Ref. Ares(2022)2404996 - 31/03/2022

Accessible, reliable and affordable solar irrigation for Europe and beyond

Deliverable 2.12

LEGAL ANALYSIS AND BEST PRACTICES

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Document information

PROJECT			
Project title:	**Accessible, reliable, and affordable solar irrigation for Europe and beyond**		
Project Acronym	**SolaQua**	**Project Number:**	952879
Start date of the project:	**01 October 2020**	**Duration in Month**	36 months
Funding scheme:	**Horizon 2020 – Coordination and Support Action (CSA)**		
Project Coordinator:	**Universidad Politécnica de Madrid (UPM)**		

DELIVERABLE			
Deliverable Title:	**D2.12 Legal analysis and best practices**		
Contractual delivery date:	31 March 2022	**Actual delivery date:**	31 March 2022
Contributing WP:	WP2: Producing KEMT	**WP Leader**	UPM
Responsible partner	CPMR	**Partners Involved**	UPM, EIC, GA, GVal
Type:	Report	**Dissemination level:**	Public
Version:	1.0		

Disclaimer
The information and opinions expressed in this report do not represent the official position of the European Commission and its entirely the responsibility of the authors.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Table of content

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 952879

Acronyms

CAP	Common Agrarian Policy
DSO	Distribution System Operator
EAFRD	European Agriculture Fund for Rural Development
EIA	Environmental Impact Assessment
EU	European Union
FI	Financial Instrument
ISINPA	Irrigators, SMEs, Investors and Public Authorities
KEMT	Key Enabling Materials and Tools
kW	Kilowatt
kWp	Kilowatt peak
MA	Managing Authority
MW	Megawatt
PA	Planning Authority
PPA	Power Purchase Agreement
PVIS	Photovoltaic Irrigation System
RDL	Royal-Decree Law
RDP	Rural Development Programme
RE	Renewable Energy
REWS	Regulator for Energy and Water Services
SI	Solar Irrigation
SME	Small and Medium Enterprise
WP	Work Package

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Executive summary

This report has been produced within the framework of the SolaQua project with the objective of supporting public authorities and other stakeholders to promote a legal and administrative framework suited to the decarbonisation of irrigated agriculture. Such a goal can only be achieved by allowing for the massive introduction of photovoltaic irrigation systems (PVIS) to replace existing, fossil-fuel based, power supply solutions for irrigation. In this regard, a suited legal and administrative framework can be a powerful tool to increase the attractiveness of PVIS for irrigators, investors and the society in general. In contrast, an unsuited legal and administrative framework can act as a barrier to PVIS market uptake limiting or even impeding the change in the energy model of the irrigation sector.

This document aims to be a practical guide to support policy action based on the analysis of the existing practices of the different countries of the Mediterranean region. A particular effort has been put into considering potential measures that have demonstrated valid in similar contexts of decarbonisation.

In order to produce this report, the CPMR Intermediterranean Commission's network territories and the rest of SolaQua´s partners carried out an extensive research work including contributions of dozens of experts from eight Mediterranean countries: France, Greece, Italy, Malta, Morocco, Portugal, Spain and Romania. The results show the need to improve the existing regulatory and administrative practices at different levels including land regulation, electricity market access and participation conditions, administrative procedures for self-consumption energy projects, taxation and subsidies among others.

The most significant barriers to PVIS highlighted in this document include:

- Land regulation limits or even prohibits the installation of PVIS systems in agrarian land which is precisely the only suitable location for such systems. This issue is particularly negative in France.

- Electricity regulation frequently stablishes a different framework for small-sized and large-sized energy production plants, being the last one much more complex and onerous. The level that stablishes the difference between small-sized and large-sized systems is too low for most PVIS systems, negatively affecting the market uptake of the technology.

- Administrative procedures to build and operate PVIS plants are complex and involve reporting and authorization from many different administrations and regulators. In many cases, the administrative procedures required for a PVIS for self-consumption are not dissimilar to those required to install a multi-MW PV plant for selling electricity to the market. This imposes additional costs that can result in the non-viability of PVIS projects.

- Quality standards in planning, building, operating and managing PVIS are not available meaning that potential consumers are not sufficiently protected.

- Supporting measures for agriculture decarbonisation, including those of the Rural Development Plans (RDP) of the Common Agrarian Policy are not adapted to the type of projects such as large-scale PVIS. Such projects are more similar to infrastructure investments than to equipment/land investments that are normally the scope of RDPs. As a result, many of the business models and financial practices that allow for investment in clean energy technologies in other sectors cannot be used in the decarbonisation of the irrigation sector.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

In order to overcome these and other barriers to PVIS market uptake identified in this document, a number of policy actions can be carried out including:

- Introduction of specific exceptions for PVIS of up to 2 MW in land regulation, electricity production and market and grid access among others.
- Availability of quality standards, best practices, and compliance incentives in relation to PVIS planning, construction, operation and maintenance.
- Existence of “one-stop shop” procedures for PVIS of up to 2 MW.
- Facilitate the use of community-owned and third-party ownership business models for PVIS projects (for example by including them as potential beneficiaries of RDP´s measures).
- Introduce tailored supporting measures for PVIS, including ad-hoc European Agrarian Fund for Rural Development financial instruments focused in allowing access to affordable capital for new projects.

