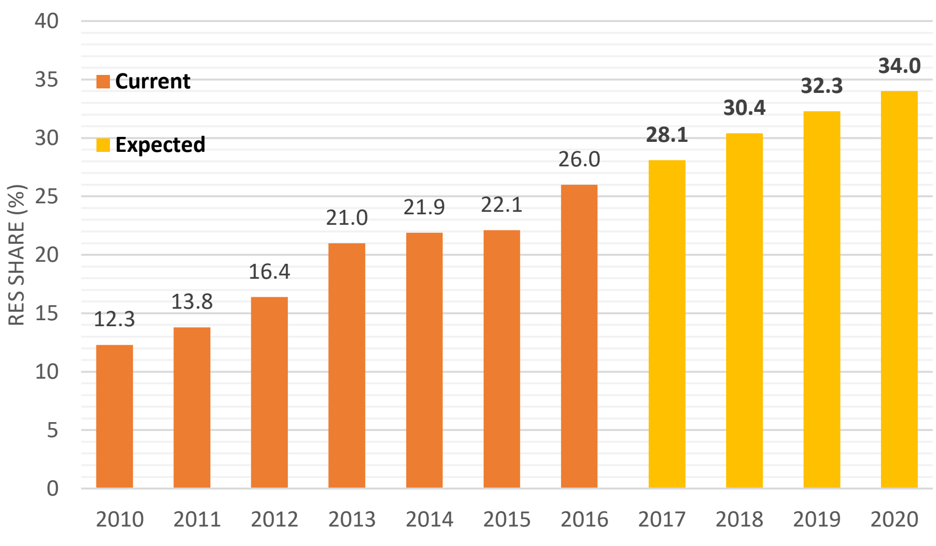

Figure 18: Electricity generation from RES (%) in Greece towards 2020. Source: [11, 12, 13].

7.1.4 Italy

A priority for Italy is to resume sustainable growth – sustainable from both the economic and the environmental perspective. The energy sector has a fundamental role to play in the growth of the economy and of the country, and achieving a more competitive and sustainable energy is therefore one of the most significant challenges in Italy. That is mainly why the Government has drawn up a National Energy Strategy [14] that sets out clearly the main goals to be pursued in the coming years, as well as describes the basic decisions to be taken and establishes the priorities of action.

To achieve this, there is the need to address some important challenges:

- Energy prices for businesses and families that are higher than in other European countries.
- Security of supply that is by no means optimal at peak loads, especially as regards natural gas, and a high dependence on imported fossil fuels.
- Economic and financial difficulties experienced by a number of operators in the sector.

The National Energy Strategy (Strategia Energetica Nazionale – SEN) [14], adopted in March 2013 (as approved by Ministerial Decree of MISE on March 8, 2013), defined four main objectives to improve the competitiveness and sustainability of the Italian energy sector by 2020:

- Significantly reduce the energy cost gap for consumers and businesses, by bringing prices and costs in line with European levels by 2020 and ensuring a longer-term energy transition,
- Meeting and going beyond European targets set out in the 2020 European Climate-energy package and Italy's National Action Plan of June 2010 (NAP),
- Improving security of supply, especially in the gas sector, and reducing dependency on imports,
- Boosting growth and employment by mobilizing investments of €170-180 billion by 2020, either in traditional sectors or in the green economy.

Moreover, consumers drive the energy transition. The distributed nature of RES, the competitive costs of RES technologies, and new developments in smart grids and battery storage solutions make it possible for energy consumers – both at a domestic and an industrial level - to become active players on the market.

For these reasons, Italy has adopted national renewable energy action plans to meet its renewables targets (including electricity, heating and cooling and transport), and to achieve its EU target for final energy consumption from RES by 2020. If the SEN energy efficiency target (126 Mtoe of final energy consumption in 2020) is reached, 21.4 Mtoe of final energy consumption should come from renewables in 2020.

Italy has reached its objectives on RES share (17%) five years in advance, thanks mainly to a sharp increase in non-hydro power production capacity between 2008 and 2012. In 2016 the provisional share of RES in the gross final consumption of energy reached 17.6% [15].

Italian electricity transmission grid operator company TERNA has published preliminary data for 2016, revealing that the country covered 34.2% of its electricity needs (310.2 TWh) with renewable energy, recording 106.2 TWh from RES (Figure 19) [16]. Specifically, 423.2 TWh of energy came from hydro plants, 225.4 TWh from solar PV installations, 174.5 TWh from wind, and 586.5 TWh from geothermal units (Figure 20). This corresponds to solar PV systems covering 8% of the country's electricity mix in 2016. Figure 21 shows the RES cumulative installed capacity in Italy (2000-2016), whereas in Figure 22, the evolution of the RES gross electricity production in Italy in the period 2000-2016 is reported. Finally, Figure 23 depicts the electricity generation from RES between the years 2010 and 2016 and the expected share towards 2020.

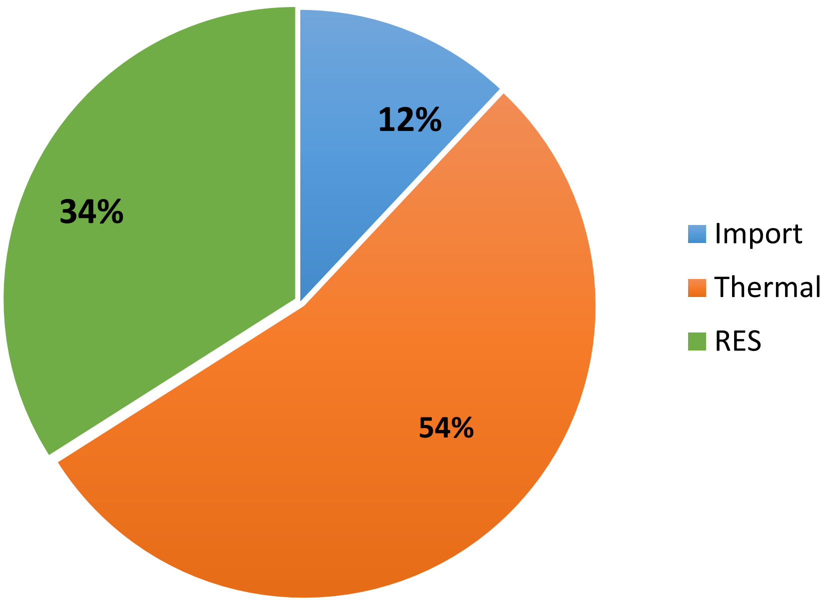

Figure 19: RES penetration to the annual electricity demand in Italy by the end of 2016.

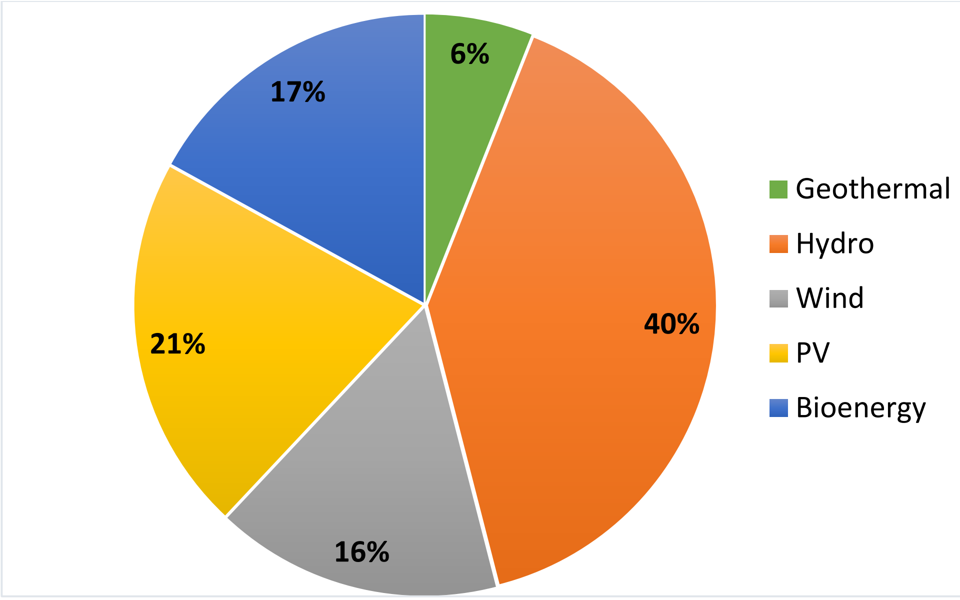

Figure 20: Share of different RES in the annual electricity demand in Italy by the end of 2016. [16]

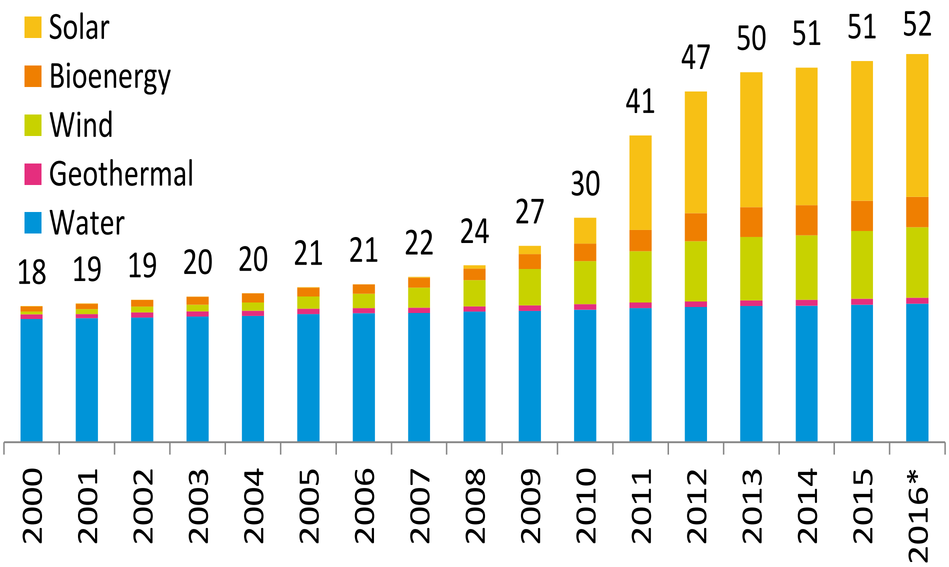

Figure 21: RES cumulative installed capacity in Italy (2000-2016) [GW]. [17]

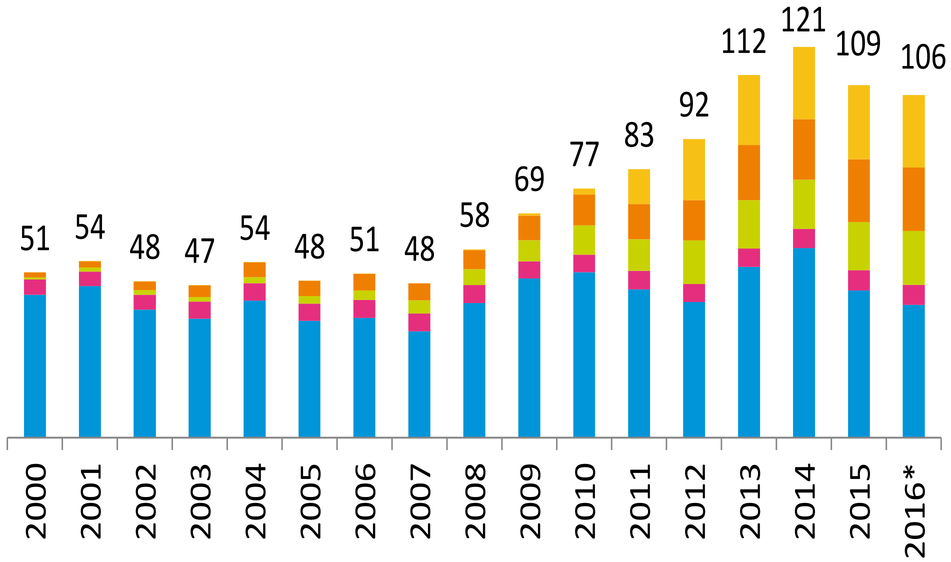

Figure 22: RES gross electricity production in Italy (2000-2016) [TWh].

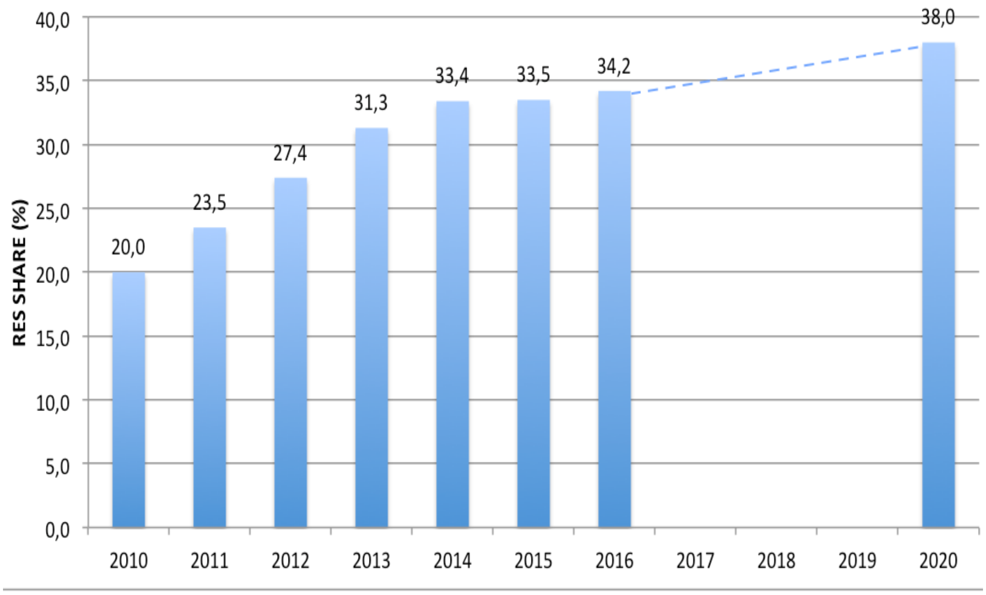

Figure 23: Electricity generation from RES (%) towards 2020 in Italy. Source: EUROSTAT and [14].

7.1.5 Portugal

The national electricity production system has a total installed capacity of 20.201 MW. As depicted in Figure 24, a share of 39.1% of the total installed electricity production systems are oil-based technologies (coal, oil and natural gas) which amounts to 7.908 MW, whilst a share of 60.9% or 12.297 MW consists of RES technologies such as Hydro, Wind, Biomass, Solar, Geothermal and Wave [18].

Considering the impact of fossil fuels to the energy system, it has been declining in recent years due to the closure of thermal power stations in mainland Portugal and the conversion of the cogeneration systems to Natural Gas, and currently there are only thermal power stations using Petroleum in the Autonomous Regions and some capacity in Cogeneration. Regarding RES contribution to the energy mix, hydro and wind are the most dominant types reaching a total installed capacity of 6.835 MW and 5.269 MW respectively, as depicted in Figure 25. Finally, the impact of solar technologies such as PV and CSP has been growing over the last years as total installed capacity reached 473 MW in 2016.

In response to the EU energy framework for 2020 [19], Portugal has put forward very ambitious national targets to be met. According the official projections, shown in Figure 26, Portugal intends to have 60% of its generated electricity coming from RES, in order to meet the 31% of its final energy consumption by 2020.

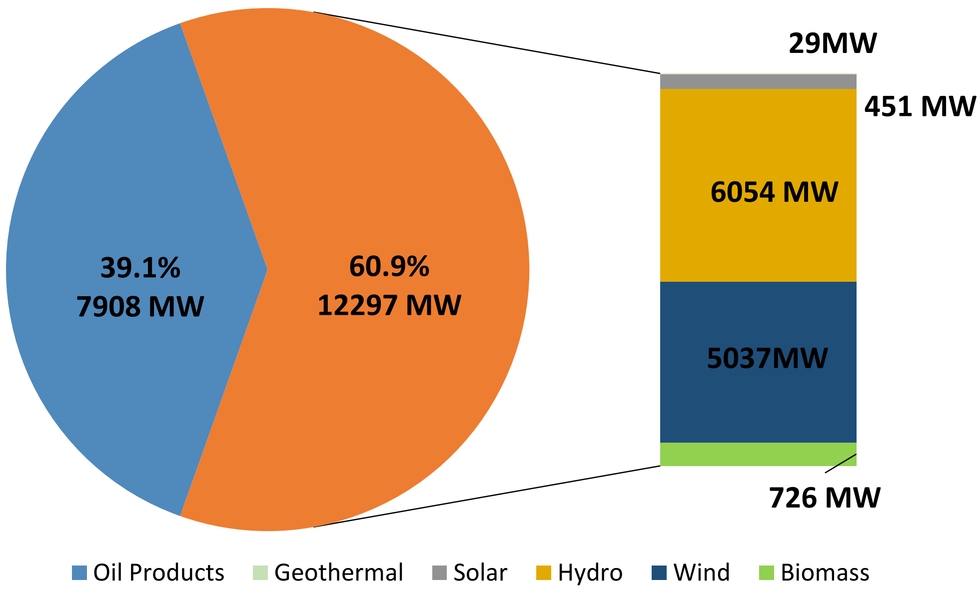

Figure 24: Total installed capacity of the electricity production system in Portugal. Source [18]

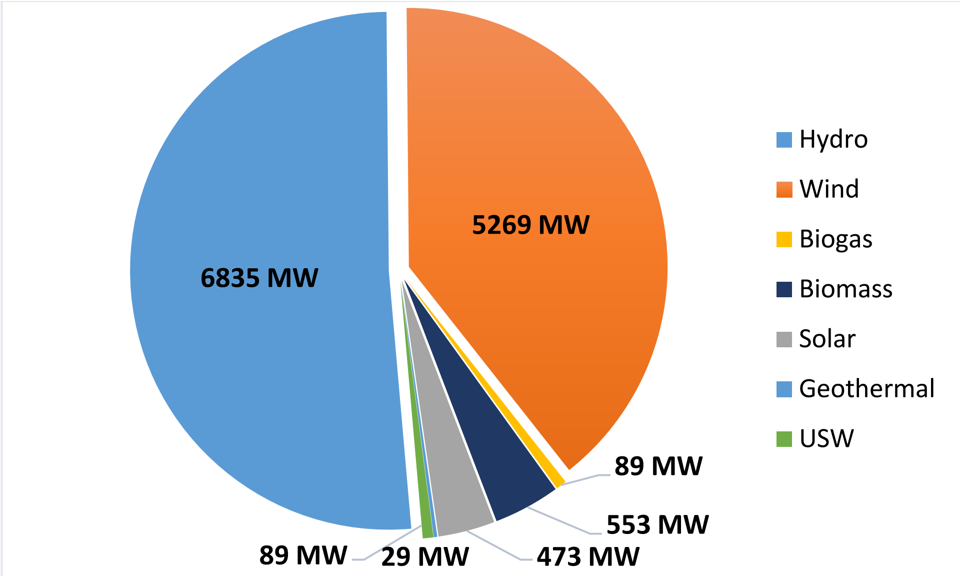

Figure 25: RES installed capacity [MW] of the electricity production system in Portugal. Source [18]

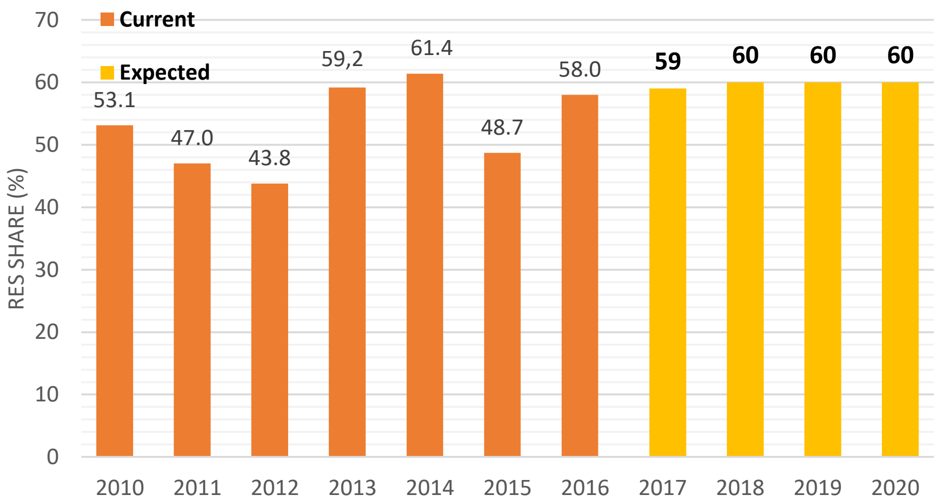

Figure 26: Electricity generation from RES [%] in Portugal towards 2020. Source [18, 19]

7.1.6 Slovenia

In Slovenia, electrical energy is produced in conventional power plants connected to the transmission grid and in dispersed small and micro power plants connected to the transmission and distribution grid. The following dispersed production in Slovenia is especially important:

- Small hydro power plants,
- Small PV power plants,
- Industrial facilities for combined heat and power (CHP).