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 952879

Introduction

SolaQua in a nutshell

SolaQua's overall objective is to increase the share of **Renewable Energy (RE)** consumption in Europe and beyond by facilitating the market uptake of **Solar Irrigation (SI)** in the farming sector. SI is based on a combination of **PhotoVoltaic (PV)** technology, **hydraulic engineering**, and high-efficiency **water management techniques** to optimize irrigated farming.

The SolaQua consortium is composed of universities, the Polytechnic University of Madrid (UPM), the University of Evora (UEVORA), the University of Sassari (UNISS) and the University Hassan II Institute of Agronomy and Veterinary Medicine (IAV), which have experience in the production of solar irrigation engineering solutions. It is also composed of an insurance company with experience in the evaluation and valuation of irrigation assets in Europe, the Abarca Companhia de Seguros (ABARCA); an organization representing Regional public authorities, the Conference of the Peripheral and Maritime Regions (CPMR) Intermediterranean Commission; as well as specific regional authorities such as the Gobierno de Aragon (GA) which is the government body of the Autonomous Region of Aragón, the Genetalitat Valenciana (GVAL), which is the government of the autonomous region of Valencia and the Calarasi County Council (CJC) which is a public administration authority from Romania. Other consortium members are the Euromediterranean Irrigators Community (EIC), which is a sectorial organization of irrigators and the Council of the National Order of Agricultural Doctors and Forest Doctors (CONAF), which represents SMEs of the agrarian engineering sector.

SolaQua's consortium, which represents more than 70% of European irrigators, is aware of the potential of SI to decisively improve the sustainability of farming and rural communities in Europe. Nevertheless, to fulfil this potential, it is necessary to overcome the existing barriers to the market uptake of SI. To do this, SolaQua will accelerate the clean energy transition in European agriculture by facilitating the development of a well-functioning market for SI. This will be done by producing and exploiting a set of 7 **Key Enabling Materials and Tools (KEMT)** and by creating **Awareness, Skills, Action, Engagement, and Commitment (ASAEC)** opportunities among more than 150,000 farmers, 70 local SMEs, and 40 Public Administrations in Europe and beyond.

The execution of SolaQua will result not only in a reduction of the cost of SI for farmers but also in the availability of effective standards for consumers and environmental protection, more efficient policies and supporting schemes, and new business opportunities for SMEs. Furthermore, to exploit the project's results and to trigger the SI market, SolaQua will facilitate a joint promotion of more than 100 MW of reliable and affordable SI led by the end-users themselves: the farmers.

To achieve the overall objective of increasing the share of RE in the European farming sector by facilitating SI market uptake, SolaQua has established the following 5 specific objectives:

1. **Produce and disseminate a set of 7 KEMT**, designed to solve technical, economic, and legal issues which are acting as barriers for the market uptake of SI.
2. **Produce SI awareness and skills among the target groups in six countries** (France, Italy, Spain, Romania, Portugal, and Morocco). At least 150,000 potential end-users will be reached, 70 SMEs will be trained, and 38 Public Authorities will be able to produce more informed policies and supporting schemes.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

3. **Trigger the European SI market by facilitating a joint promotion of at least 100 MW of SI**, exploiting SolaQua's KEMT and led by the target audiences engaged in SI because of the project's dissemination and communication actions.
4. **Increase the effectiveness of public supporting schemes for on-farm investments for the promotion of SI**: SolaQua will produce a new European Agricultural Fund for Rural Development (EAFRD) financial instrument that will be implemented in 3 European regions and will support more than 40 MW of new SI capacity.
5. **Facilitate market uptake of reliable and affordable SI in markets outside the EU** that will not only result in increased cooperation but also in business opportunities for European SME´s and investors.

Purpose and scope

This document was produced to analyse how, why and under which circumstances existing legal frameworks can be an obstacle or an asset for PVIS. This document can serve as a **reference for informed policymaking** and as a **tool** for improving existing regulations in all the regions suitable for PVIS. It will bring together guidelines for informed policymaking on SI for public authorities and for Managing Authorities of Rural Development Programmes (RDPs).

Methodology

This report is based on **qualitative and quantitative data.** Qualitative data was collected through desk research and surveys sent to experts from technical departments focusing on the sectoral fields of energy and water in the CPMR Intermediterranean Commission member regions, as well as to sectoral experts from universities. The quantitative data, i.e., the evaluation of certain aspects, is based on the contribution of experts in the field of solar energy and therefore may constitute subjective opinions. These contributions have been supplemented by documentary and desk research, which allows us to give them more objectivity.

This report gathers data for the countries of the SolaQua project consortium and other Mediterranean countries for which the consortium considered the topic of photovoltaic irrigation to be relevant, i.e., countries with a significant agricultural sector and high sunshine levels. The information gathered for this report comes from the technical departments of regional authorities and universities from **France, Greece, Italy, Malta, Morocco, Portugal, Romania and Spain**. This selection of eight countries gives a broad overview of the current legislative situation in the Mediterranean and beyond.

The document is divided into **three main parts**. The first part presents a **description and an analysis of the current situation of the PVIS-related legal and regulatory framework** in the targeted countries. This part contains different sections in order to deal separately with the impact of regulation in the administrative, technical and financial aspects of a PVIS project. The second part contains a **set of best practices in the relevant regulatory framework for PVIS market uptake**. Finally, a **conclusions section** has included to briefly present the main findings and recommendations of the project. A particular focus has been dedicated to analyse and propose actions which can be implemented directly by the managing authorities of the Rural Development Plans with the aim to support their activity.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

PART 1. Analysis of the legal framework of PVIS in the Mediterranean countries.