Slovenian electricity production in 2015 amounted to 11.741 TWh, with 33.3% share of thermal power plants, 32.3% hydro power plants and 22.9% nuclear power plants. A total 0.981 TWh of produced electricity is included in the support scheme for RES and highly efficient CHP. The total electrical energy consumption in Slovenia in 2015 was 13.905 TWh and 13.041 TWh without considering losses in transmission and distribution grid. In comparison to 2014 total consumption was 0.266 TWh higher, which presents a 2.7% increase.

The regulation supporting the electricity generation from RES and High-efficiency CHP came into force on November 24th 2016 and specifies the technologies for production of electricity from RES and high-efficiency CHP, which are eligible for support, amount and duration of support, conditions and other questions related to the support.

Support can be carried out as:

- Guaranteed purchase of electricity;
- Financial support for operation of RES and high efficiency CHP.

Support for electricity production can be given to the following RES types:

- Energy potential of watercourses (hydroenergy);
- Onshore wind energy;
- Solar energy (photovoltaic);
- Geothermal energy;
- Biogas energy form biomass;
- Landfill gas energy;
- Gas from water treatment plants;
- Energy from biodegradable waste;
- High efficient CHP from wood biomass.

Supports for producers of electricity are guaranteed for a maximum of 15 years for new RES systems and a maximum of 10 years for new CHP systems. The FiT are eligible in the case where generation does not exceed 10 MW, except for wind power plants, where the nominal power must be less than 50 MW.

The Slovenian Environmental Fund (Eko sklad) is responsible for disseminating the support schemes by inviting interested prosumers to tenders and also publishes public calls on a regular basis. The Ministry of Infrastructure (Directorate for Energy, Energy Efficiency and Renewable Energy Sources Division) also publishes specific calls and tenders where the Slovenian Environmental Fund (Eko sklad) invites applications for soft loans. Different RES technologies are generally eligible for support; however, limits exist to the total installed capacity of certain RES types. Apart from support schemes for CHP with RES, the most substantial support for RES in Slovenia is heating and cooling and financial incentives are available from the Ministry of Infrastructure.

According to the annual status report of Energy Sector published by the public Energy Agency of the Republic of Slovenia, the total installed RES capacity accounted for 459.7 MW in 2016 as shown in Figure 27 [20]. It can also be observed that the capacity for Thermal and Hydro reached 1458 MW and 1271 MW respectively. Finally, Figure 28 illustrates the share of RES in the annual gross electricity generation between 2010 and 2015 along with the national 2020 energy target [21]. Slovenia is expected to achieve a share of 25% by 2020 in order to meet the national targets set by the EU.

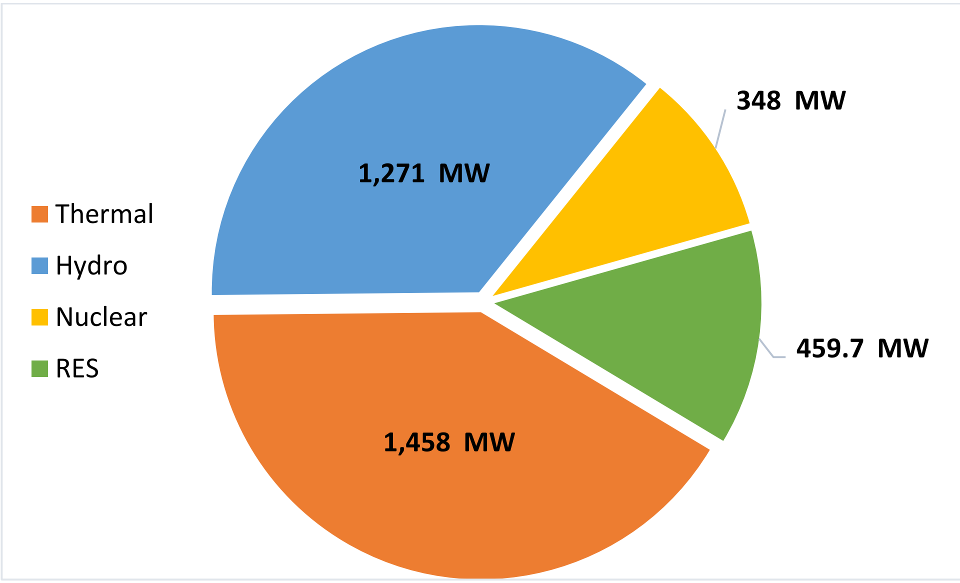

Figure 27: Installed power (MW) of production facilities in Slovenia, 2016.

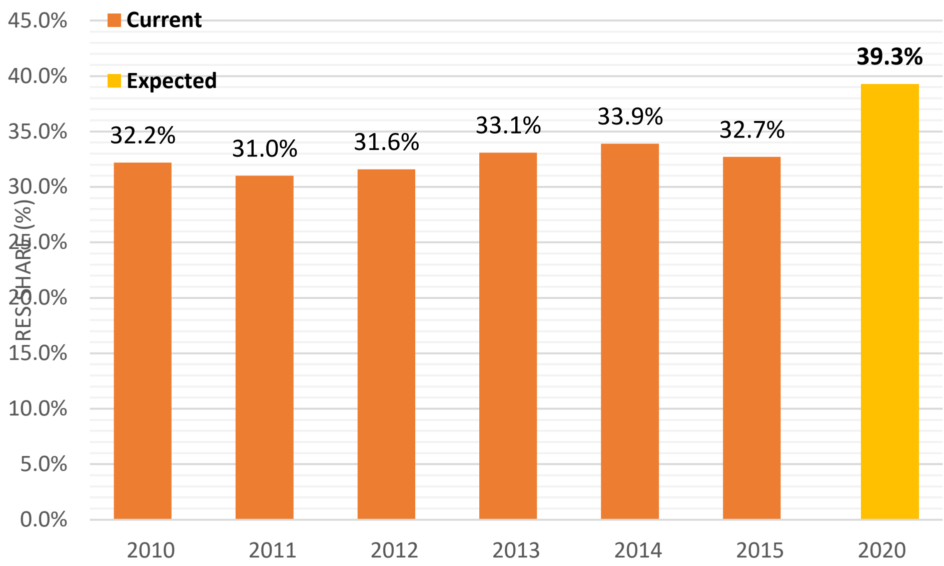

Figure 28: Share of RES in gross final electricity generation in Slovenia between 2010 and 2015. [Source: Eurostat, NREAP Slovenia].

7.1.7 Spain

The RES share in the electricity generation in Spain has experienced a considerable increase the previous years. As shown in Figure 29, the share of RES in electricity generation has doubled between the years 2007 and 2013, reaching a share of almost 40% in 2016 [22]. More specifically, the distribution of electricity production from different sources is depicted in Figure 30 for the year 2016. It can be observed that the four most important sources are Nuclear and Carbon for non-renewable energies, whilst hydro and wind are the most dominant RES sources.

Considering the installed renewable power in Spain in 2016, the data is depicted in Figure 31, which shows how wind (48%) and hydraulic energy (36%) cover the bulk of the installed RES. Solar photovoltaic covers a 10% of the total installed capacity [23].

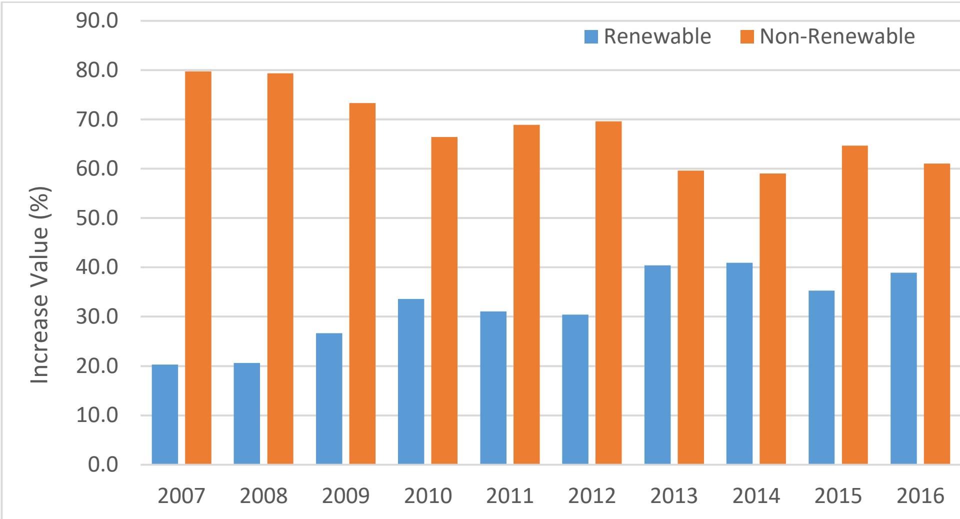

Figure 29: Evolution of RES in electricity generation in Spain up until 2016.

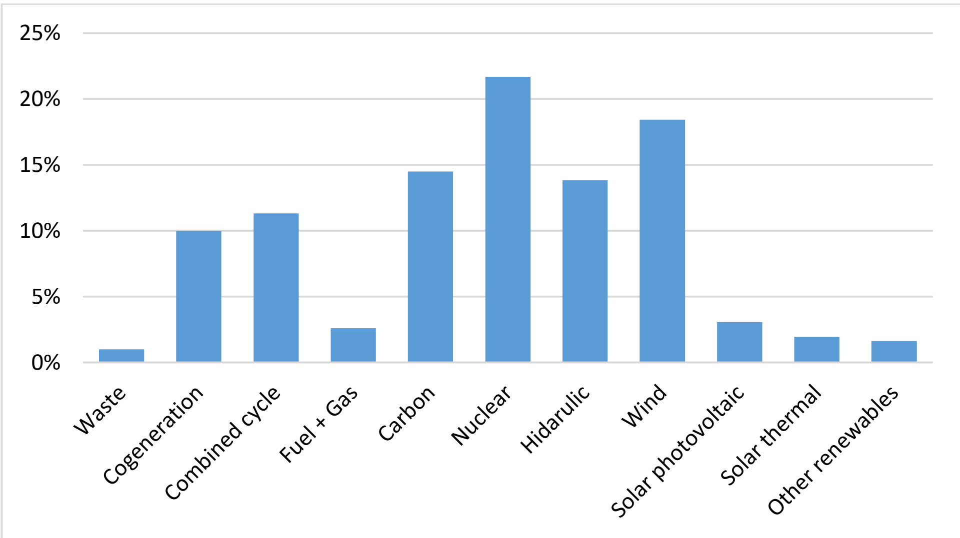

Figure 30: Breakdown of the annual electricity generation in Spain, 2016.

Finally, Figure 32 shows the evolution of the RES penetration in the electricity generation in Spain, together with the expected share for 2020 according to the current Plan of Renewable Energies 2011-2020 in Spain [23].

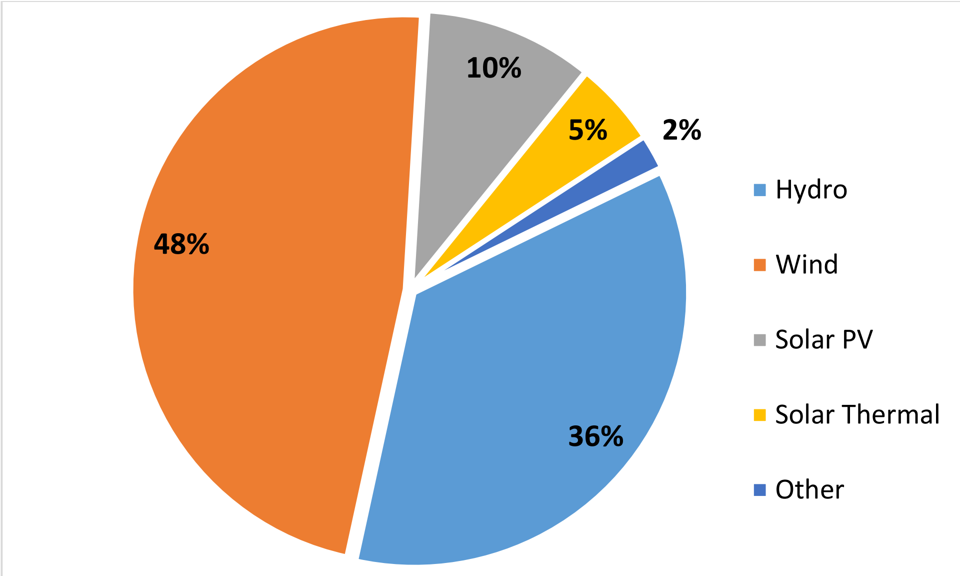

Figure 31: Breakdown of the different RES installed in Spain, 2016.

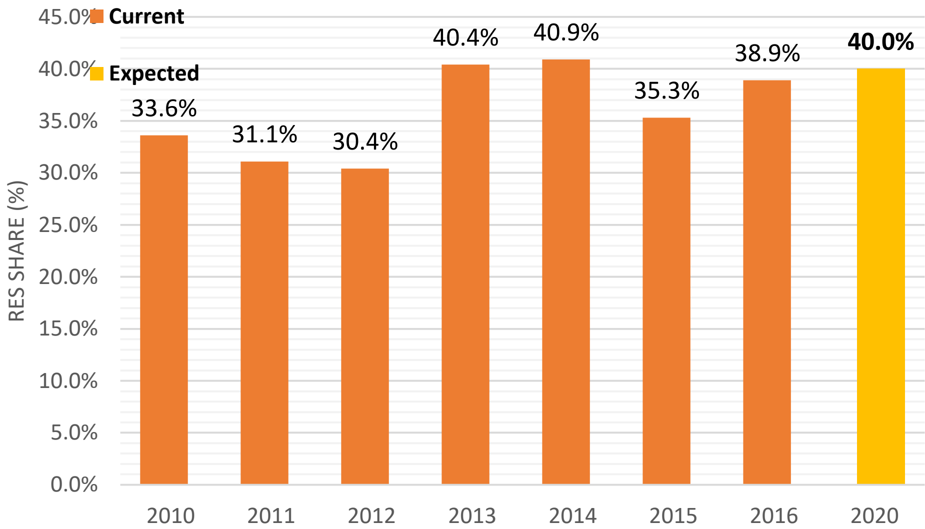

Figure 32: Share of RES in gross final electricity generation in Spain between 2010 and 2015 and expected trajectory towards 2020. [24].

7.2 Photovoltaics

7.2.1 Cyprus

Photovoltaic technology has seen remarkable growth in Cyprus during the last few years, with PV installed capacity almost doubling in consecutive years (see Figure 33). Grid parity conditions combined with the implementation of favourable policies such as net-metering have contributed to this trend of increasing PV system installations on the island.

Overall, there have been several financial programmes announced over the last years in Cyprus to encourage the further deployment of PV systems. The Cyprus government 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 a total of 43 MWp installed capacity by the end of 2013.

Additionally, a similar scheme was announced in the same year, supporting large-scale PV projects of capacity above 150 kWp by means of a competitive bidding process. The first tender was organised by the Ministry of Energy, Commerce, Industry and Tourism (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 installations under FiT incentives by the end of 2016 amounted to 53.0 MWp installed capacity.