Administrative aspects

This Chapter analyses the administrative aspects involved in planning, building and operating PVIS. It is itself divided into two sections in order to deal separately with the **administrative aspects of photovoltaic systems** and with the **administrative aspects affecting irrigation infrastructures and more precisely photovoltaic irrigation**, if existing in the regulation.

The data gathered is based on desk research and on the answers of the technical experts of the regional public authorities. Alongside details of the legal and administrative framework of PVIS, a qualitative assessment has been requested in order to produce a rating. The rating of each legislative aspect by the experts of the technical departments of the European regions is represented in a map and ranges from 1 to 5, with 1 being very adequate and 5 very inadequate. The rating is subjective to the opinion of the expert who answered the survey.

For photovoltaics

In this section, the focus is on the analysis of the administrative aspects that affect PVIS in general as they are a key part of a PVIS. A brief reference is presented of the different laws and regulations that govern the PV sector in aspects such as energy self-consumption regulation, ease of obtaining information, permits, land regulation, purchasing models, stability of the legal framework, restrictions to self-consumption, access to the electricity grid and collective self-consumption. The data collected allows to understand which elements of the legislation can hinder/facilitate the installation of PV self-consumption systems on agricultural land, which is necessary to further develop PV irrigation systems.

Laws governing the Photovoltaic sector

In this subsection, we map the different laws and regulations governing the PV sector in our sample of Mediterranean countries and beyond.

France

In France, the photovoltaic sector is regulated by:

- The Energy code, version in force in February 2022.
- The Decree No. 2016-687 of 27 May 2016 on the authorisation to operate electricity production facilities
- The Law n° 2015-992 of 17 August 2015 on the energy transition for green growth. The law devotes Chapter V to "Promoting renewable energies to diversify our energies and enhance the resources of our territories".
- The decree of 19 November 2009, which establishes a regulatory framework for ground-based photovoltaic installations (building permit, impact study, public enquiry).

Greece

In Greece, the photovoltaic sector is regulated by:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

- Law 4759/2020 (2020). In Government Gazette (245A/09.12.2020). This law tackles the topics of urban planning, energy regulations for photovoltaics, exceptional levy, energy communities and increase of net-metering.
- Law 4685/2020 (2020). In Government Gazette (92A/7.5.2020). This law tackles the reform of the environmental legislation and the renewable energy sources licensing process. This law aimed at easing the environmental licensing procedure as well as fostering the installation of new renewable energy capacity. Photovoltaic projects under 1MW are exempted from seeking a license.
- Law 4643/2019 (2019): Energy market liberalization, PPC modernization, DEPA privatization and RES support and other provisions. In Governmental Gazette (193/03.12.2019).
- Law 4513/2018 on Energy Communities and Other Provisions

Italy

In Italy, the renewable energy system and the photovoltaic sector are regulated by:

- Legislative Decree 28/2011, which transposes into Italian law the provisions of Directive 2009/28/EC on the promotion of the use of energy from renewable sources. It regulates the construction and operation of renewable energy installations according to specific administrative procedures for each type of installation.
- Ministerial Decree 10/09/2010 providing guidelines to administrative procedure and on project presentation.
- Legislative Decree No 387 of 29 December 2003, implementing the European Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market. The decree creates a basic framework for the promotion of renewable energy. It establishes an observatory for renewable energy (Osservatorio nazionale sulle fonti rinnovabili e l'efficienza negli usi finali dell'energia).

More precisely for the Puglia region, other decrees exist. They give details on the national regulatory system and adapt them to the local law system and give details on land and environmental regulation.

Malta

In Malta, the guidelines governing the installation of photovoltaic systems can be divided into two categories:

- The good-practice visual and aesthetic design which is governed by the national Planning Authority.
    - *The Planning Authority (PA) in Malta is the entity responsible for good-practice design guidance. The PA encourages the use of photovoltaic modules as a means of generating electrical power.*
- The authorization to connect to the grid which is governed by the Regulator for Energy and Water Services.
    - *The Regulator for Energy and Water Services administers the allocation and approval of feed-in tariffs[1] for solar photovoltaic generation capacities in accordance with the Feed-in Tariffs Scheme Regulators S.L.545.27. Any*

[1] A feed-in tariff is a policy mechanism designed to accelerate investment in renewable energy technologies by offering long-term contracts to renewable energy producers

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

generating station must comply with the Electricity Market Regulations S.L. 545.13.

Morocco

In Morocco, the PV sector is governed by:

- the Law No. 13-09 which aims to support the development of the renewable energy sector. This law acts in synergy with the national energy policy and intervenes to develop and adapt the renewable energy sector to future technological developments and to encourage private initiatives. The legislative framework for the renewable energy sector offers, among other things, prospects for the construction and operation of electrical energy production facilities from renewable energy sources by natural or legal persons, public or private, specifying the general principles that they must follow and the applicable legal regime including for marketing and export.
- Law No. 58-15 promulgated by Dahir No. 1-16-3 of January 12, 2016 amends and completes Law No. 13-09: this law amends and supplements Law No. 13-09 and aims to remedy the shortcomings of Law 13-09 and facilitate its application. The main additions and modifications made by Law No. 58-15 concern the following points:

  - The opening of the low voltage network to producers of electricity produced from renewable energy sources;
  - Consideration of the opinion of the hydraulic basin agency in the authorization process for the construction of installations for the production of electrical energy from renewable energy sources;
  - The possibility of selling to ONEE the excess energy produced from renewable sources by installations connected to the national high voltage (HT) and very high voltage (THT) network, within the limit of 20% of its excess;

  The implementing decrees for this law have not yet been published, which limits the application of this law.
- The Law n° 16-09 relating to the National Agency for the development of renewable energies and energy efficiency. This law led to the creation of the National Agency for Renewable Energy Development and Energy Efficiency.
- Law 47-09 on energy efficiency which deals with the performance of energy appliances and equipment;
- Law 36-15 on water: Law 36-15 is based on several principles that regulate the exploitation of groundwater, in particular:

  - Groundwater is part of the hydraulic public domain (Articles 4 and 5);

  - Any abstraction of surface or underground water resources is subject to authorization by the hydraulic basin agency concerned (Articles 26 and 114);

  - Integration of a system of offenses and sanctions (to control direct debits) (Articles 131 and 137);

  - The introduction of the collector-pays principle (article 27).;

- The Decision n° 927-20 of April 2nd, 2020 on the Moroccan standards of photovoltaic products and solar and thermal installation.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Romania

In Romania, the photovoltaic sector is governed by the Law no. 220/2008 for the promotion of energy production from renewable energy sources. This Law provides the legal framework for expanding the production and use of electricity from renewable sources. Objectives include reducing production costs and primary energy imports, balance in national energy use, reduction of pollutant emissions, and providing a financial and operational framework.[1]

The Electricity and Natural Gas Law no. 123/2012 ("Energy Law") also governs the energy production. The law was first amended on May 19, 2020, by Government Emergency Ordinance (GEO) no. 74/2020 to expand the possibility to enter into power purchase agreements. This ordinance was motivated by the desire to improve the uptake of renewable energy in the country. It was also amended by a Government Emergency Ordinance issued on December 28, 2021, with the main purpose of transposing the provisions of Directive (EU) 2019/944 concerning common rules for the internal market in electricity and amending Directive 2012/27/EU. Thus, to the date of the writing of this report, the "Methodology for establishing the rules for the sale of electricity produced in power plants from renewable sources" has been issued but will enter into force in May 2022.

Moreover, various orders issued by the National Regulatory Authority for Energy (NRAE) govern this sector.

Spain

In Spain, the most recent laws governing the PV sector are the:

- the Royal Decree-Law (RDL) 23/2020, of 23 June, approving measures in energy and other areas for economic recovery. This Decree includes a series of measures to promote the energy transition towards a 100% renewable electricity system and to promote economic recovery in line with the European Green Deal. The RDL approves measures in the field of energy and other areas for economic reactivation. It introduces numerous changes in the sector and regulatory changes to adapt to the European Directives on the electricity market and renewables. More precisely, it:
    - Regulates the access and connection of projects, to order a very high number of requests for access to the electricity grid by renewable energy installations.
    - Establishes a new competitive tendering mechanism for renewable energy projects.
    - Improves and simplifies the processing of authorisation procedures for the construction, extension, modification and operation of electricity production, transmission and distribution facilities.
    - Promotes new business models that will allow the development and implementation of investments and the creation of sustainable and quality employment
- The Royal Decree 960/2020, of 3 November, regulating the economic regime of renewable energies for electricity production facilities and implementing the RDL 23/2020. It establishes a new framework for future renewable installations to be developed through auctions.
- The Royal Decree 244/2019, of 5 April, regulates the administrative, technical and economic conditions for the self-consumption of electricity. This RD recognizes the figure of shared self-consumption, which enables to several users the possibility of

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

benefiting from the same generating facility; it simplifies the bureaucratic procedures and deadlines for the legalization of facilities; it introduces a simplified compensation for generation surpluses; the generation power is not limited, nor is it subject to the contracted power for consumption; finally, it indicates that self-consumed energy from renewable sources, as well as surplus energy discharged into the transport and distribution network, is exempt from all types of charges and tolls.

- The Order TED/1247/2021, of 15 November, regulates the implementation of variable distribution coefficients in collective self-consumption.

More precisely in the region of Andalusia, the Order of 26 March 2007 approves the technical specifications for Andalusian photovoltaic installations. The purpose of this Order is to establish the minimum technical and safety conditions for photovoltaic installations in Andalusia.

Laws/norms for photovoltaic stand-alone and self-consumption systems

In this section, we map the regulations applicable to stand-alone and self-consumption photovoltaic systems. Stand-alone PV systems are those that works off-grid, with or without energy storage. On the other hand, the individual self-consumption operation is the fact that an energy producer, called self-producer, consumes all or part of the electricity produced by his/her installation on the same site. The part of the electricity produced that is consumed is either instantaneous or after a period of storage.

France

The Energy Code facilitates the installation of self-consumption systems in collective and individual housing. Self-consumption buildings equipped with smart meters (e.g. Linky), which choose to sell the surplus to the main grid, can do so without additional connection costs. User charges for self-consumption systems should be set soon, to consider the savings made by the grid. This law includes tax relief for self-consumed electricity. The Tariff Order of 9 May 2017 introduces an investment premium for self-consumption systems below 100 kWp and the provisions for the buy-back of surplus energy.