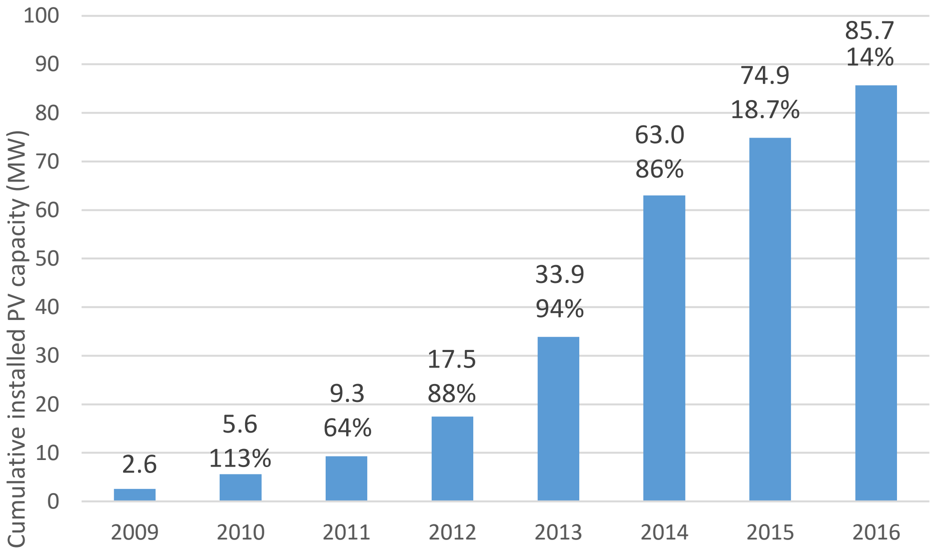

Figure 33: Cumulative installed PV power capacity in Cyprus for the years 2009 till the end of 2016.

The net-metering support scheme administrated by the MECIT under the "Solar Energy for all" programme was established in 2013 under Law No.112(I)/2013 [25]. Under this scheme, the installation of residential PV systems having maximum capacity up to 3 kWp was allowed. According to the framework amendment released by the year 2015 [26], the upper limit for net-metered systems has been increased to 5 kWp. This comprises the only available policy framework for residential PV installation in Cyprus and the total approved capacity cap for the year 2015 was 23 MWp. In order to push further the utilisation of net-metered PV systems, governmental subsidies were offered for vulnerable prosumers (i.e. low income families) who could benefit up to €2700 of the total system price. The favourable conditions of net-metering scheme fuelled the deployment of small-scale PV systems, reaching a total number of installations close to 8000, corresponding to 28.25 MWp of total installed capacity at the end of 2016. This can be verified in Figure 34 showing the decreasing trend in FiT installations and the increasing trend of the net-metering installations between 2014 and 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. As defined by the Electricity Authority of Cyprus (EAC), 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. In fact, considering 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. Historically, the total permitted capacity for new installations under self-consumption offered by the MECIT by 2010 was 5 MWp, whilst according to 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.

Concluding, Table 2 summarizes the capacity caps for each policy framework established in Cyprus along with the total installed PV capacity in Cyprus under different policy frameworks up until the end of 2016. The establishment of support schemes is an important part of the energy strategic plan of the government towards promoting RES penetration and in particular solar PV system through the active engagement of consumers in achieving high shares of PV in the energy mix of the island. Self-consumption can be considered as a plan to expand towards managing optimal allocation of storage in the future active distribution networks of Cyprus for achieving the foreseen energy transition.

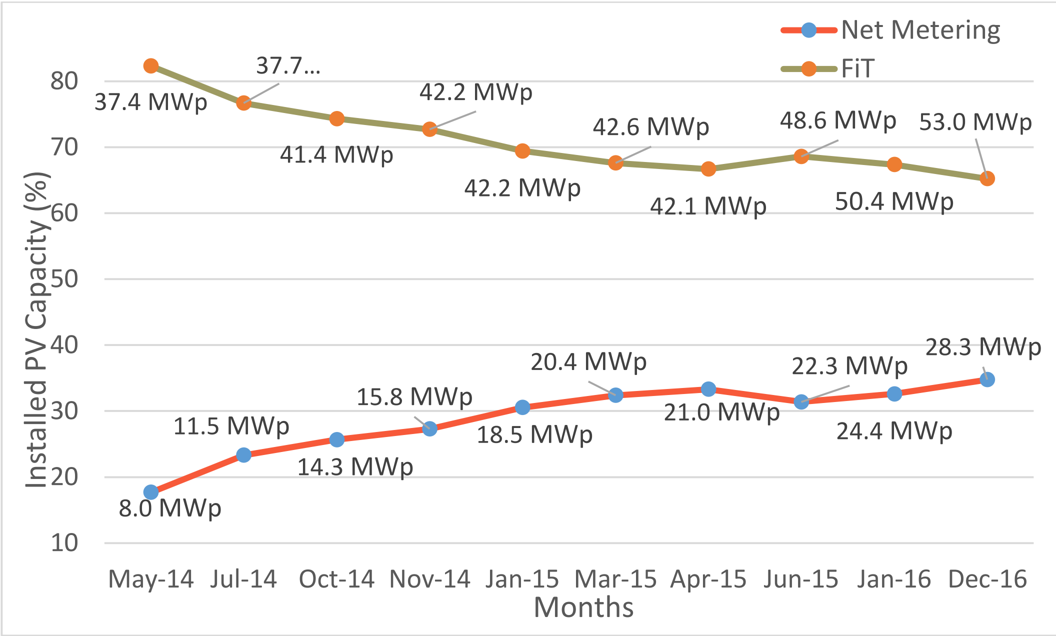

Figure 34: Installed PV capacity in Cyprus under FiT and net-metering scheme.

Table 2: PV capacity cap under different support schemes in Cyprus, 2016.

	Net-metering MWp	**Self-Consumption MWp**	**FiT/Tender MWp**
2010 – 2014 Capacity cap	15	5	No limit/50
2016 Capacity cap	23	40	-
Total Capacity Cap	38	45	≥ 50
Total Installed PV Capacity	**28.3**	**3.7**	**53.0**

7.2.2 France

PV installed capacity has been increasing significantly during the last ten years thanks to national incentives (feed-in tariffs for small plants and call for tenders for bigger plants). This situation is depicted in Figure 35, where 7.15 GWp were installed by the end of 2016, among which 718 MWp in the Auvergne – Rhône-Alpes region. The objective is to reach 10.2 GWp in 2018 and between 18.2 and 20.2 GWp in 2023 [27].

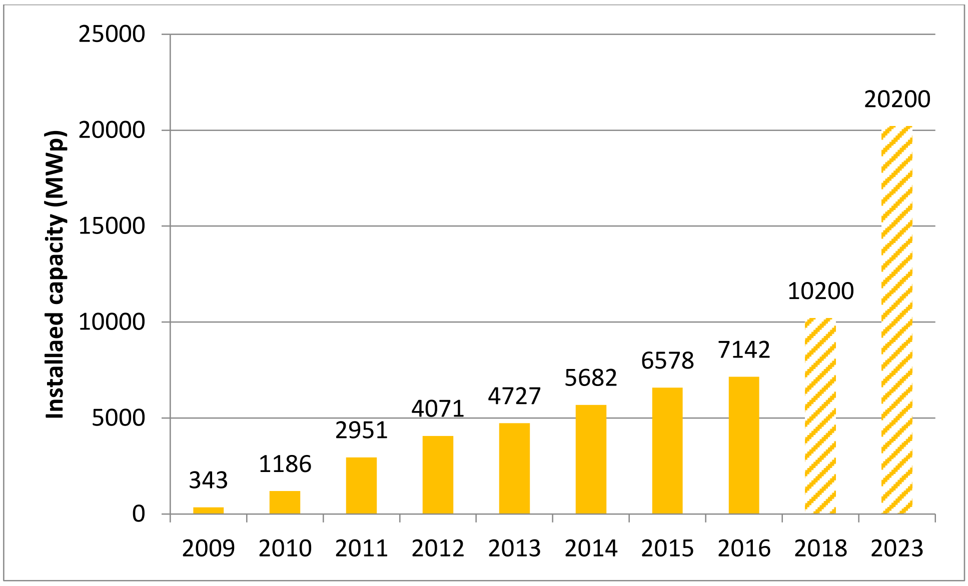

Figure 35: PV installed capacity since 2009 in France.

Even though the highest number of PV plants corresponds to small plants (under 3 kWp), most of the installed capacity is represented by large plants (> 250 kWp). Small plants have been fostered by a high feed-in tariff and by a tax credit (in the first years of development), which accounts for this breakdown profile. As shown in Figure 36, this trend is slowing down and there are fewer residential plants installed per year (8000 residential PV plants were installed in the first 2016 semester, whereas they were 12300 during the same period in 2014).

The Feed-in tariff scheme does not apply above 100 kWp, which explains why there are fewer big plants. Plants above 100 kWp have to apply to national call for tenders, which is organized a few times a year (typically two or three times).

Nearly all the plants sell their electricity to the grid. There is no figure regarding PV plants under self-consumption, since this scheme was hardly chosen till now. Nevertheless, the National Barometer on Electric RES (2016) estimates that the market for self-consumption is starting now and represented 20% of the new plants below 3 kWp in 2015. The market is also expanding for larger plants (on commercial buildings) thanks to a dedicated call for tenders (in 2016 a call for tender was launched so as to develop 40 MWp of large PV plants using self-consumption). Plants are well distributed on the whole national territory as shown in Figure 37, but the highest capacities are installed in the southern part due to higher solar irradiation [28].

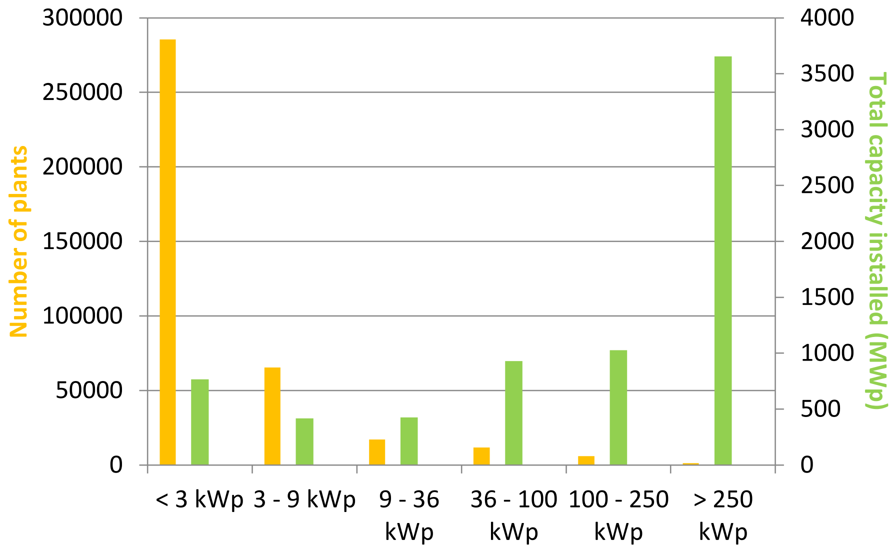

Figure 36: Breakdown of all the installed PV plants according to capacity range in France, 2016.

Figure 37: Geographical representation of PV plants in France, 2016 (MWp).

7.2.3 Greece

As shown in Figure 38, the installation of PV systems in Greece has been remarkably increased during the last few years. This is attributed to support schemes, launched by the Greek government, offering FiT incentives to prosumers as well as to the recently employed net-metering policy. The FiT scheme was adopted by the Greek state in 2006, while the net-metering support policy was initiated in April 2015. As depicted in Figure 39, during 2012 the electricity produced from the installed PV systems covered 2.94% of the country total energy demand. This percentage has been significantly increased during the last four years, climbing up to 6.87%.

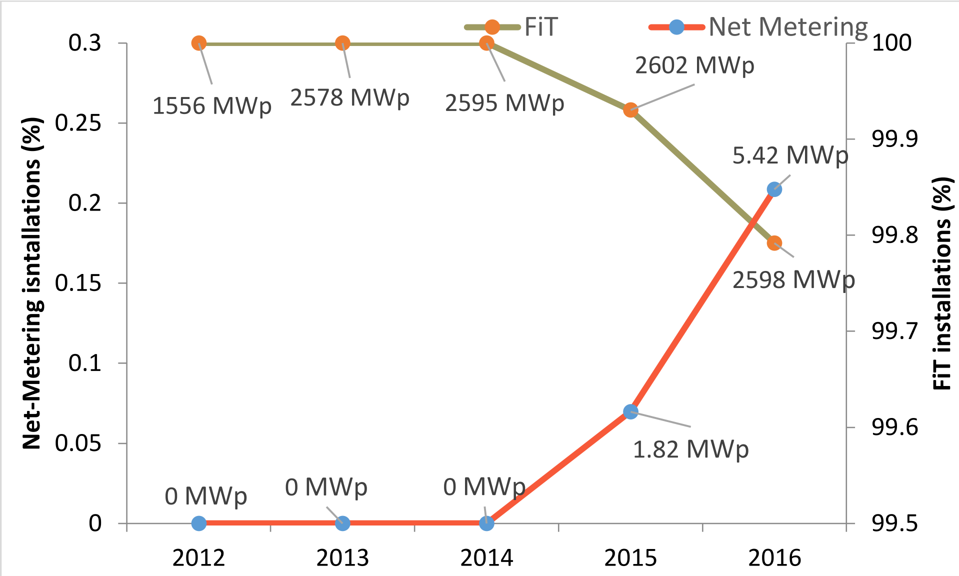

Figure 38: Installed PV capacity in Greece under FiT and net-metering scheme.

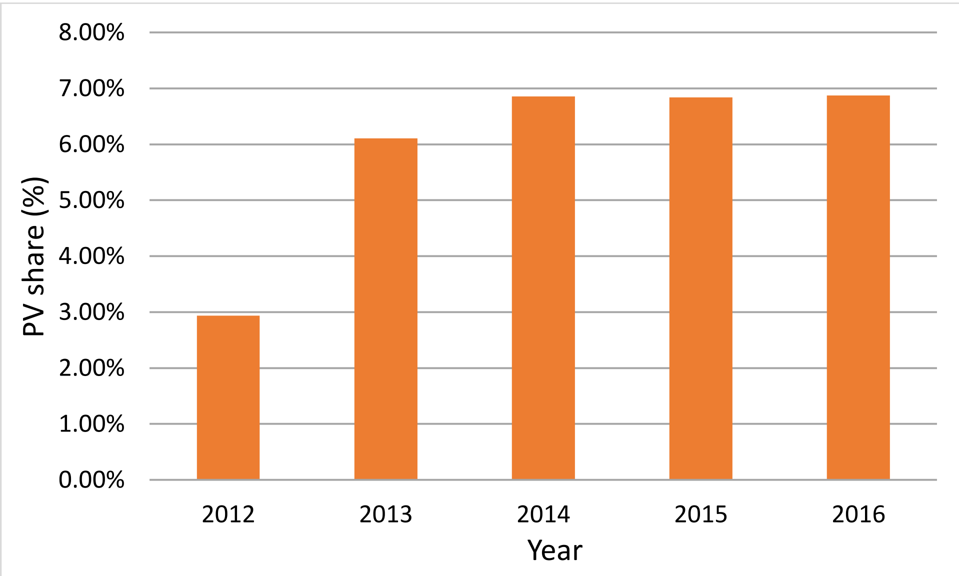

Figure 39: PV share of IC and NIC system in Greece from 2012 to 2016.

7.2.4 Italy

In the past years, the number and capacity of PV plants in Italy grew at a very sustained pace. From January 2009 to July 2013, new PV systems with minimum capacity of 1 kWp were eligible for installation under the FiT scheme (Energy Account – Conto Energia). In 2008 PV capacity was about 2% of the total renewable capacity installed in Italy. In 2016 this share became 37% [16, 17]. According to the GSE (Gestore Servizi Energetici), the state-owned company responsible for the promotion of renewable energy sources (RES) and implementation of support policies in Italy, by the end of 2016 more than 730,000 PV plants were installed, for a total power capacity of 19.3 GWp. The incremental installation of PV systems in 2016 did not result in significant changes in its territorial distribution, which remains almost unchanged from the previous year.

The new PV installations in 2016 reached about 373 MWp, whereas 300 MWp was achieved in 2015. This amount is not expected to differ significantly today, due to the current weak growth of the sector. In 2016, Italy met 7.3% of its electricity needs with solar, and the country installed 19.26 GWp of solar PV cumulatively[1]. Despite this outcome, the rate of new PV installations in Italy has declined compared with the past years, with the majority of solar being added through the Italian net-metering scheme (Figure 40). By considering the current trend of PV installations in the post FiT era (Figure 41), the results of preliminary data for 2016 show that PV capacity increased by 373 MWp of which 20 MWp were supported by the Energy account, and 353 MWp were not supported by the Energy account, but mainly under the "net billing" scheme.

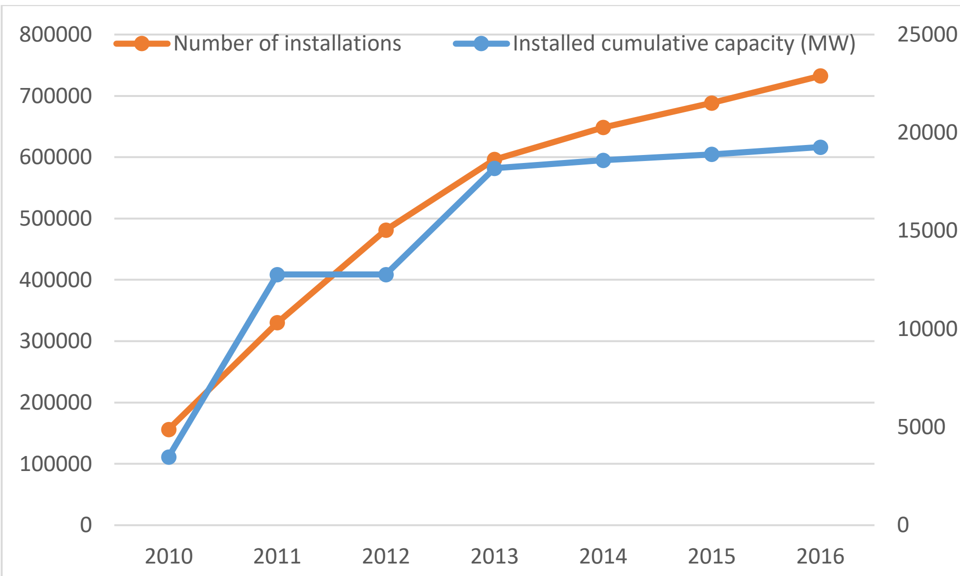

Figure 40: Number and capacity of PV plants in Italy (2010-2016) [MW].