Greece

The Law 4643/2019 aims to liberalise the Greek energy market, modernise the public electricity company (PPC), privatise the public natural gas company (DEPA) and update support for renewable energy.

Italy

In Italy, stand-alone and self-consumption systems are regulated by the Legislative Decree 387/2003.

The final customer can assume the status of self-consumer of renewable energy and in this case:

- it can generate and store renewable electricity for its own consumption (by setting up a RE generation facility or with one or more RE generation facilities located in buildings or on sites other than those where the self-consumer operates, but, in any case, at its disposal).
- it may sell self-generated renewable electricity and may offer ancillary services and flexibility, possibly through an aggregator.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Malta

The design guidance laws for off-grid/stand-alone and self-consumption photovoltaic systems in Malta are the same as those described in the previous section regarding the laws governing the photovoltaic sector, meaning that photovoltaic panels must be installed as per guidance given by the Planning Authority.

Off-grid systems are the same as on-grid systems but instead of being connected to the grid, the energy produced is stored in batteries. In Malta, off-grid systems can be found on farms and in remote locations where electricity is not available. In addition, the installation of a photovoltaic system must be notified or authorised by the Regulator for Energy and Water Services (REWS).

Morocco

In Morocco, the stand-alone and self-consumption systems are regulated by the Law 13-09 amended by the Law 48-15. This law establishes the right for an operator to generate electricity from renewable energy sources on behalf of a consumer or group of consumers connected to the national medium-voltage, high-voltage and very high-voltage electricity grid, under an agreement by which the latter undertake to take off and consume the electricity thus generated exclusively for their own use. According to the chapter five, article 24, the electrical energy produced by the operator of one or more installations to produce electrical energy from renewable energy sources is intended for the national market and for export.

Law 82-21: relating to the self-production of electricity, it has been approved by the government but has not yet been promulgated. It arouses criticism among producers and installers of solar panels. According to these actors, this text brings many constraints: the limitation of the surplus production intended for sale to ONEE to 10% of the annual production is a measure which is not at all an incentive; the reception capacity given by the network managers multiplies the number of participants instead of creating a one-stop shop.

This law project stipules that any natural or legal person governed by public or private law to benefit from the status of self-producer, with a few exceptions, in accordance with the principle of neutrality. The text provides for three systems that regulate self-production in the event of connection to the electricity networks (declaration system, connection approval system and authorization system), as well as measures to monitor compliance with the application provisions of the law and penal and administrative sanctions. Furthermore, producers can produce electrical energy at the same place of final consumption or even elsewhere. The law requires interested parties to have a smart meter knowing that a regulatory text will set the method of calculating the energy produced as well as the quantities injected into the electricity network and the fate of the surplus which must not exceed 10% of the total production capacity of the installed electrical unit. The text establishes fees in the event of connection to the national electricity grid to benefit from its services.

A joint resolution No. 3851.21 of the Minister of Energy for the Transition of Energy and Sustainable Development and the Minister of Interior (November 30, 2021) Setting a course for the next ten years, extending from 2022ف o 2031, which consists of envelopes for the injection of electrical energy produced from renewable energy sources in the medium voltage electrical network.

Romania

In Romania, self-consumption is regulated by the Law no. 220/2008 for the promotion of energy production from renewable energy sources.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Spain

In Spain, the Law 24/13, of 26 December 2013, on the Electricity Sector establishes the regulation of the electricity sector, guaranteeing electricity supply with the necessary levels of quality and at the lowest possible cost, as well as adhering to the "principles of environmental protection of a modern society" and "ensuring the economic and financial sustainability of the system".

Stand-alone PV systems are regulated by the Royal Decree 842/2002, of 2 August, which approves the low-voltage electrotechnical regulation, under the technical section BT-ITC-40 for low voltage generating facilities.

The Royal Decree 1955/2000, of 1 December regulates the activities of transmission, distribution, commercialisation, supply and authorisation procedures for electrical energy installations.

The Royal Decree 413/2014, of 6 June, regulates the activity of electricity production from renewable energy sources, cogeneration and waste. It establishes the remuneration system for renewables, based on the receipt of income obtained from the sale of electricity to the market, plus an additional remuneration calculated using a series of standardised parameters in accordance with the technologies existing in the market.

The Order IET/1045/2014, of 16 June, establishes the remuneration parameters for renewable energy installations.

The Royal Decree 244/2019, of 5 April, regulates the administrative, technical and economic conditions for the self-consumption of electricity. It has already been introduced in "Laws governing the photovoltaic sector".

The Royal Decree Law 23/2020, of 23 June, approves measures in the field of energy and other areas for economic reactivation. It introduces numerous changes in the sector and regulatory changes to adapt to the European Directives on the electricity market and renewables.

The Royal Decree 960/2020, of 3 November, regulates the economic regime of renewable energies for electricity production facilities and implements RDL 23/2020. This document sets the remuneration framework for the generation of electrical energy from renewable energy sources, called the economic regime of renewable energy ("régimen económico de energías renovables"), based on the long-term recognition of a price for energy.

Existence of a "one-stop shop" procedure

Even if a well-developed regulation framework for PV has been developed in the analysed countries over the last years, the specific administrative procedures related to this regulation are also very relevant. In particular a complex and lengthy administrative procedure for PV can severely affect the introduction of PVIS. In this section we investigate how close to an ideal one-stop-shop procedure are the countries we focus on, i.e. a virtual and/or physical place where one can find all the information and services needed to implement a PV system (cost, profitability, administrative procedures, companies, technical solutions, production potential depending on geographical location and orientation) and thus facilitate the installation procedure of a PVIS.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

France

In 2020, a guide named "Applying for planning permission for ground-mounted solar power plants[2]" has been released to enable a sustainable expansion of solar energy in the country. It recommends creating in each territory a **"renewable energy development centre"** bringing together all the State services concerned, open on a case-by-case basis to interested local authorities. This centre should bring together the relevant regional and departmental government departments for urban planning, environment, heritage (archaeological and architectural), risk management and agriculture/forestry, as well as the elected representatives concerned, to analyse these high-stake projects. For example, the intercommunality of the Guérande peninsula opened a one-stop shop[3] in 2021.

Italy

A "one-stop shop" procedure exists in Italy and is regulated nationally by Art. 12 of the legislative decree 387/2003. The procedure set out in the article is as follows:

- A single authorisation is required for the construction and operation of renewable energy production facilities, and this also applies to related works (demolition, building renovation, environmental restoration, etc.).
- The competent authorities are diverse. They can be the regions (or provinces if delegated by the regions) or the Ministry of Economic Development for installations with a capacity of 300 MW or more. For offshore installations, the Ministry of Transport issues the authorisation, after hearing the Ministry of Economic Development and the Ministry of the Environment, Land and Sea. The Ministry of Culture may be involved if the area is considered cultural heritage.
- A yearly tax is to be paid, whose amount depend on the entity involved (according to the art. 63(3-4) legislative decree of 26 October 1995 n. 504).
- The relevant administration meets within 30 days of receipt of the application to define the guidelines for an environmentally and landscape friendly procedure. An impact assessment may be carried out, but the whole procedure should not take longer than 30 days.

Morocco

The Law 13-09 governs the authorisation procedure and it **can be considered as a one-stop-shop procedure** as all procedures are managed by the administration, more precisely by The National Electricity Board.

The decree 2-10-578 (April 11, 2011) provides that the authorizations or declarations of installation, production and exploitation of photovoltaic energy (as defined by law 13-09) are the responsibility of the government authority responsible for energy.

[2] The purpose of this document is to specify each of the steps and requirements of the authorization procedure for a solar power plant project. Each of the actors will thus be able to fully assume their role, facilitating the sequence of the different stages of the project in a simple way. The recommendations are the result of discussions and consultation with government departments in the territories and stakeholders.

[3] https://www.info-energie-paysdelaloire.fr/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Malta

Three entities are involved in the installation of PV panels: the planning authority, the Energy and Water Services Regulator and Enemalta plc which is the main energy service provider, with another entity ARMS Ltd responsible for providing electricity bills. The existence of a single register for PV panels installations could help reduce bureaucracy.

Permits to be obtained prior to PV installation

In this section, we present the characteristics of the permits that must be obtained to install a photovoltaic system. We will focus on general information on permits for PV installation, difficulty, and cost of obtaining permits and authorisations to build a 500 kW PV system for self-consumption on agricultural land and to connect to the grid, as well as the conditions to unlock a permit.

General information on permits for PV installation

We gather in a table information on the type of permit(s) required, the level of government issuing the permit(s) and the expected time to obtain it/them. Regarding Spain, we have gathered data according to the legislation applied in three regions: Aragon, Andalusia, and Valencia. Thus, we separated these three regions in the table.

It can be observed that overall, the types of permits required are building permits/planning permits. In France, Morocco, and Spain, it is issued at the local level (the municipality) whereas in Greece and Malta, at the national level. In Italy, either at the regional or national level. In countries such as France, Malta and Morocco, the time to obtain a permit is fairly short, ranging from a few days to 6 months depending on the permit. In contrast, in Greece, Italy and Spain, the time taken to obtain a permit can be very long, usually more than 6 months.

Table 1: permits to be obtained before PV installation in some European countries and regions

Country/Region	Type of permit	Level	Expected time for obtention
France	- Planning permit for installations with a capacity of more than 250 kWp - Prior declaration for installation with a capacity of less than 250 kWp	Local	1 to 3 months
	Operating permit (for installations more than 50 MW)		
Greece	Planning permit	National	More than 6 months
	Industrial use license		
	Commercial use license		
Italy	Building permit	Local, Regional	More than 6 months
Malta	Planning permit (if the PV installation falls outside the scope of guidelines)	National	1 to 6 months

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

	Authorisation by the REWS (PV systems greater than 16A per phase)		3 to 5 days
	No Objection document from Enemalta plc (leading energy services provider)		16 to 33 days
Morocco	Specific license to commercialize extra production	Local	Not yet applied
Romania	Planning permit	Local	3 to 6 months
Aragon (Spain)	A simplified Assessment for more than 10 hectares	Local	More than 6 months
	An Ordinary Assessment for more than 100 hectares		
Andalusia (Spain)	Planning permit	Local and regional	Less than one month
	Municipal licence e.g., ICIO and environmental authorization (only for large installations)		
	Connection permit		
Valencia (Spain)	Planning permit	Local, regional and national	More than 6 months
	Specific license to commercialize extra production		
	Building permit		
	Connection permit (with surplus)		
	Access permit (with surplus).		