[1] Preliminary data

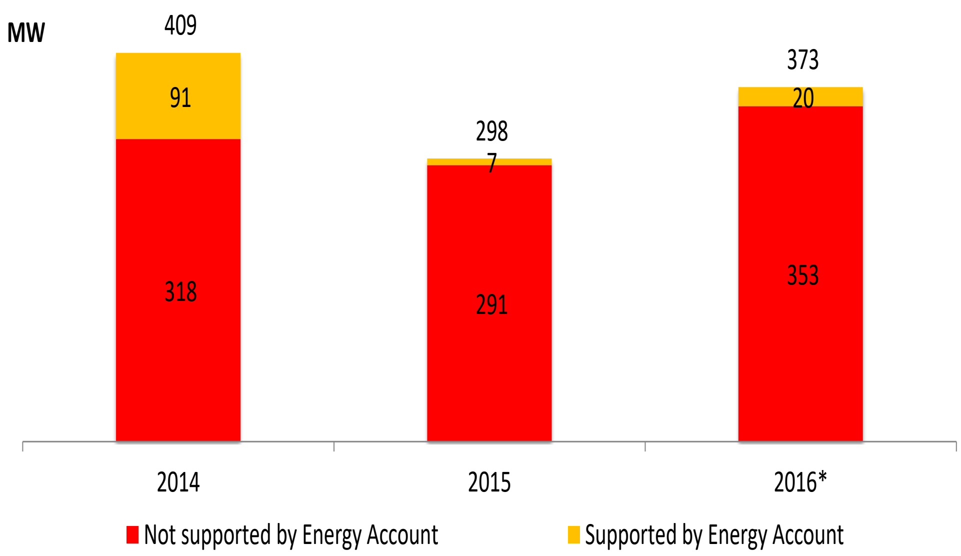

Figure 41: Trend of PV installations in the post FiT era, 2016. Source: [17].

In Table 3, the distribution of power plants subdivided by size is reported, highlighting that the majority of power plants have small size. In fact, 91% of PV plants have size below 20 kWp, with average capacity of 5 kW (626472 plants, 20% of overall capacity). Moreover, 98% of PV plants are below 200 kW (676,705 plants, 40% of overall capacity).

Table 3: Breakdown of PV installations by capacity (2015-2016)

	2015		2016	
Size (kW)	**n°**	**MW**	**n°**	**MW**
1<=C<=3	228.267	627	245.408	670
3<C<=20	398.205	2.942	423.572	3.107
20<C<=200	50.233	3.932	51.786	4.033
200<C<=1.000	10.566	7.266	10.659	7.301
1.000<C<=5.000	945	2.319	949	2.327
C>5.000	182	1.807	183	1.827
Total	**688.398**	**18.892**	**732.557**	**19.265**

The vast majority of power plants installed are connected to the low voltage network. The remainder, consisting of around 20,000 plants, are connected to the medium voltage. Finally, a small number of installations is connected to the high voltage network. The new plants entered in service during 2016 are mainly (96%) small plants connected to the low voltage network.

Referring to the breakdown of PV installations in 2016 by sectors (Figure 42), 79% of PV plants are residential, mainly small size (about 5 kWp), and 52% of PV capacity refers to the industry sector, including utility-scale plants (average size 233 kW).

The PV concentration is scattered across the Italian territory as well as the distribution of rated power capacity (Figure 43). Surprisingly, the highest concentration of installations is in the northern regions reaching a share of 54% of the total installed PV capacity in Italy. Approximately 18% is in the centre and the remaining 28% in the South. As for the electricity generation from PV plants, this was equal to 22.9 TWh in 2015 and slightly lower in 2016 reaching up to 22.4 TWh in 2016 (Figure 44). This is predominantly caused by the reduction of the *full-load hours* as an effect of the intermittent climate factors (irradiation, temperature). Considering the share of RES, in 2008 PV generation was about 0.3% of total RES generation in Italy, and in 2016 this share became 21.1%.

Italy is also defining 2030 renewable energy targets. PV will play a strategic role in 2030 energy scenario, depending on the adopted assumptions (price of electricity and CO_2) and policies (Figure 45).

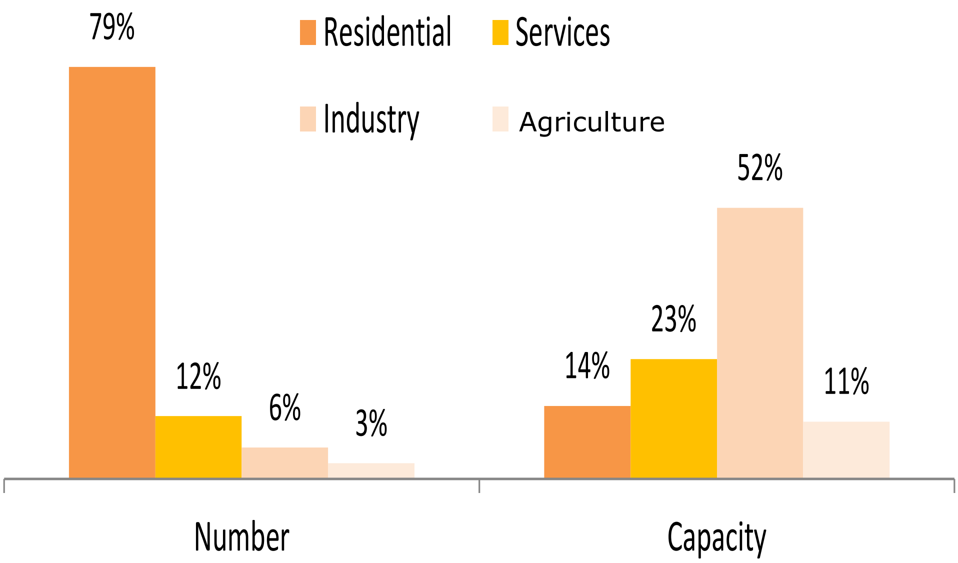

Figure 42: PV power by sectors in Italy, 2016. Source: [17].

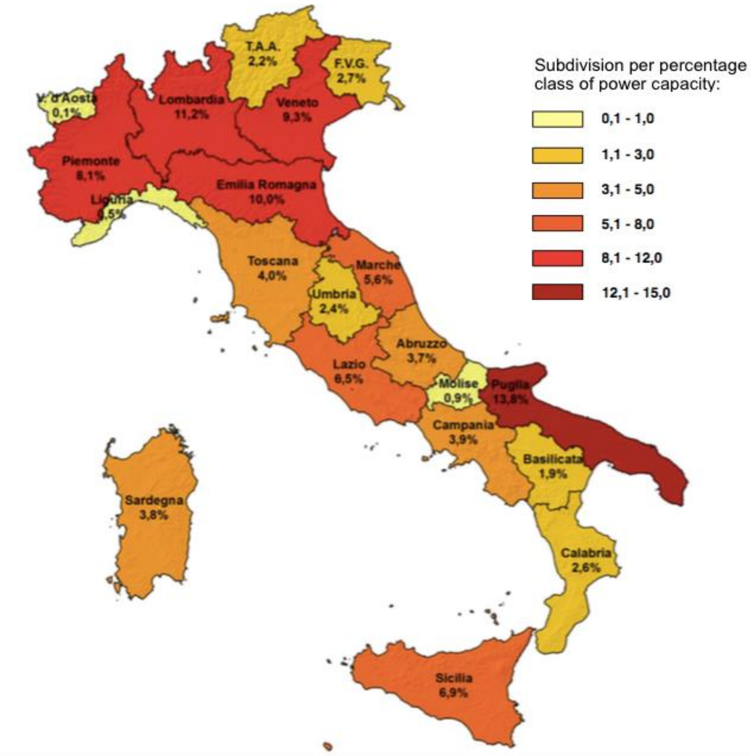

Figure 43: Map of Italy showing the PV capacity distribution. Source: [17].

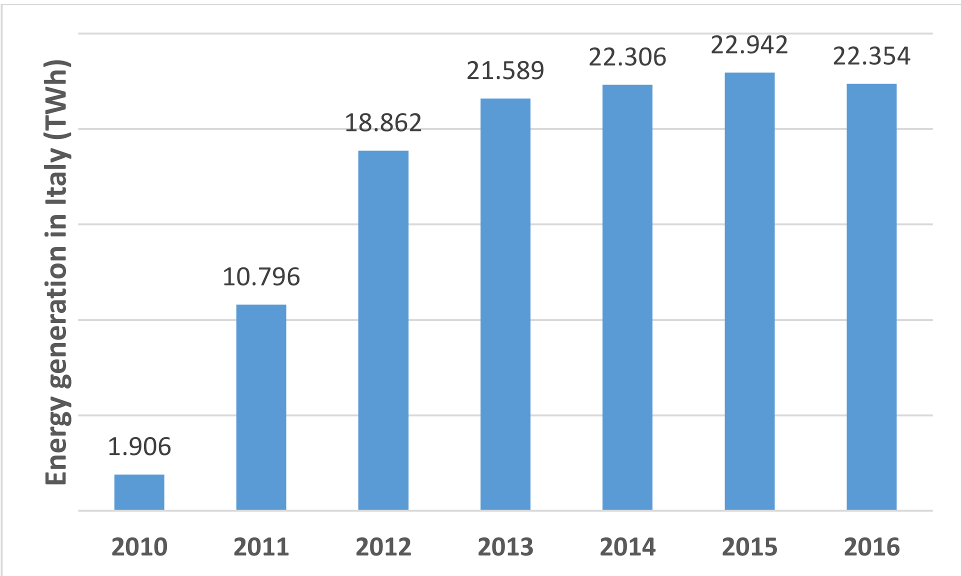

Figure 44: PV generation in Italy, 2016. Source: [17].

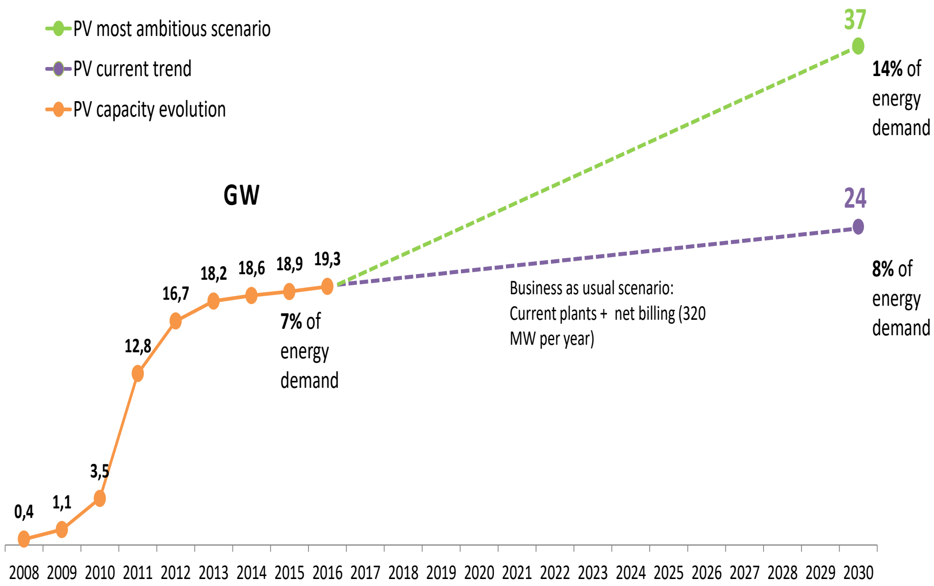

Figure 45: Evolution of PV capacity and possible future trends in Italy [17].

7.2.5 Portugal

Portugal had 467 MWp of cumulative installed PV capacity at the end of 2016, according to the data from the Portuguese Directorate General for Geology and Energy as shown in Figure 46 [18]. Additionally, 100.9 MWp of the cumulative PV capacity are small residential PV systems up to 3.68 kWp and 72.5 MWp from PV systems of capacity up to 250kWp. At the end of 2016, the country had more than 13.38 GW of installed renewable energy capacity. Most of this capacity, however, comes from wind (5.3 GW) and hydropower generation facilities (6.8 GW).

The Decree-Laws 363/2007 and 34/2011 have set the production and commercialization of electric energy in a system of micro and mini production respectively. From 2010 to 2017 the average annual growth rate of this production was 31%. Around 3500 units of electricity production for self-consumption (UPAC) were installed in 2015. During 2016, this number increased to 6067 installations and within the next few years it is expected to reach 10,000 installations and a total installed capacity of 50.393 kWp, according to the data provided by the Directorate General of Energy and Geology (DGEG) [18].

A permission is required for the installation of new PV systems, where interested eligible prosumers can communicate with the Directorate General for Energy and Geology (DGEG) via a digital platform. This is mainly because of the low system power that is between 200 to 1500 Wp and without injection in the electrical network, ranging from one to six panels.

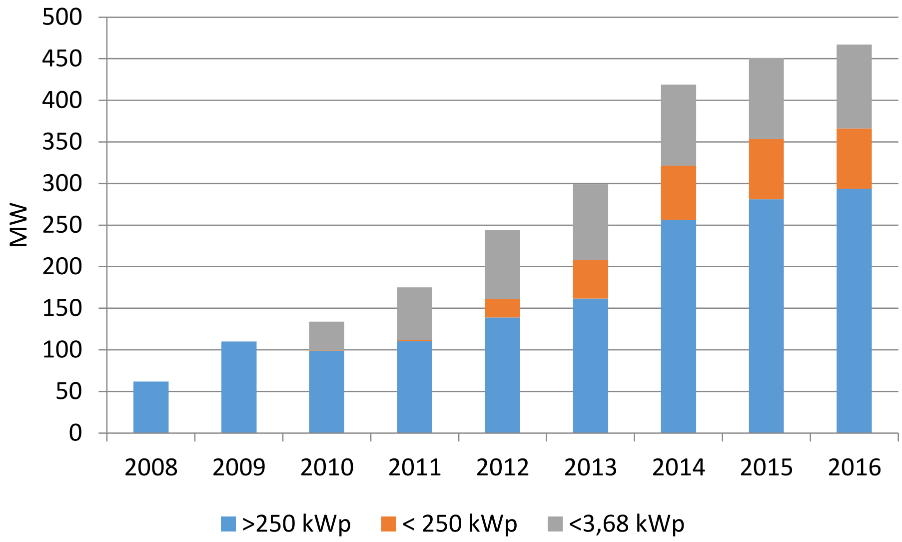

Figure 46: Installed PV capacity per size in Portugal by the end of 2016.

7.2.6 Slovenia

In Slovenia, the installation of PV and other RES types can be supported through governmental subsidies and loans and is promoted through the following schemes:

- Feed-in Tariff (FiT) scheme or so called guaranteed purchase of electricity,
- Feed in Premium tariff (FiP) scheme or so called operating premium for electricity production,
- Net-metering.

According to the Energy Agency of the Republic of Slovenia, the installation of PV systems was firstly mentioned in 2006 (0.3 MWp) under the FiT or FiP scheme, receiving a tariff of 0.374 €/kWh and 0.337 €/kWh respectively. The prosumer could also benefit from an additional tariff from selling the energy on the market, if the FiP scheme was chosen. In the year 2007 there were some additional installations of PV power plants (0.5 MWp). In 2008 the guaranteed purchase price was 0.3996 €/kWh and 0.3472 €/kWh for the operating premium where the peak installed power increased to 1.8 MWp. In April 2009, the European directive 2009/28/EC for the promotion of the use of energy from RES was adopted. Therefore, Slovenia tuned its national policies accordingly and in May 2009 the Decree for the Support of RES for electricity generation with new methodology was adopted. This was a very important step to encourage the deployment of PV since the support scheme for guaranteed purchase was improved with 15 years guaranteed purchase with even higher purchase price for micro PV power plants installed on the existing buildings (<50 kWp integrated in the building envelope: 0.47778 EUR/kWh). On the other hand, the steadily decreasing cost of PV led to very attractive business opportunities for the investors. This reflected to the significant increase of the PV installed capacity between the years 2010 and 2013, as shown in Figure 47.

On the other hand, the steadily decreasing PV price over the next few years caused the reduction of FiT. As a consequence, in March 2014 a new Energy Act was adopted which limited the inclusion of new PV power plants. The guaranteed purchase price for the micro PV power plants on buildings (< 50 kW) in September 2014 was 0.09222 EUR/kWh. For this reason, FiT was not any more attractive for the investors and the installed PV capacity remained constant between 2013 and 2015.

In January 2016, the Regulation on the self-supply of electricity from RES and the net-metering scheme came into force. Based on the data obtained by the National Energy Agency, a total 2,3 MWp were installed under the aforementioned schemes in 2016. According to the local DSO who is responsible for the organization of the net-metering scheme, the peak power of 925.34 kVA for domestic users and 93.52 kVA for other consumption on low voltage network was installed with the net-metering scheme in 2016.

The Slovenian Environmental Fund (Eko sklad) invites applications for tenders and publishes public calls on a regular basis. The Ministry of Infrastructure (Directorate for Energy, Energy Efficiency and Renewable Energy Sources Division) also publishes specific calls and tenders. The Slovenian Environmental Fund (Eko sklad) invites applications for soft loans. All renewable energy generation technologies including PVs are generally eligible for support (approximately 20% of eligible costs). However, there are limits to the plant size for certain technologies. Limitations on eligibility for subsidies and loans may be specified in the applicable call for applications document.

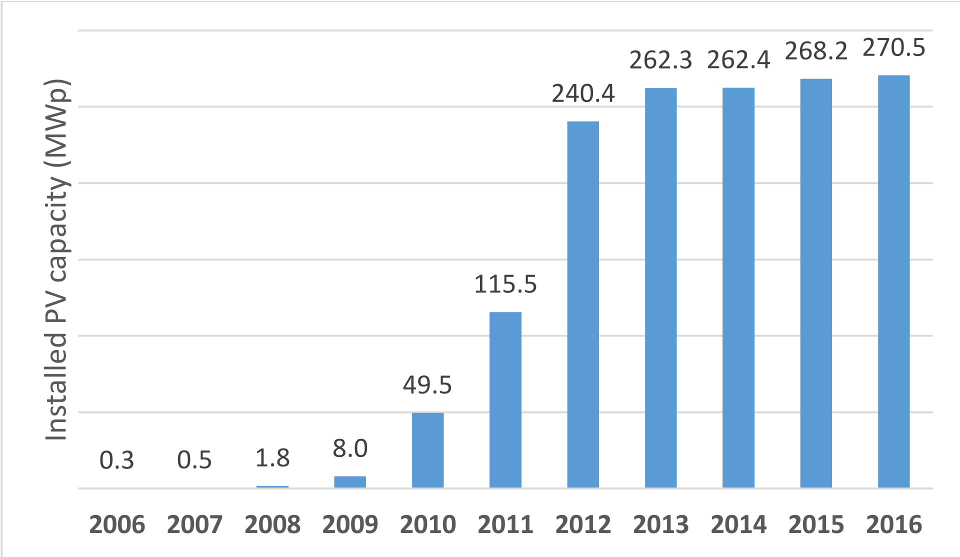

Figure 47: Cumulative installed PV capacity in Slovenia over the last decade.