Difficulty/cost of obtaining permits and authorisations to build a 500 kW PV system for self-consumption on agricultural land

In this sub-section, we will map the difficulty and cost of obtaining permits and authorisations to build a 500 kW PV system for self-consumption on agricultural land.

France

To date, it seems difficult to build 500 kW PV systems for self-consumption on agricultural land as the French legislator considers that photovoltaic power plants[4] should not occupy arable land, which should be reserved for food production. Still, photovoltaic parks that only take up part of the land they occupy are compatible with certain agricultural practices such as extensive sheep farming or beekeeping, small-scale market gardening and other ways of using the land. Agrivoltaics[5] could be an option in the future but only for shades and vertical panels.

[4] A photovoltaic park or a solar farm consists of the installation of solar panels on land of several hectares.

[5] Agrivoltaism is presented as installations that make it possible to innovatively couple secondary photovoltaic production to main agricultural production by allowing a demonstrable operating synergy.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Greece

The process of obtaining a permit to build a 500 kW PV system for self-consumption on agricultural land is long. It takes two months to get the permit from the utility agencies (e.g., the forestry office), another two months to get the permit from the national electricity grid operator and about two months for the construction company to build the system.

To overcome this lengthy process, solutions have been implemented to simplify the authorisation procedures for renewable energy sources. Thus, legislation has been adopted with a series of interventions that are necessary to make the existing institutional framework work efficiently, with the aim of reducing the average licensing time to two years, which also corresponds to the European average.

In addition, the competent ministry is preparing the relevant legislation for the second "wave" of simplification of licensing for new renewable energy sources projects by consolidating three licensing stages, so that they "work" in parallel and save time.

Italy

According to Art 13. of the Decree of the President of the Republic of 6 June 2001 on legislative and regulatory dispositions in construction issues, the competence to issue building permits lies with the manager or the person in charge of the one-stop shop in compliance with the laws, regulations and urban planning instruments.

Regarding the construction of a 500 kW PV system for self-consumption on agricultural land, work is underway to provide approvals according to the type of system, its size and dimension, and the type of agricultural production. The procedure is sometimes considered controversial because the system can be considered industrial: to be approved, it must be located and linked to a real and relevant agricultural activity. However, there is still no comprehensive legal framework for this procedure.

Malta

The authorisation and permit costs associated with the installation of a 500kW PV system can be broken down as follows:

- **Planning Permit**: For a full development permit, this would depend on the area covered by the PV panels as delineated in Legal Notice 126 of 2013 and Subsidiary Legislation 552.12. Plans must be drawn by an architect, usually accompanied with photo montages and streetscape views and these are vetted by the Planning Authority to determine whether the solar arm fits appropriately within the site topography. Usually, for large-scale projects (especially those on agricultural land), this would also necessitate the introduction of an Environmental Impact Assessment report.

- **Grid Connection Study**: The cost for a grid connection study, which is performed by Enemalta, depends on the peak power of the PV system installed. The total cost for a grid connection study for peak powers equal to 500 kW is €350. However, should the grid connection study conclude that, for example, a nearby substation needs to be constructed for the 500 kWp to be installed, or for example, the transformer in an existing substation needs to be replaced, the owner applying to install the PV system has to pay for these costs themselves. In general, it can become quite expensive to replace/install a new substation.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Morocco

Law 13-09 provides that the creation, operation, extension of capacity or modification of installations for the production of electrical energy from renewable energy sources are subject to prior declaration, when the installed power, per site or group of sites belonging to the same operator, is less than 2 megawatts and greater than 20 kilowatts.

The prior declaration is accompanied by a file administrative to ensure the identity of the declarant and the nature of its activities and a technical file indicating the source of renewable energy to be used, the production capacity, the production technology used and the site of the installation considered.

The installation for the production of electrical or thermal energy from renewable energy sources, the subject of the declaration, may be transferred to another operator when the installation has not been commissioned within a period of three years. Any modification affecting one of the main characteristics of the installation for the production of electrical energy from renewable energy sources must be communicated to the administration beforehand.

Spain

Electricity self-consumption in Spain is mainly regulated by the Royal Decree 244/2019 that stablishes different categories regarding the size of the systems and their connection to the public grid. In the case of a 500 kW system, the process is quite simple for a non-connected configuration and it essentially consists in presenting to the regulators a project in compliance with the technical requisites validated by a certified professional.

In case that the installation is connected to the grid the administrative burden is more complex as it has to obtain a number of authorizations especially if the objective is to inject surpluses into the grid and obtain an economic return as a result. The related procedures can last between 6 months and a year an require the validation of the several public and private entities.

Planning permission (or building permit) is mandatory and must be obtained from the local administration (City Council) before starting the installation works. All consumers under any form of self-consumption modality must be registered in the administrative register of electricity self-consumption. The registry is telematics, declarative and free to access.

Difficulty and/or cost of obtaining permits to connect a 500 kW PV system to the public grid

In this section we map the difficulty of obtaining permits and authorisations **to connect a 500 kW PV system to the public grid** in order to sell or share the surplus. Indeed, in order to guarantee the stability of the electricity grids, grid operators tend to impose regulations on producers wishing to connect. Demonstrations must be carried out by calculation and simulation, and then by validation in regulatory tests when the generation site is commissioned. The procedure may be different for self-consumption with surplus resale, for full resale and net-metering. In this section we focus on installations mainly oriented towards self-consumption.