7.2.7 Spain

In Spain, since 2004 and mainly 2007, a firm commitment was made to photovoltaic energy, through Royal Decrees 436/2004 and 661/2007, which established premiums for photovoltaic energy producers. However, the compensation system established in 2007 was poorly designed, since there were no limits on installed capacity, which caused the boom of 2008 installations and all the regulatory chaos that came afterwards. Since 2012 there has been hardly any increase in installed capacity. The evolution of installed capacity year by year in Spain is shown in Figure 48 [22].

Although other market players such as the Spanish Photovoltaic Union (UNEF) in recent years have attributed a slightly higher photovoltaic installation since the official statistics of REE do not capture part of the isolated power and of self-consumption. Figure 49 shows the aggregated data [29], although it confirms the installation stoppage of recent years and the slight recovery of the sector.

Finally, self-consumption is encouraged in Spain through the Royal Decree 900/2015 approved in October 9th 2015. The Decree defines two different types of self-consumption. Small-scale installations with peak consumption power less than 100 kWp and with a single legal person involved are subjected to Type 1 where Type 2 involves all consumers not covered by Type 1. In both cases, the utilization of energy storage systems (ESS) is eligible. However, the maximum generated power must be less than the maximum consumption. The number of installations with ESS is still small compared to the number of self-consumption facilities without ESS, as can be seen in Figure 50 [29, 30].

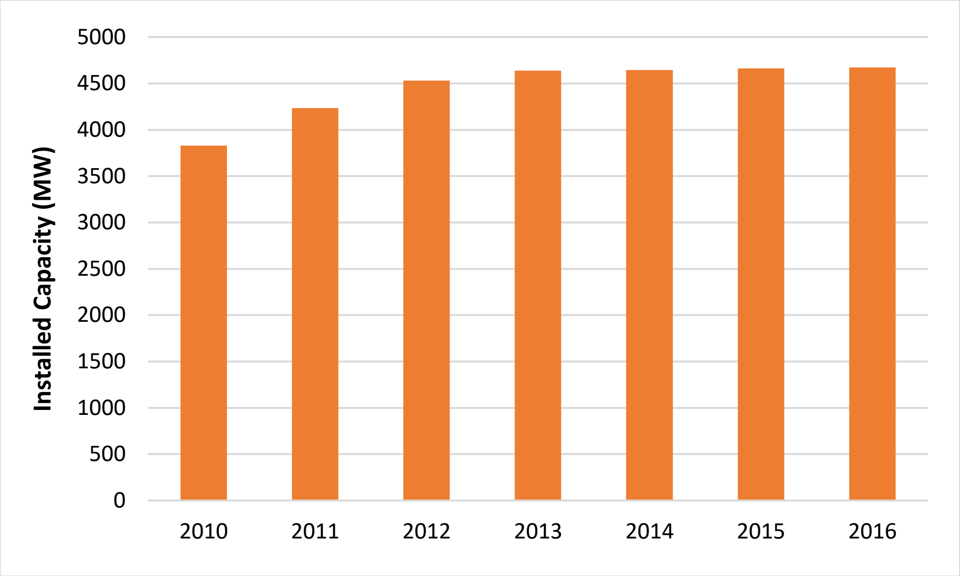

Figure 48: Cumulative installed PV capacity in Spain between the years 2010 and 2016. [22]

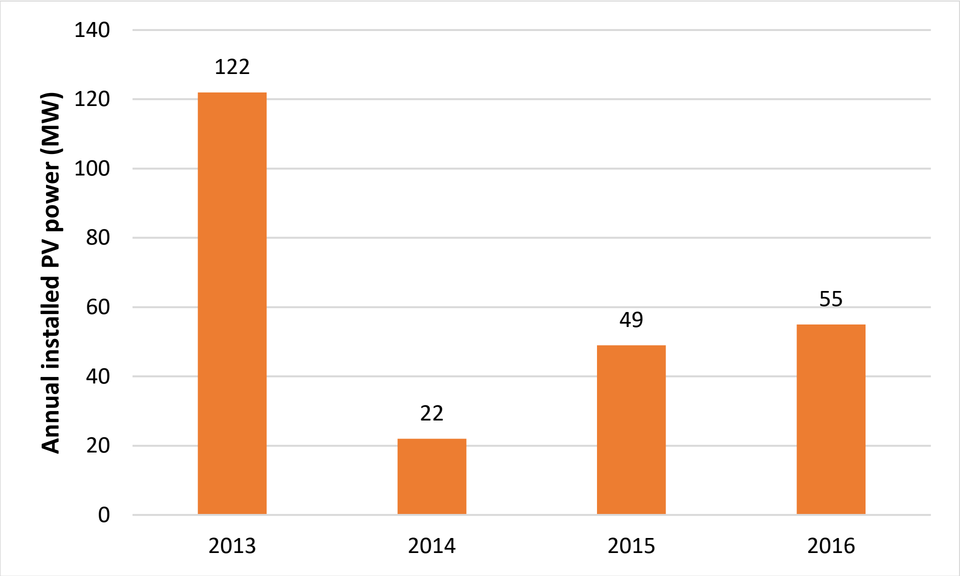

Figure 49: Annual installed PV capacity in Spain between 2013 and 2016. [29]

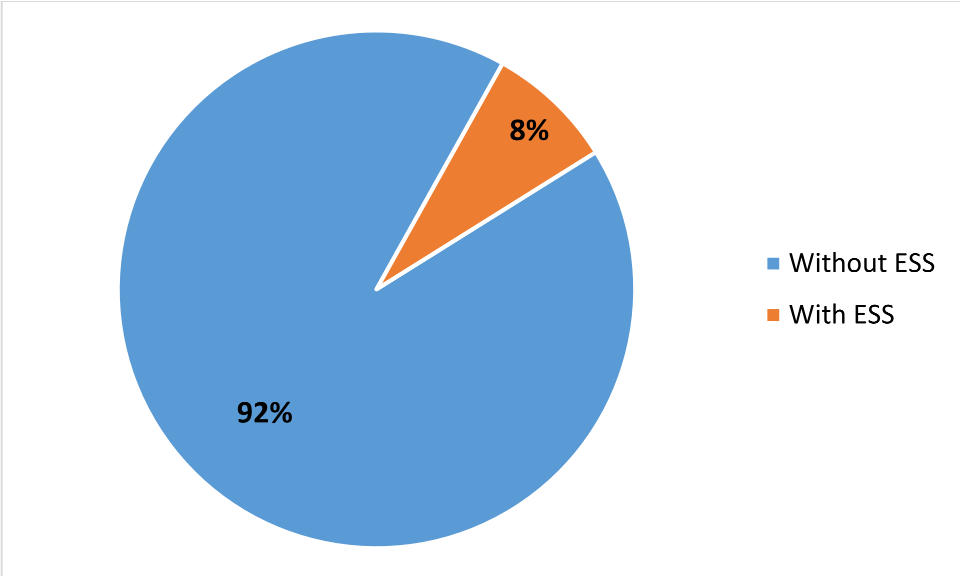

Figure 50: Percentage PV installations with and without ESS under self-consumption scheme. [29, 30]

8. State of the art Legislation in MED regions

The aim of this section is to outline the PV related legislation that exists in each participating region with particular emphasis on the support schemes for PV systems. In order to analyse the various mechanisms applied in the MED regions for residential and utility scale solar PV systems, the following set of parameters (Table 4) has been chosen to cover the most important aspects of the net-metering and self-consumption schemes. The energy legislations for the different partner countries are outlined in Table 5, Table 6, and Table 7 based on the parameters listed in Table 4. The individual analysis follows next.

Table 4: Set of parameters used for analysing net-metering and self-consumption schemes in MED regions as applied in December 2016 [31].

PV Self-Consumption	**Right to Self-Consume**	Right to self-consume the on-site produced electricity.
	Revenues from self-consumed PV	Savings on the variable price of electricity and any additional revenues such as self-consumption bonus.
	Charges to finance T&D cost	Additional costs such as taxes and fees.
Excess PV Electricity	**Revenues from excess electricity**	Any compensation the consumer will receive for injected electricity to the grid such as credit in kWh or credit in monetary unit.
	Maximum timeframe for compensation	Refers to schemes that allow credits for all electricity injected and the compensation is permitted during a certain period of time.
	Geographical compensation	Right to compensate consumption and generation in different locations (i.e. Virtual net-metering).
Other System characteristics	**Third party ownership**	Right to own the generation asset by a third-party.
	Grid codes and additional taxes	Refers to which specific grid codes must be met and which additional costs (i.e. self-consumption fee, balancing cost) can be applied.
	Other enablers of self-consumption	Refers to additional supports to self-consumption such as Demand Side Management (DSM), Storage or ToU tariffs.
	System Capacity Limit	Maximum PV capacity limit as applied by the compensation scheme.

Table 5: PV policy analysis for Cyprus, France and Greece

		Cyprus	France	Greece
PV Self-Consumption	**Right to self-consume**	Yes	Yes	Yes
	Revenues from self-consumed PV	Retail Price	Avoided cost by a Premium bonus for residential systems	Avoided cost
	Charges to finance T&D	A fee per installed kWp	None	None
Excess PV Electricity	**Revenues from excess electricity**	None	FiT (tariff above the cost of retail electricity)	Credits to be used in the next billing period, only for production charges
	Maximum timeframe for compensation	One (1) year	Real time	One (1) Year
	Geographical compensation	On-site only	On-site only	Virtual net-metering for specific investors, (city and regional councils, schools, universities, farmers and farming associations
	Grid codes and additional taxes	Grid code requirements and taxes on generation	Grid code requirements	Grid code requirements
	Other enablers of self-consumption	Storage option, tax exemptions for energy that is self-consumed	Not Applicable	Not Applicable
	System Capacity Limit	10 MWp	Not Applicable	100 kWp (LV) and 500 kWp (MV) for the mainland 50 kWp for Crete and 20 kWp for isolated islands

Table 6: PV policy analysis for Italy and Portugal.

		Italy	Portugal
PV Self-Consumpti	**Right to self-consume**	Yes	Yes
	Revenues from self-consumed PV	Avoided cost	Avoided cost
	Charges to finance T&D	None	None
Excess PV Electricity	**Revenues from excess electricity**	Net billing: energy quota plus service	FiT
	Maximum timeframe for compensation	Not Applicable	Real time
	Geographical compensation	On-site only	On-site only
Other System characteristics	**Third party ownership**	All	The self-consumer must be the owner of the system
	Grid codes and additional taxes	None	Grid code requirements
	Other enablers of self-consumption	None	Time of Use rates
	System Capacity Limit	200 kWp	Connected load less than 100% of the connected power in the consumer installation

Table 7: PV policy analysis for Slovenia and Spain.

		Slovenia	Spain
PV Self-Consumption	Right to self-consume	Yes	Yes
	Revenues from self-consumed PV	Avoided cost	Avoided cost
	Charges to finance T&D	None	A fee per consumed kWh
Excess PV Electricity	Revenues from excess electricity	None	None
	Maximum timeframe for compensation	One (1) year	One (1) Year
	Geographical compensation	On-site only	On-site only
Other System characteristics	Third party ownership	The self-consumer must be the owner of the system	The self-consumer must be the owner of the system
	Grid codes and additional taxes	Not applicable	Grid code requirements and taxes on generation
	Other enablers of self-consumption	Not applicable	Time of Use rates
	System Capacity Limit	11 KVA per prosumer	None

8.1 Cyprus

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 provided by the Ministry of Energy, Commerce, Industry and Tourism (MECIT) 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. In particular, 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. However, the low cost of electricity generation from PV systems prompted the authorities to reduce the feed-in tariff and finally eliminate the scheme in 2013. As a consequence, the net-metering framework as imposed in "Solar Energy for all" by the law N.157(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. In addition, 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 local energy storage through battery systems. The particular model is based on the fact that grid parity has already been achieved from decentralised 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 a number of 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 applications 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 envisaged that appropriate mechanisms will be applied to incentivise storage deployment.

8.2 France

Several schemes are available for PV systems in France, starting with the FiT, which concerns PV plants that are located on buildings and whose capacity is under 100 kWp. The received credit depends on the type of the system and the awarded tariff decreases every three (3) months. In December 2016, the FiT in France was as shown in Table 8. The structure of this FiT scheme is presently being revised in France and will soon be modified (decree expected).

Table 8: Feed-in Tariffs as applied in France, December 2016

Feed-in tariff category	Integration	c€/kWh
T1: Capacity < 9 kWp	Full integration	23.90
T4: Capacity 9-36 kWp	Simplified integration	12.48
T4: Capacity 36-100 kWp	Simplified integration	11.87
T5: Capacity > 100 kWp	Not integrated	5.51

In addition to the aforementioned tariffs, producers with plants under 100 kWp can also choose to sell only their "excess energy" to the grid. Therefore, they consume the on-site produced electricity when possible. Alternatively, if the production is less than the consumer energy needs, any additional electricity can be bought from the grid. Finally, consumers can benefit from the same FiT as for the "full sale" scheme. Consumers eligible for the FiT scheme benefit from lower network fee than in the "full-sale" scheme.

The self-consumption scheme is also available, where prosumers can consume all the electricity which is produced. Hence, the injection of any excess electricity to the grid is not permitted. For plants under 36 kWp, administrative requirements have been simplified as regards the DSO. In fact, the possibility of collective self-consumption is also possible, where producers and consumers should be able to exchange electricity between themselves if located in the same area. A decree is expected that will provide more details concerning this.

Finally, five different types of tenders have been published in France. As a consequence, the development of large-scale PV systems with capacities ranging from 100 kWp to 17 MWp was achieved and different FiTs have been applied for each category.

The first type was published through a national call for tenders in September 2016 to foster the development of PV plants with a capacity between 100 kWp and 500 kWp. Nine periods are planned between March 2017 and October 2019. The aim is to support 75 MWp in each of these periods. Candidates have to respect precise specifications. They propose a reference price for electricity and they are ranked according to a formula that takes into account this price as well as the carbon impact of the plant. Then, the successful bidders benefit from a compensation price for 20 years.

The second one was published in August 2016 and aims at supporting PV plants between 100-500 kWp with a total capacity of 40 MWp, producing energy under self-consumption. It is open to any kind of electric RES. Overall, 72 projects totalling a capacity of 20.5 MWp have been selected among which 3 in Auvergne- Rhône- Alpes region. The average premium tariff was settled to 40.88 €/MWh for a period of 10 years.

Another national call for tenders was published in September 2016 to foster the development of PV plants with a capacity between 500 kWp and 8 MWp. Nine periods are planned between March 2017 and October 2019. The aim is to support 75 MWp in each of these periods. Candidates have to respect precise specifications. They propose a price for electricity and they are ranked according to a parameter that takes into account this price as well as the carbon impact of the plant. Then, the successful bidders benefit from a purchase agreement during 20 years. This compensation price corresponds to the reference price required by the producer less the market price where the production also has to be sold.

Additionally, a national call for tenders was initiated aiming to support ground-mounted PV plants. Six (6) periods are defined between January 2017 and June 2019 so as to develop 3 GWp of plants, divided into 3 categories:

- Plants between 5 MWp and 17 MWp
- Plants between 500 kWp and 5 MWp
- Plants on parking shelters between 500 kWp and 10 MWp.

In all these cases, the successful bidders benefit from a compensation price delivered in addition to the market price. This compensation price is given during 20 years.

The last tender category tends to support PV systems in conjunction with storage. A first call for tenders was organised in May 2015 and 33 projects representing 52 MWp were awarded. A second call for tenders was open until June 2017 based on the same model. The successful bidders benefit from a purchase agreement of their excess electricity for 20 years.

8.3 Greece

Three main legislative efforts have been made by the Greek Government to promote RES in the Greek IC and NIC networks. At first, under the FiT scheme the price of the energy generated by either ground mounted or rooftop PV systems is compensated with a price defined in the Greek Government Gazette 1103/02.05.2013 (current legislation after a series of changes to the price since 2009) and is valid for the new installations after this date, as shown in Table 9 [11, 13]. Ground mounted and rooftop PV systems with a capacity of up to 500 kWp are eligible for a feed-in tariff. Nevertheless, current FiTs (2017) are quite low and do not guarantee viable investments. The Greek Government is planning to present new FiTs for small-scale PV systems in 2017.

Table 9: FiTs for PV systems in Greece below 500 kWp.

	Ground mounted & rooftop PV systems >10 kWp on the mainland and Interconnected Islands (€/kWh)		Ground mounted & rooftop PV systems >10 kWp on the Non-Interconnected Islands (€/kWh) all sizes	PV systems on residential & commercial rooftops ≤10 kWp (€/kWh)
	> 100 kWp	≤100 kWp		
$aMSP_{n-1}$= Average Marginal System Price during the previous year n-1	1,1*aMSPn-1	1,2*aMSPn-1	1,1*aMSPn-1	Aug. 2016: 0,110 Feb. 2017: 0,105 Aug. 2017: 0,100 Feb. 2018: 0,095 Aug. 2018: 0,090 Feb. 2019: 0,085 Aug. 2019: 0,080
Contract duration	20 years			25 years

On applying the regulations of Ministerial Decision (Greek Government Gazette B΄3583/31.12.2014) regarding the installation of PV systems with net-metering, the reception of connection requests began in April 2015. The program involves the installation of PV systems by electricity consumers in order to cover own needs of electricity, by applying net-metering. The net-metering is the annual 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 IC and NIC electrical networks, applying different rules in each occasion, as follows:

- Firstly, in the IC network, PV system capacity is limited to 20 kWp or to 50% of the agreed power of consumption of the installation (in kVA), if the latter is more than 20 kW. Moreover, for either governmental or non-governmental non- profit organizations (e.g. universities and hospitals), the net-metering law allows for PV installations that cover an organization's electricity needs fully.
- Secondly, in the NIC network, PV system capacity is limited to 10 kWp or to 50% of the agreed power of consumption of the installation (in kVA), if the latter is more than 10 kW. 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 of the NIC network.
- PV systems must be installed at the point of consumption that they supply and are assigned to the local meter of the consumer. The net-metering contract between the prosumer and the electricity supplier is valid for 25 years, starting on the date of the connection of the PV system. Energy compensation for net-metering owners is taking place on an annual basis. If

the absorbed energy from the grid is more than the injected energy to the grid, then the PV owner is charged with the difference. In the opposite case, the surplus energy injected to the grid is not compensated.

A recent RES related law (L.4414/2016) was voted by the Greek Parliament in August 2016 initiating the Feed-in premiums, tender schemes for PV, and virtual net-metering. 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 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 NIC electrical network of the islands.
- Virtual net-metering. 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 neighbour in 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.

Considering the use of storage, the Greek distribution network operator (HEDNO) currently prohibits the installation of such systems in the electricity network. However, some exceptions apply, permitting the installation of ESS in conjunction with RES systems to form a hybrid station. This application is mostly applicable for isolated networks of the NIC network and also for desalination purposes where storage can be used as a fixed power supply unit.

8.4 Italy

Italy has used a mix of instruments to promote the development of RES. Economic incentives for electricity generation, in the form of FiT and tradable green certificates (GCs) had been the main policy tools. The Italian FiT was one of the first in Europe. It enabled the connection of almost 14 GWp in two years. Furthermore, Italy had a leading role in including PV in system analysis and requiring a massive retrofit of PV inverters to enable voltage and frequency regulation.

Production of heat from RES is supported by the White Certificate system for energy efficiency. Direct investment subsidies and requirements to install RES in buildings have also been used. All these programmes have been effective in the development of RES, and in the achievement of RES share targets.

Until July 2013, under the FiT scheme, the “Fifth energy account” (Conto Energia), PV plants with a minimum capacity of 1 kWp and connected to the grid could benefit from a FiT, which was based on the electricity produced. The tariff differed depending on the capacity and type of plant and was granted over a period of 20 years [17]. The “Fifth energy account” also had a premium dedicated to self-consumption.

The self-consumption model is based on the fact that in some countries (e.g. Italy) renewable electricity – mainly solar PV – has achieved grid parity, that is the situation where an expected unit cost of self-generated renewable electricity matches or is lower than the per-kWh costs for electricity obtained from the grid, i.e. the variable part of a consumers’ electricity bill. Under grid parity, consumers can save money by generating their electricity rather than buying it from the grid. In this situation, renewable energy self-consumption can result in a number of benefits for both consumers and the whole energy system.

The fifth FiT “Conto Energia” ended in July 2013, with few exceptions in areas affected by earthquake. Since 2013 the investments in the PV sector have been strongly reduced, as depicted in Table 10. The descending trend of the cost of installation, especially from 2010 to 2013, is mainly due to the decline in component costs (PV modules, inverters, etc.)

Table 10: PV investments in Italy between 2010 and 2016.

		2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
PV	MW	2.323	9.370	3.328	1.736	383	290	393
	m€	7.600	20.135	6.215	2.508	658	558	602
	€/kW	3.271	2.134	1.863	1.440	1.709	1.924	1.532

Net-metering is currently the remuneration policy scheme for new PV systems. Since 2009, the Italian energy regulator AEEGSI “*Autorità per l'energia elettrica, il gas ed il sistema idrico”* (Decision ARG/elt 74/08, as subsequently amended and supplemented by Decision ARG/elt 186/09) has assigned to GSE the management of the net-metering service (Scambio sul Posto, SSP), activated at the request of interested parties. Under the service, the electricity generated by a consumer/producer in an eligible on-site plant and injected into the grid can be used to offset the electricity obtained from the grid.

The SSP scheme seeks to ensure:

- Transparency due to the fact that the electricity balances in the power grids can take into account the electricity fed in and withdrawn;
- Correct economic value of the electricity fed in and withdrawn with SSP;
- Increase of self-consumption.

GSE has the role of managing net-metering and paying the related contribution to the customer, based on injections and withdrawals of electricity in a given calendar year and on their respective market values. GSE determines the contribution taking into account: the characteristics of the plant, the contractual conditions between the customer and his/her supplier and the data that grid operators and suppliers are required to periodically report to GSE.

The eligible plants that may apply for the net-metering service are:

- RES plants with a capacity of up to 20 kW;
- RES plants with a capacity of up to 200 kW (commissioned after 31 Dec. 2007);
- High-efficiency CHP plants with a capacity of up to 200 kW.

In Italy 57% of net energy production is related to plants with self-consumption. PV self-consumption amounts to 4.3 TWh in 2015 (33% of net generation produced by plants with self-consumption and 19% of total net generation) (Figure 51). Most PV plants with self-consumption are supported by net billing, a net metering where different rates are used to value the excess energy fed into the grid and energy received from the grid. Almost all domestic plants have a self-consumption quota. The industry sector is the one with the highest self-consumption quota on net generation, whereas the residential sector is the one with the highest self-consumption quota on consumption (Figure 52).

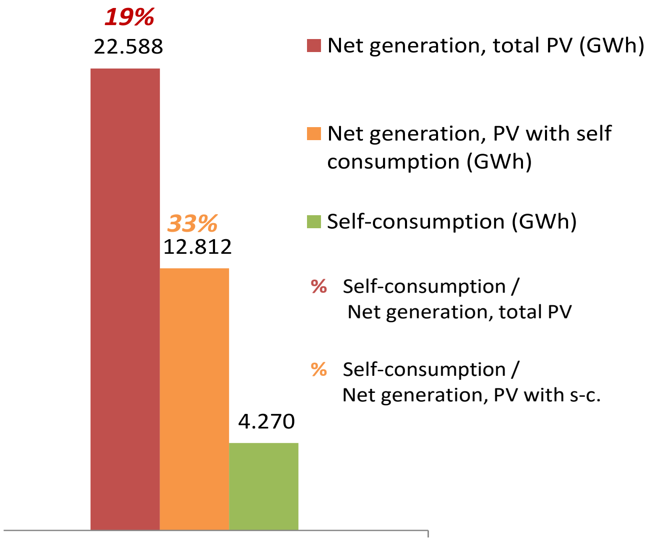

Figure 51: PV capacity for systems under self-consumption in Italy, 2015.

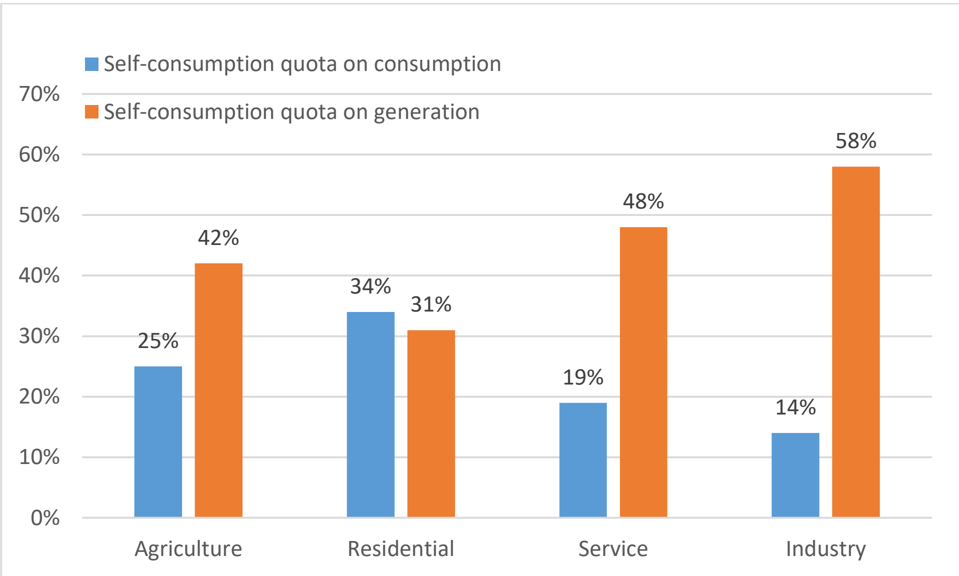

Figure 52: PV generation and self-consumption by sector, 2015.

AEEGSI is committed to reform the Italian electricity market and has released two important resolutions aimed at developing the usage of electrochemical energy storage systems. These are resolutions n. 574 [32] and n. 642 [33], introduced in 2014.

Resolution n. 574/2014 defines how storage systems can access and use the electricity grid, and resolution n. 642/2014 complements the n. 574/2014 by defining the grid services to be provided by storage systems. Furthermore, the Italian Electrotechnical Committee (CEI), a private association responsible for the national technical standardisation in the field, has released the technical standard CEI 0-16 for HV and MV applications [34], and CEI 0-21 for LV applications [35]. These standards define the connection scheme of the power plants and storage systems to the grid, with relative measurement and protection systems, and the grid services required for effective integration of the same. The AEEGSI resolutions n. 574/2014 and n. 642/2014 are significant for the development of a domestic storage market because, together with CEI technical standards documents, they have set the rules for storage installations. The AEEGSI resolutions and the CEI requirements are driving the cost reduction of storage systems.

The Energy Association ANIE (ANIE Energia) is working on allowing renewable energy systems coupled with energy storage systems to participate in the dispatching and balancing electricity markets. Following the release of the Law 9/2014 and the Law Decree 91/2014 introduced in August 2014, ANIE Energia is supporting the Italian Parliament in developing the related Implementing Decrees, particularly focused on Italian small islands. The main objective is to make the electrical system in the small islands that are not connected to the grid more efficient both at the distribution and consumption level. Once implemented, it will introduce all the necessary market tools in order to reduce the price of electricity. In particular, it will support the development of renewable energy coupled with storage systems, as well as the wide use of electric vehicles with a view to a smart grid. The downside of this is that the implementation of the Law 9/2014 and the Law Decree 91/2014 is part of the wider reform of the electricity market.

In April 2017 ANIE Energia and RSE - Research on the Energy System, with the collaboration of Enel Green Power, and the University "Politecnico di Milano" published a White Paper on "*Prospects and opportunities for Electrochemical Storage*", including selected best case projects in Italy that integrate electrical storage systems and RES plants [36].

8.5 Portugal

The actions described in the National Renewable Energy Action Plan (NREAP) together with the actions of the National Energy Efficiency Action Plan allow Portugal to comply with the Overall and National Objectives of the European Renewable Energies Directive 2009/28/EC on the promotion of the use of energy from RES.

The NREAP was defined by the Council of Ministers' Resolution nº 20/2013, published in the Portuguese Official Journal, 1st Series, Nº 70 from 10th of April 2013. This official document foresees that the contribution of PV for 2020 is 670 MWp of installed capacity and 1039 GWh of produced energy, respectively.

To date, the FiT scheme was the first support measure for the implementation of RES for electricity production. FiT scheme was firstly introduced in Portugal in 2007 with the establishment of the Decree Law 225/2007. However, the financial crisis of the last years and the phasing out of the FiT trend led to a decrease of PV installations during the last years.

The self-consumption Law was then released in 2015 in order to boost PV installations in Portugal. The new regulatory framework (Decree-Law 153/2014) is applicable for small-scale PV generation with grid injection and for generation based on any kind of source for own consumption (no capacity limit), though the great majority of installations are PV systems. The scheme allows the installation of PV systems with capacity up to 250 kWp under a 15-year contract, and is remunerated by the tariff attributed on the basis of a bidding model. An amount is added if at least 2 m^2 of solar thermal panels are used in the consumer's installation or if there is an electric vehicle charging power outlet connected to the mobility grid in the consumer facility.

Considering the own consumption installations, it will be up to the producer to choose whether or not to inject the surplus electricity into the public service energy network. The remuneration is made taking into account "the value resulting from the simple arithmetic average of the closing prices of the Iberian Energy Market Operator (OMIE) for Portugal" for the current month. If excess electricity is injected to the grid, it will be necessary to pay a registration fee depending on the installed PV power as shown in Table 11 below.

Table 11: Registration fees that apply for electricity injection to the grid in Portugal.

	PV system capacity				
PV Capacity	Up to 1.5 kW	1.5-5 kW	5-100 kW	100–250 kW	250kW–1MW
Registration Fee	€30	€100	€250	€500	€750

8.6 Slovenia

In January 2016 the Regulation of Self-consumption came into force providing measures to promote the use of electricity generated from RES by means of electricity production system for self-supply using the net metering scheme.

The energy billing and network costs take into account the amount of electricity (kWh), which represents the difference between consumed electricity from the grid (kWh) and injected electricity to the grid, taken at the same measurement point of a premise with RES system at the end of the accounting period. If the amount of electrical energy (kWh) delivered via the measuring point in the network is greater than the quantity of received electrical energy (kWh), the excess amount of electrical energy is free of charge transferred to the ownership of the supplier. For active electrical energy, received and delivered via the measuring point to which the RES system is connected, flat tariff measurement of electricity is used. The maximum total nominal power of the RES systems for self-supply for the calendar year is 7 MVA for households and 3 MVA for small business customers.

Regulation on the Support for Electricity Generated from RES and High-efficiency CHP came into force in November 2016, specifying the technologies for production of electricity from RES and high-efficiency CHP, which are eligible for support, amount and duration. Support can be carried out as guaranteed purchase of electricity, where the centre for supports (company Borzen) buys all produced electricity from RES and high efficiency CHP (Feed-in tariffs). Additionally, there is financial support for operation of RES and high efficiency CHP, where licensed generators can obtain the so-called "operational subsidy" on top of the electricity price that they achieve on the free market (Premium tariffs).
Credits for the electricity production can be given for various types of RES but more importantly for PV systems. Consumers with installed PV capacity less than 10 MWp are eligible for FiT. This situation is depicted in Table 12, where received electricity tariffs per kWh are outlined. With regards to energy storage, there are no legal policies to allow the integration of ESS to the electricity grid in Slovenia. Currently, prosumers can benefit from the net-metering scheme and use the grid to virtually store excess RES electricity. However, the intermittent nature of RES along with any possible increase of the installed RES capacity may create problems to the energy system. This situation makes ESS an important element capable of ensuring the stability of the electricity system. Therefore, the development of new policies is urgently needed in order to encourage the deployment and ensure the sustainability of ESS in Slovenia.

Table 12: Feed-in-tariffs and premium tariffs for PV systems after September 2014

	PV system peak power	**FiT guaranteed purchase (€/MWh)**	**Premium tariff- operational subsidy (€/MWh)**
Rooftop PV systems	< 50 kW	98.15	61.24
	50 kW- 1MW	89.75	52.84
	1 MW-10 MW	74.48	36.31
	10 MW – 125 W	No guaranteed purchase	24.34
Ground-mounted PV systems	< 50 kW	92.22	55.31
	50 kW- 1MW	84.95	48.04
	1 MW-10 MW	68.48	30.31
	10 MW – 125 W	No guaranteed purchase	21.65

8.7 Spain

The first energy regulation in Spain was published through the Law 82/1980 for energy conservation aiming at tackling the oil crisis and at the improvement of energy efficiency.

Almost two decades later, in 1999, a governmental regulation was published for the Promotion of Renewable Energy (PFER) targeting the growth of the renewable technology (12% of primary energy consumption) in Spain. Further to this, the Royal Decree 1663/2000 on the connection of photovoltaic systems to the low voltage grid went a step further by simplifying the connection conditions of these installations up to 100 kVA. Additionally, with the Renewable Energy Plan (PER) issued between 2005-2010, the share of RES was expected to reach at least 12% of the total primary energy consumption in 2010.

More recently, the Royal Decree 1578/2008 modifies the economic regime regarding production of electrical energy by solar PV systems and classifies new installations in two types depending on whether they are located on rooftops (type I) or ground-mounted (type II). Due to the economic impact on the tariff system of renewable energy, the Royal Decree Law 6/2009 was established in order to optimally adjust the mechanisms regarding the remuneration system of special regime installations (except for PV technology, already regulated in the Royal Decree 1578/2008).

In January 2012, the Royal Decree-Law 1/2012 suspends economic incentives for projects involving installation of new electric energy production plants through renewable sources, cogeneration and waste. At the end of 2012, the Royal Decree-Law 29/2012 was approved for the elimination of the tariff deficit limit in 2012 and 2013, in which the prime economic regime was corrected or abolished for special regime facilities. On the 13th of July 2013, the Royal Decree-Law 9/2013 was established approving a new legal and economic regime for the production of electrical energy from renewable energy, cogeneration and waste.

Since 2013, the Spanish regulation specifically approves self-consumption. The Law 54/1997 of the electricity sector (repealed by Law 24/2013) included for the first time the concept of self-consumer in the definition of producer. Further to this, Royal Decree 1955/2000 defines that the access to the distribution network is a right for prosumers who can produce both total and partial consumption.

The Royal Decree 900/2015, of the 9th of October, which is currently in force, regulates the administrative, technical and economic conditions of the supply of electric energy with self-consumption and production with self-consumption. The decree defines two types of self-consumption. The first one allows a maximum PV installed capacity of 100 KWp, where the owner of the point of consumption must be the same as that of the production plant. The surplus produced and discharged to the grid is not remunerated. Spill or not surplus is required to request the connection point to the electric distribution company. Also, an obligation exists to install an approved meter that measures the energy generated and another that independently measures the energy that the home takes from the grid. The second type of self-consumption is applied to cases where the consumer at the point of consumption is not the same as at the point of production. As a result, the self-consumed energy is not exempt from paying the charges to self-consumption.

Amongst various amendments that need to be done in order to structure a resilient and flexible energy system, the most important ones are the following:

- The recognition of the right to self-consumption of electricity without any charge, since at no time is the use of the electricity grid needed. It is therefore a question treating the self-consumption scheme as any other measure of energy saving or efficiency.
- The possibility for several consumers to share the self-consumption scheme; this is considered essential for self-consumption to be implemented in the domestic urban area and contributing to the fight against energy poverty.
- A simplified administrative procedure especially for the small installations that do not inject electricity to the electrical network for which a notification should suffice.

Given the large installed capacity of PV systems in Spain, energy storage in the form of coupled PV-ESS systems forms an interesting option, capable of tackling the barriers related to the intermittency of RES and the grid stability. Both technologies have found many applications in Spain with significant benefits to the prosumer with the most important being the reduced electricity cost. On the other hand, such systems have a negative impact on the operation of the electricity network. The consumption of on-site stored generation makes the end users energy dispatch a very difficult task to deal with, especially during high energy demands that cannot be supplied from the ESS. In order to support the further deployment of ESS in the Spanish distribution network, a new proposition is under development which includes necessary measures to eliminate the associated restrictions.

9. Barriers related to further PV and ESS deployment-MED regions

The continuously increasing PV penetration in the energy mix combined with the intermittent nature of RES impose significant challenges to the electricity system operation. Therefore, the adoption of new technologies is urgently needed in order 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 to the aforementioned barriers, the lack of financial compensation mechanisms along with high capital costs are the main obstacles to ESS deployment [37].

Taking Cyprus as an example, the small and non-interconnected electricity network restricts the integration of RES since various issues, connected to the stability of the grid, may arise. Moreover, the installation of RES to the electricity grid in Cyprus is restricted by legal barriers for both new and existing renewable systems. On the other hand, grid parity, Net-metering, and self-consumption in Cyprus are important drivers for enhanced PV deployment on the island. Storage systems are expected to boost PV installations as they can offer applications and services which can allow for the development of a sustainable scenario in order to accomplish higher rates of PV self-consumption. Currently, energy storage systems in Cyprus are only permitted under self-consumption, which involves the integration of large PV systems (10 kWp–10 MWp) and stationary batteries. Further suitable financial compensation incentives are required in order to truly promote self-consumption towards achieving even higher PV penetration in Cyprus. A similar situation also exists in France and Portugal. Apart from technical barriers, administrative restrictions exist in France since procedures and legal frameworks are not ready yet to take into account storage in conjunction with PV systems. In particular, there is presently no economic interest to finance coupled PV-ESS in residential premises. Even more, the relatively low electricity price for residential customers does not incentivise prosumers to store and consume their own production and it rather reinforces the FiT scheme as prosumers prefer to sell their excess electricity to the grid provider.

The integration of storage to the electricity grid is a more complicated situation in Greece. Although there are no legal barriers prohibiting the installation of energy storage systems (ESS) in both IC and NIC networks, there are two additional barriers blocking the deployment of ESS. The first one is related to the current policy of the Greek distribution network operator (HEDNO), which prohibits the installation of ESS in the electrical network. There are some exceptions to this DSO policy. These refer to ESS that is installed together with RES to form a hybrid station, which is mainly applicable in saturated networks of the NIC islands. Other applications involve the combination of RES and ESS for desalination purposes, and the use of ESS in conjunction with solar thermal power stations to form fixed power supply units. The second barrier is related

to the fact that the majority of the existing PV installations are under the FiT scheme. FiT is considered as a strong economic incentive for the RES owner to produce and sell energy to the main grid. Therefore, the use of ESS does not practically have any economic return for the owner. On the other hand, the charge/discharge of the ESS results in energy losses which are not compensated by the HEDNO. Therefore, the use of energy storage systems should be further incentivised.
Owing to the relatively high PV capacity of 19 GWp, the concept of storing energy is becoming very interesting in Italy. However, there are some uncertainties about the contribution of storage to the income statement of a PV plant and also about the payback time. For instance, the current payback period for a residential PV system under the net-metering scheme is around seven years. Therefore, the combination of storage for on-site utilisation is not yet viable. In order to tackle these barriers, the Italian Authority is now focused on distribution storage in order to identify a cost-effective solution for storage installations [38]. Relatively similar conditions apply for the deployment of PV in Slovenia. The installed PV capacity was around 250 MWp by 2013 and remained at the same levels up until 2016. Regardless of the supporting schemes that apply from the government for new PV installations such as net-metering and subsidies, the low guaranteed purchase price of electricity is the primary barrier preventing the further deployment of new PV systems.

Finally, there are no technical barriers that prevent the implementation of coupled PV-ESS systems in Spain. Both technologies have found many applications in the Spanish energy industry. However, in some cases, local governments offer payment strategies and schemes that appear to be penalizing the PV and ESS technologies, creating barriers to their implementation and development. For instance, the Royal Decree 900/2015 (Spain) regulates the economic conditions of the modalities of supplying electric energy with self-consumption by introducing new taxes to the toll system for the consumers. On the other hand, recent announcement of the proposition of "The Law for the Promotion of Electric Self-Consumption 2017" includes many measures to eliminate administrative barriers that currently limit the development of the aforementioned technologies in Spain.

To conclude, the primary issues that prevent the integration of energy storage in MED countries are technical and financial. There is an urgent need to lift off the barriers concerning the integration of ESS to the grid and more importantly to develop a sustainable compensation scheme that will render PV-ESS systems as a viable and cost-effective solution.

10. Solar Resource, PV System cost and existing electricity tariffs

In the next section the solar resource along with typical PV system prices for small systems as well as the breakdown of the electricity prices in the participating countries are presented. These parameters will be useful when analysing the viability of the coupled PV-storage solutions in these countries.

10.1 Solar Resource

The information concerning the solar resource of the participating regions was extracted by using the capabilities of the JRC's PVGIS tool [39, 40]. The cumulative annual sum of global irradiation in each country (kWh/m^2) 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 is presented in Table 13.

Table 13: Summary of the solar resource and generated electricity from PV in the participating MED countries. Data obtained from JRC-PVGIS tool [39].

	Cyprus	**France**	**Greece**	**Italy**	**Portugal**	**Slovenia**	**Spain**
Maximum Global Irradiation (kWh/m^2)	2000	1500	1800	1800	2000	1400	1900
Maximum Generated Electricity (kWh/kWp)	1500	1300	1350	1350	1500	1050	1425

10.1.1 Cyprus

The annual global horizontal irradiation in Cyprus is shown in Figure 53 and reaches up to 1800 kWh/m^2 in the mountainous regions where the expected generated electricity for horizontally mounted PV systems is 1350 kWh/kWp. For the seaside and urban regions, the yearly sum of global irradiation is around 2000 kWh/m^2 which results in an approximated generated electricity greater than 1500 kWh/kWp for horizontal inclination.

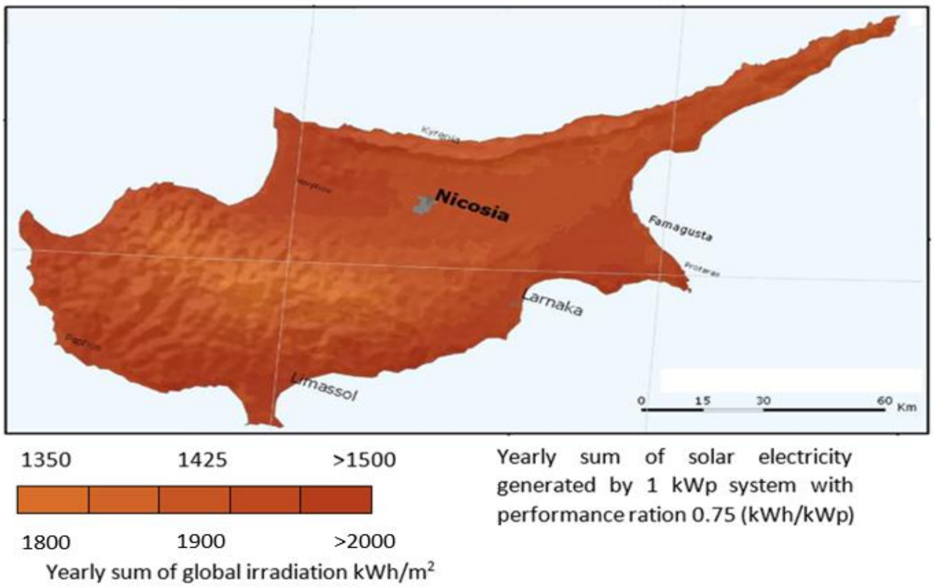

Figure 53: Annual global irradiation in Cyprus on the horizontal plane

10.1.2 France

The Rhône- Alpes region is a large region of France and therefore the solar irradiation varies. This is depicted in Figure 54 where the regions located at the north-east experience the lowest irradiation levels around 1200 kWh/m^2 per year, whereas at the south-east of the region the irradiation levels increase to 1500 kWh/m^2 per year. The approximated electricity generated from solar PV is around 900-1300 kWh/kWp.

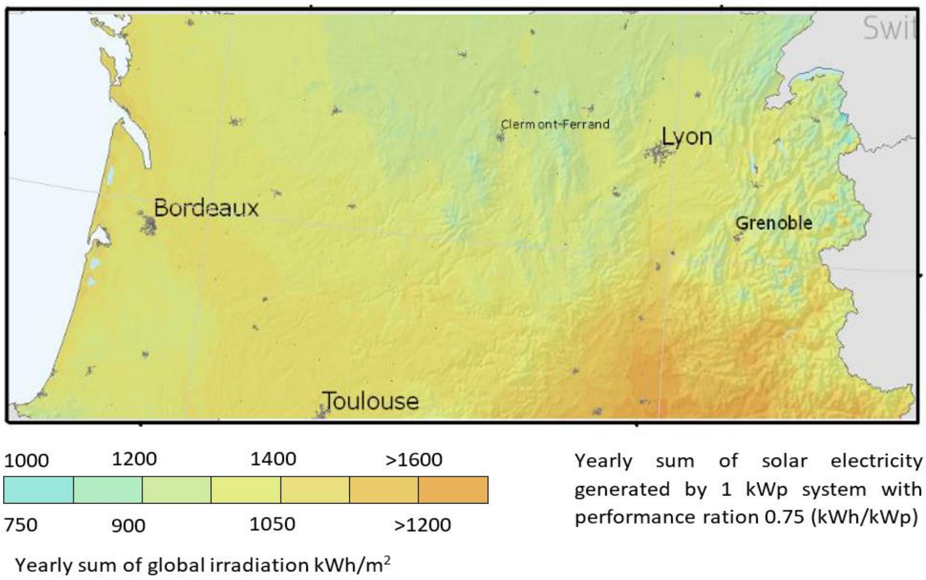

Figure 54: Annual global irradiation in the Rhône- Alpes region, France on the horizontal plane.

10.1.3 Greece

The region of Central Macedonia is located in the northern part of Greece. This results in lower irradiation in comparison to the southern part of the country. Based on the information provided from the JRC's PVGIS tool shown in Figure 55, the annual global irradiation in Central Macedonia ranges between 1500 and 1800 kWh/m^2 with the annual sum of solar electricity to be around 1125 and 1350 kWh/kWp.

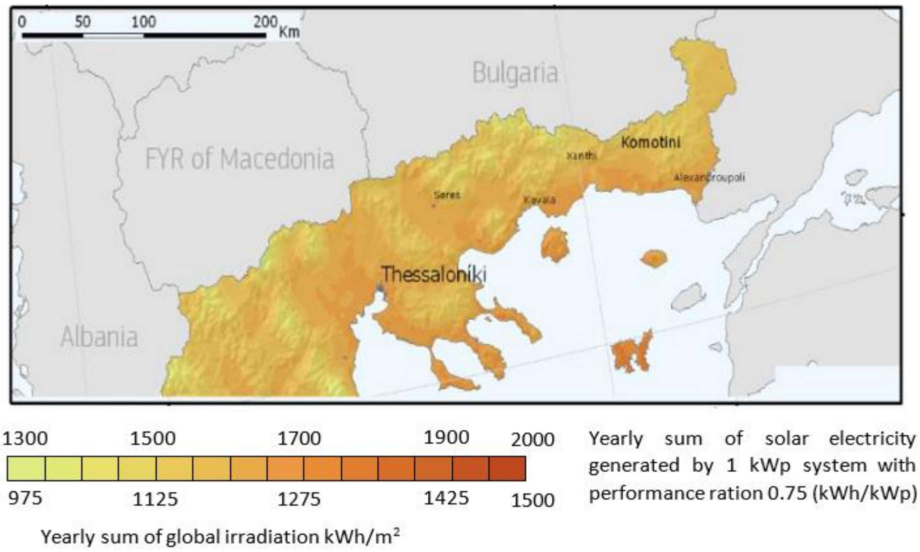

Figure 55: Annual global irradiation in the region of Central Macedonia, Greece on the horizontal plane.

10.1.4 Italy

The Sardinia region in Italy has high solar resource compared to the other coastal regions with an annual global irradiation close to 1700-1800 kWh/m^2 as depicted in Figure 56. As a consequence, the solar generated electricity is around 1250-1350 kWh/kWp on the horizontal plane.

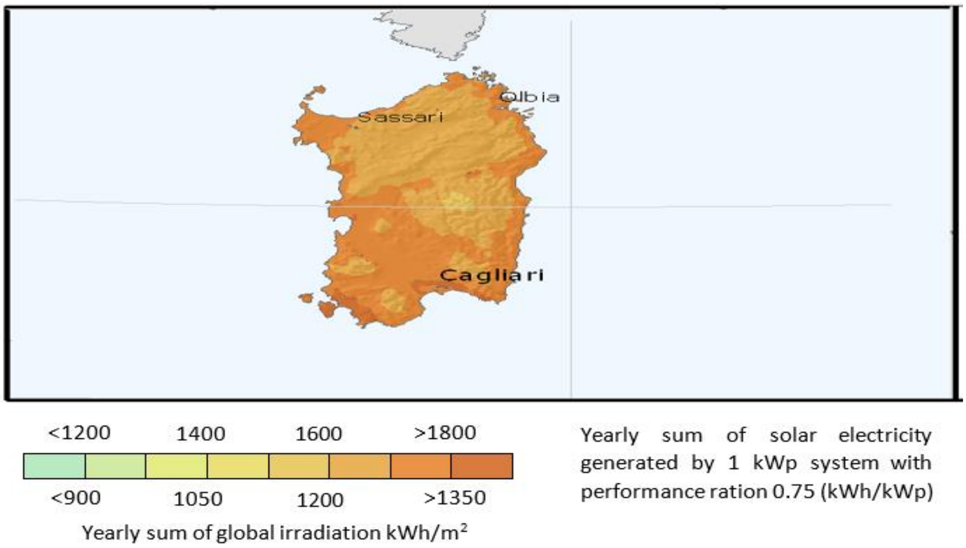

Figure 56: Annual global irradiation in Sardinia, Italy on the horizontal plane.

10.1.5 Portugal

The Algarve region in Portugal experiences a high solar resource as shown in Figure 57**,** with the annual global irradiation ranging between 1900 kWh/m^2 and 2000 kWh/m^2. This results in a solar generated electricity between 1425 and 1500 kWh/kWp on the horizontal plane.

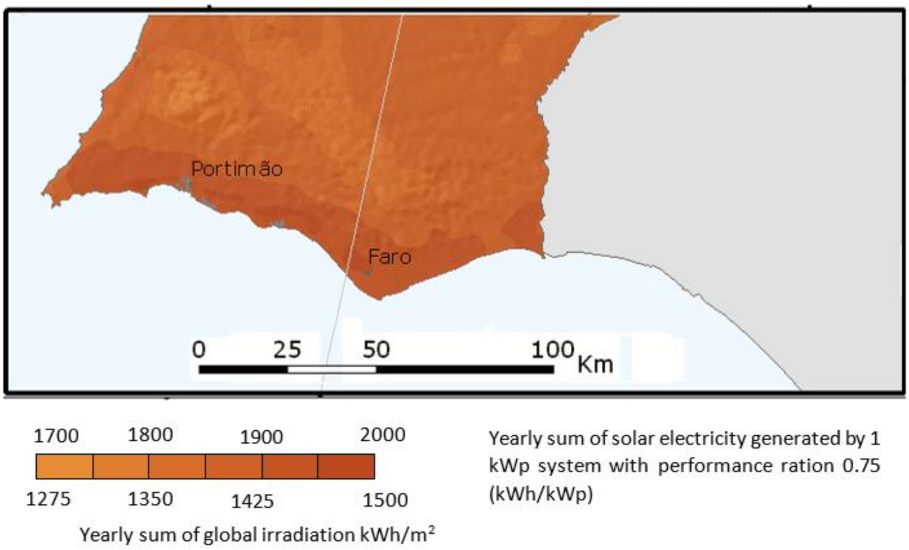

Figure 57: Annual global irradiation in Algarve, Portugal on the horizontal plane.

10.1.6 Slovenia

The map in Figure 58 shows that Slovenia experiences the highest irradiation levels in the regions near the sea reaching up to 1400 kWh/m^2 and at the north-east of the country with an annual global irradiation of 1300 kWh/m^2. The lowest annual global irradiation levels are experienced in the inner-country and the mountainous regions where the annual global irradiation falls to 1100 kWh/m^2. The approximate solar PV generated electricity ranges between 825 and 1050 kWh/kWp on the horizontal plane.

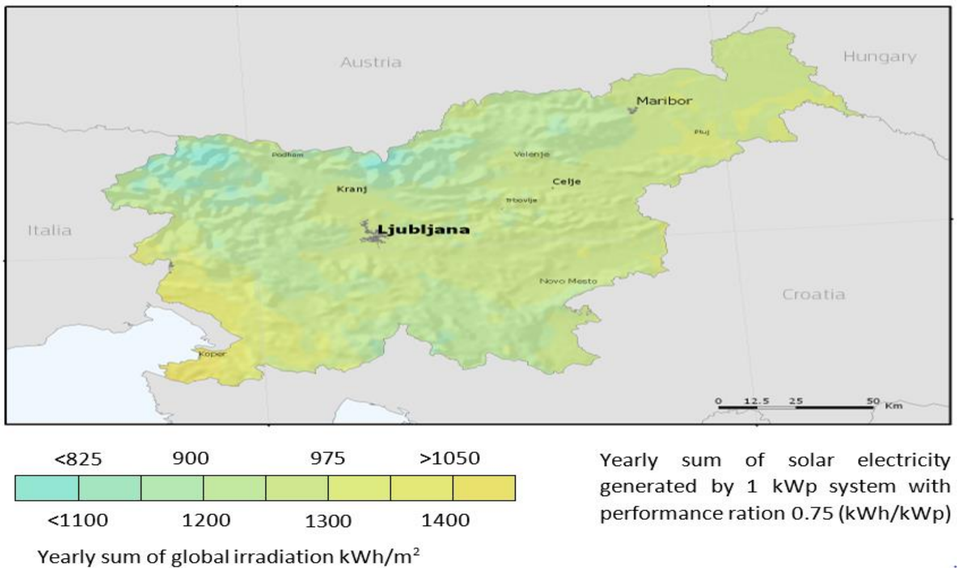

Figure 58: Annual global irradiation in Slovenia on the horizontal plane.

10.1.7 Spain

The Aragon region covers a large part near Zaragoza and experiences high solar resource over the southeast coastal regions. The annual global irradiation is shown in Figure 59, ranging between 1800 kWh/m^2 and 1900 kWh/m^2. This results in a solar generated electricity between 1350 and 1425 kWh/kWp on the horizontal plane.

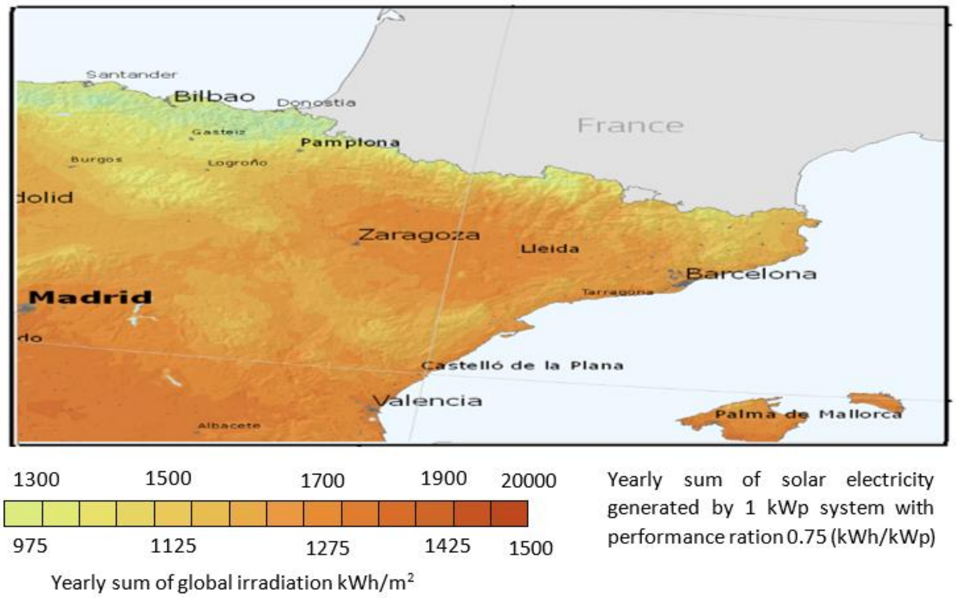

Figure 59: Annual global irradiation in Aragon, Spain on the horizontal plane.

10.2 Electricity tariffs

This section focuses on the analysis of the residential electricity price for all participating regions. The domestic electricity prices for all regions were analysed for the year 2016 and include the electricity Tariff, the Standing Fees and Taxes. The breakdown was estimated for a typical household with annual consumption between 2500-5000 kWh and 5000-15000 kWh. A summary of the electricity tariffs for all participating regions is shown in Table 14 and in the following sections the tariffs for each region are analysed.

Table 14: Summary of the electricity prices (incl. VAT) in the participating countries for the end of 2016

	Domestic electricity price for an annual consumption of 2500-5000 kWh (c€/kWh)	**Domestic electricity price for an annual consumption of 5000-15000 kWh** (c€/kWh)
Cyprus	17.97	18.31
France	17.40	16.60
Greece	17.90	22.91
Italy	24.13	28.31
Portugal	23.64	22.65
Slovenia	16.31	18.08
Spain	22.83	19.95

10.2.1 Cyprus

The electricity price breakdown for Cyprus is shown in Table 15. The cost per kWh of electricity in Cyprus was estimated for a low rate domestic tariff under the net-metering scheme. In calculating the total unit cost, a Fuel Adjustment Coefficient, as determined by the Fuel Adjustment Clause, is added to the basic fuel price of €300 per Metric Tonne (M.T.) which arises from the increase of the average fuel cost to €301.35 in December 2016 [41]. Additional regulations such as the 8% deduction which is the current decision from the Cyprus Energy Regulatory Authority (CERA) [42] along with the Green Tax were included for the electricity breakdown calculation [43].

Table 15: Electricity price breakdown per kWh for Cyprus, 2016

Energy Consumption (kWh)		**2500-5000**		**5000-15000**	
Country	**Allocated Charge**	**¢€/kWh**		**¢€/kWh**	
Cyprus	Tariff	13.28	93.0%	14.13	97.0%
	Standing Fee	0.85	6.0%	0.27	1.8%
	Taxes and Levies	0.13	1.0%	0.13	1.2%
	Total Before VAT	14.26		14.53	
	VAT	2.71	19.0%	2.77	19.0%
	Green Tax	1.00		1.00	
	Total	**17.97**	**¢€/kWh**	**18.31**	**¢€/kWh**

10.2.2 France

Electricity tariffs in France both depend on the subscription (kVA) and on the consumption (kWh). Considering the base residential tariff without ToU (6 kVA subscription), the average cost is estimated as an average of the costs for a 2500 kWh and a 5000 kWh consumer which are summarised below. With regards to the most common ToU tariff (12 KVA subscription), we consider that half of the annual consumption occurs during peak hours and the other half during off-peak hours. The average costs which are as an average between a 5000 kWh/yr consumer and a 15000 kWh/yr consumer are presented below in Table 16.

Table 16: Electricity price breakdown per kWh for France, 2016

Energy Consumption (kWh)		2500-5000		5000-15000	
Country	**Allocated Charge**	**¢€/kWh**		**¢€/kWh**	
France	Tariff	8.90	60%	8.90	63.1%
	Standing Fee	2.80	19%	2.30	16.3%
	Taxes	3.20	21%	2.90	20.6%
	Total Before VAT	14.90		14.10	
	VAT & additional Tax	2.50	17%	2.50	17%
	Total	**17.40**	**¢€/kWh**	**16.60**	**¢€/kWh**

10.2.3 Greece

To derive typical values of electricity tariffs, two different scenarios are considered. In the first scenario, the annual consumed energy varies between 2500 and 5000 kWh/y, which corresponds to an average monthly consumption of 312,5 kWh [44, 45]. Additionally, in the second examined scenario, the annual consumption is increased between 5000 and 15000 kWh/y, i.e., 833 kWh per month, and the corresponding average values of the electricity price are presented in Table 17. It can be observed that in both cases the production cost covers almost 50% of the total electricity price. On the other hand, the percentage of network charges as well as the standing fees are decreased as long as the consumed energy is increased. On the contrary the taxes share, including the value added tax (VAT), is increased with respect to the consumed energy. Finally, it can be concluded that the second category results in an increased electricity price compared to the first category.

Table 17: Electricity price breakdown per kWh for Greece, 2016

Energy Consumption (kWh)		2500-5000		5000-15000	
Country	**Allocated Charge**	**¢€/kWh**		**¢€/kWh**	
Greece	Tariff	12.12	76.5%	12.91	63.7%
	Standing Fee	0.26	1.6%	0.10	0.5%
	Taxes	3.45	21.9%	7.27	35.8%
	Total Before VAT	15.85		20.28	
	VAT	2.05	13.0%	2.63	13.0%
	Total	**17.96**	**¢€/kWh**	**22.91**	**¢€/kWh**

10.2.4 Italy

In Italy the typical family has an average electricity consumption of 2.700 kWh per year (rated PV power capacity is 3 kWp). The trend of the electricity price for the average residential customer in Italy has been fluctuating over the last years having an average price of 18.83 ¢€/kWh. In Table 18, the electricity reference price during 2016 is analysed in detail for two consumption categories: first category having consumption between 2500-5000 kWh and the second category between 5000-15000 kWh.

Table 19: Electricity price breakdown per kWh for Italy, 2016

Energy Consumption (kWh)		**2500-5000**		**5000-15000**	
Country	**Allocated Charge**	**¢€/kWh**		**¢€/kWh**	
Italy	Tariff	13.19	60.1%	14.77	57.4%
	Standing Fee	1.23	5.6%	1.20	4.7%
	Taxes	7.52	34.3%	9.76	37.9%
	Total Before VAT	21.97		25.73	
	VAT	2.19	10%	2.57	10%
	Total	**24.13**	**¢€/kWh**	**28.31**	**¢€/kWh**

10.2.5 Portugal

To derive the electricity tariffs presented in Table 20, an annual consumption of 2500 kWh –5000 KWh was assumed. The consumer is charged for the total amount of energy consumed for the "services of general interest" charge. The transmission and distribution (T&D) charges are calculated based on the amount of incoming energy.

Table 20: Electricity price breakdown per kWh for Portugal, 2016.

Energy Consumption (kWh)		**2500-5000**		**5000-15000**	
Country	**Allocated Cost**	**¢€/kWh**		**¢€/kWh**	
Portugal	Tariff	12.40	64.5%	12.4	67.3%
	Standing Fee	0.20	1.0%	0.20	1.1%
	Taxes	6.60	34.5%	5.80	31.6%
	Total Before VAT	19.22		18.42	
	VAT	4.40	23%	4.20	23%
	Total	**23.64**	**¢€/kWh**	**22.65**	**¢€/kWh**

10.2.6 Slovenia

For residential users, the electricity price breakdown for the high and low tariffs is presented in Table 21. The Slovenian households can use the single or double tariff system. The double tariff is most likely used, because the single tariff is very close to the price of the high tariff.

Table 21: Electricity price breakdown per kWh for Slovenia, 2016.

Energy Consumption (kWh)		2500-5000		5000-15000	
Country	**Allocated Cost**	**¢€/kWh**		**¢€/kWh**	
Slovenia	Tariff	10.31	77.1%	10.23	68.4%
	Standing Fee	0.77	5.8%	0.77	5.1%
	Taxes	2.28	17.1%	3.96	26.5%
	Total Before VAT	13.36		14.96	
	VAT	2.96	22%	3.12	22%
	Total	**16.31**	**¢€/kWh**	**18.08**	**¢€/kWh**

10.2.7 Spain

The general scheme of the electricity prices in Spain is composed of three main concepts:

- Voluntary price for small residential prosumers (applicable only for installations with capacity less than 10 KW).
- Fixed annual price.
- Free price with any electricity supplier.

The prices for domestic consumers for the two consumption scenarios are shown in Table 22 below.

Table 22: Electricity price breakdown per kWh for Spain, 2016

Energy Consumption (kWh)		2500-5000		5000-15000	
Country	**Allocated Cost**	**¢€/kWh**		**¢€/kWh**	
Spain	Tariff	13.42	71.1%	11.72	71.1%
	Standing Fee	4.54	24.0%	3.97	24.0%
	Taxes	0.91	4.9%	0.8	4.9%
	Total Before VAT	18.87		16.49	
	VAT	3.96	21%	3.46	21%
	Total	**22.83**	**¢€/kWh**	**19.95**	**¢€/kWh**

10.3 Solar PV System price

Technology improvements and cost reduction 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 60 [46].

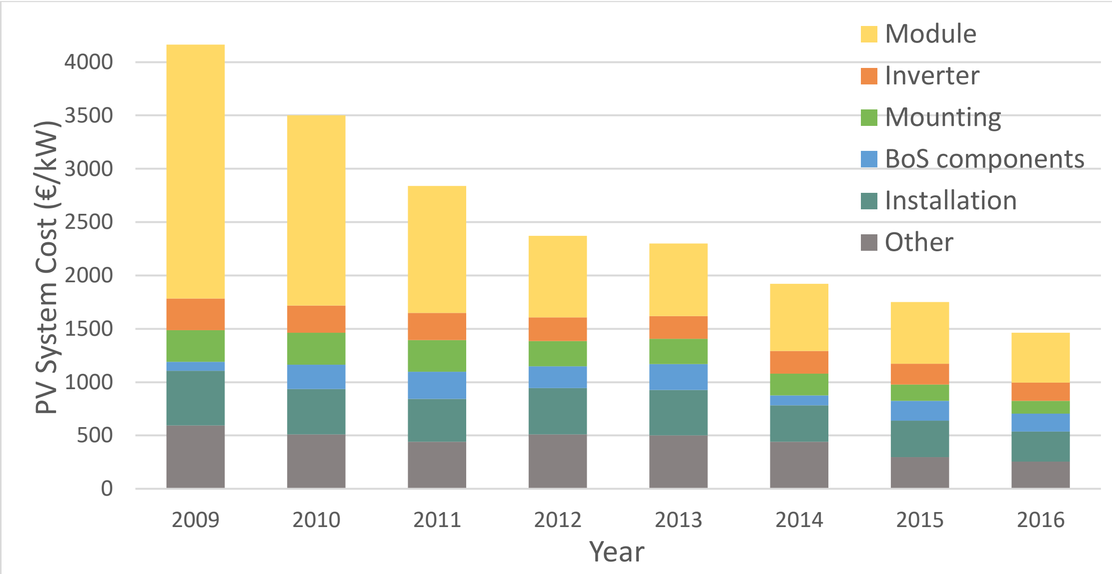

Figure 60: Retail price of PV systems in Europe (€/kWp). Source: IRENA [46]

The payback period of the systems is a parameter that depends on the size of the system, the solar resource and the electricity cost in some cases. This section presents the average PV system cost for typical residential applications for all participating countries. These costs have been derived by calculating the average values of several retail prices, which were provided from electrical equipment suppliers. The price breakdown includes the PV module and other BoS cost along with the installation and administrative expenses. The PV system price per installed kWp is summarised in Table 23 and the following sections analyse the PV system cost for each participating country. According to the analysis, it can be observed that the cost of PV panels presents the greatest share of the total cost.

Table 23: Total turnkey PV system cost (€/kWp) including equipment cost, installation and administrative cost for the participating regions. All prices and taxes are corrected as of December 2016.

	3 kWp	5 kWp	10 kWp
Cyprus	1.670	1.580	1.500
France	3.600	3.070	2.420
Greece	1.610	1.500	1.400
Italy	2.200	1.980	1.540
Portugal	1.542	1.476	1.353
Slovenia	1.990	1.988	1.671
Spain	2.400	2.360	1.942

10.3.1 Cyprus

Table 24: Typical turnkey PV system cost (€) in Cyprus, December 2016.

	3 kWp	5 kWp	10 kWp
PV Modules	2.225	3.700	6.910
PV Inverter	850	1.300	2.540
BoS components	675	960	1.950
Installation	200	450	960
Administrative	250	250	250
Total exc. VAT	4200	6.660	12.610
VAT (19%)	800	1265	2396
Total	**5000**	**7.925**	**15.000**
Unit Price per kWp	**1.667**	**1.585**	**1.500**

10.3.2 France

Table 25: Typical turnkey PV system cost (€) in France, December 2016.

	3 kWp	5 kWp	10 kWp
PV Modules	3.583	5.156	8.060
PV Inverter	1.000	1.461	2.418
BoS components	750	1.289	2.418
Installation	1.833	2.664	4.388
Administrative	333	430	716
Total exc. VAT	7.500	11.000	18.000
VAT (20%)	1.500	2.200	3.600
Total	**9.000**	**13.200**	**21.600**
Unit Price per kWp	**3.000**	**2.640**	**2.160**

10.3.3 Greece

Table 26: Typical turnkey PV system cost (€) in Greece, December 2016.

	3 kWp	5 kWp	10 kWp
PV Modules	2.400	4.000	7.955
PV Inverter	840	1.195	2.000
BoS components	160	260	495
Installation	160	260	495
Administrative	335	335	345
Total exc. VAT	3.895	6.050	11.290
VAT (24%)	935	1.450	2.710
Total	**4.830**	**7.500**	**14.000**
Unit Price per kWp	**1.610**	**1.500**	**1.400**

10.3.4 Italy

Table 27: Typical turnkey PV system cost (€) in Italy, December 2016.

	3 kWp	5 kWp	10 kWp
PV Modules	2.100	3.150	4.900
PV Inverter	480	720	1.120
BoS components	1.440	2.160	3.360
Installation	900	1.350	2.100
Administrative	1.080	1.620	2.520
Total exc. VAT	6.000	9.000	14.000
VAT (10%)	600	900	1.400
Total	**6.600**	**9.900**	**15.400**
Unit Price per kWp	**2.200**	**1.980**	**1.540**

10.3.5 Portugal

Table 28: Typical turnkey PV system cost (€) in Portugal, December 2016.

	3 kWp	5 kWp	10 kWp
PV Modules	1.500	2.500	5.000
PV Inverter	1.010	1.550	2.300
BoS components	100	100	100
Installation	1.050	1.750	3.500
Administrative	100	100	100
Total exc. VAT	3.760	6.000	11.000
VAT (19%)	865	1.380	2.530
Total	**4.625**	**7.380**	**13.530**
Unit Price per kWp	**1.542**	**1.476**	**1.353**

10.3.6 Slovenia

Table 29: Typical turnkey PV system cost (€) in Slovenia, December 2016.

	3 kWp	5 kWp	10 kWp
PV Modules	2.250	3.750	7.500
PV Inverter	750	1.250	1.400
BoS components	390	650	1.300
Installation	270	450	500
Administrative	1.230	2.050	3.000
Total exc. VAT	4.890	8.150	13.700
VAT (23%)	1.080	1.790	3.010
Total	**5.970**	**9.940**	**16.710**
Unit Price per kWp	**1.990**	**1.988**	**1.671**

10.3.7 Spain

Table 30: Typical turnkey PV system cost (€) in Spain, December 2016.

	3 kWp	5 kWp	10 kWp
PV Modules	2.200	4.500	8.200
PV Inverter	800	1.800	3.900
BoS components	450	450	450
Installation	2.000	2.500	3.000
Administrative	500	500	500
Total exc. VAT	5.950	9.750	16.050
VAT (21%)	1.250	2.048	3.370
Total	**7.200**	**11.798**	**19.420**
Unit Price per kWp	**2.400**	**2.360**	**1.942**

11. Conclusions

This report constitutes an important task of the project where the current energy status for the European Union is analysed with an emphasis on the participating MED countries. In this study, a thorough analysis of the current RES development and PV penetration at both European and MED level was carried out which focused on the installed RES and PV capacity until 2016. Concurrently, a valid comparison between the existing penetration levels and the regional targets for 2020 was performed, highlighting that new technologies are necessary in order to eliminate the barriers emerging with the steadily increasing share of RES in the energy mix of the countries.

Focusing on the participating 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 frameworks and incentives including FiT, Net-metering and self-consumption schemes with different upper capacity limits apply in different regions. Overall, the report finds that there exist many challenges concerning financial and technical aspects for energy storage integration in the public grid and that there is an urgent need for new policy frameworks in order to allow the effective deployment of coupled PV-ESS technology in the MED countries.

This report also highlights the high solar potential of the Mediterranean regions following an analysis of the solar resource of each participating country. Further to this, a detailed breakdown of the conventional electricity prices in each region was performed which indicated that a major contributor to the relatively high tariffs across the MED region was the high cost of production and network cost. Finally, typical PV system prices were collected and analysed for each country with the PV modules constituting the most expensive component.

In conclusion, this study outlines the current situation in Europe and in MED countries with regards to RES levels and it is considered as the starting point (the baseline) of the subsequent work to be carried out in the StoRES project. The existing legislation and current electricity prices for each participating region extracted from this study will be used as input parameters towards developing a storage optimisation tool targeting to address the main barriers preventing the deployment of PV and ESS in the MED.

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