Results show that mostly, there is an administrative burden when starting the procedures to connect a PV installation to the grid. Regarding the cost, it varies among countries.

France

The procedure and the administrative steps to follow in order to connect a PV installation to the grid (the Enedis network) **are numerous.** One needs to:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

- Compile a file for analysis. Various documents must then be attached to the file (the town planning permission, the location plan of the installation, the layout plan, photos of the current connection, the title deed of the building and a certificate attesting to the professional qualification of the solar installer, and more).
- Provide the certificate of conformity, which must be validated by the Comité National pour la Sécurité des Usagers de l'Électricité and the Operating Access Contract.

The connection of the PV system is free of charge for self-consumption with resale of the surplus.[6]

Greece

As mentioned in the previous sub-section on the difficulty and cost of obtaining a permit for installation on agricultural land, the **authorisation procedures to connect renewable energy sources (RES) to the grid have been simplified to reduce the difficulty**.

Italy

Electricity suppliers are legally obliged to allow the connection of PV systems to the public grid in order to sell the surplus. Indeed, according to the Legislative Decree No. 79 of 16 March 1999 (DL 79/99), **operators of renewable energy plants are entitled to be connected to the national electricity grid upon request**. However, complications can arise during the authorization procedure, especially if it involves protected areas. **In some cases, the procedure may involve up to 30 entities** and therefore take a long time. In addition, there are also economic constraints (the procedure can be very costly).

Malta

The cost of the Grid Connection Study, which is performed by Enemalta, depends on the peak power of the PV system installed. The total cost for a grid connection study for peak powers equal to 500 kW is €350.

Morocco

The regulation about the connection of PV systems to National grid is organized by the joint Decision of the Minister of Energy for Energy Transition and Sustainable Development and the Minister of the Interior No. 3851.21 p. published on November 30, 2021. setting a course for the next ten years, starting in 2022 Until 2031, launching a secure source of renewable energy for a self-sufficient electric grid medium voltage.

Spain

The connection of a PV system to the grid depends essentially in the availability of an interconnection point and sufficient capacity in the existing grid. Distribution companies are responsible to identify the nearest connection point to the system being the related costs charged to the self-consumer. A number of problems and potential conflicts of interest have been identified as distribution companies does not always have incentives to facilitate new connections to distributed renewable energy systems. Furthermore, many parts of the grid are already at full capacity so no more connections are allowed. Also, an installation of 500 kW has to obtain a preliminary authorization from the competent authority in order to be built. The total cost of the related actions can vary significantly depending on the distance to the injection point.

[6]https://mypower.engie.fr/energie-solaire/conseils/raccordement-panneau-solaire.html

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Conditions to unlock a building permit

In this section, we map the conditions to unlock a permit to build a photovoltaic system. Two main conditions emerged from our research: **the environmental impact assessment,** which consists of integrating environmental issues throughout the preparation of the project and the accompanying decision-making process; and **the public inquiry** which is a procedure for consulting the public before administrative decisions are taken. The purpose is to ensure that the interested parties are informed and involved, and that the interests of third parties are considered when decisions are being made likely to affect the environment.

From the results, we observe that the environmental impact assessment is required to unlock a building permit in all the countries concerned by our study. We observe that a public inquiry is required in France, Greece, Italy, Romania and Spain whereas it is not in Malta and Morocco.

France

In France, the Environmental Code (Article R 122-8) makes the **environmental impact assessment** and **the public enquiry mandatory for ground-mounted photovoltaic installations** with a peak power of more than 250 kW. Furthermore, these installations are subject to the provisions in force concerning town planning and the preservation of water resources, Natura 2000 sites, land clearing, as well as electrical law. Ground-based facilities should meet additional environmental considerations: siting in flood-prone areas, fire risk, protection perimeter for public water catchments, water legislation, Natura 2000 zone.

Greece

In Greece, an environmental impact assessment, a brief description and a public consultation are required to unlock a permit.

Italy

In Italy, an environmental impact assessment with brief description is required, as well as a public consultation.

Malta

In Malta, any application involving a major project that may have an impact on the environment is examined by the Environment and Resources Authority (ERA). This is **to determine whether a project falls under the Environmental Impact Assessment (EIA) Regulations (S.L. 549 46**). If the audit concludes that the project requires an EIA or further screening, a Project Description Statement (PDS) is requested. A PDS is a report prepared by the architect that describes the project proposal, including all the operations that are to take place and the site of the development, together with a preliminary assessment of the likely significant effects of the proposal on the environment. Through the PDS it will be possible for the ERA to determine whether the proposed development requires the submission of an EIA.

Morocco

In Morocco, only an environmental impact assessment with brief description is required.

Romania

In Romania, an environmental impact assessment with brief description is required, as well as a public consultation.

Spain

In Spain, an environmental impact assessment with brief description is required. Furthermore, in Andalusia and Valencia a public consultation is also required.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Land regulation

PV systems require a significant amount of space to place the solar panels and other components. In the case of PVIS these elements must be located at the pumping station which is normally situated on agricultural land. Therefore, land regulation can include objections to the installation of PV systems, due to the change of land use, from agricultural to industrial purposes, which can be a barrier to PVIS. In this section, we map the land regulations related to the installation of PV systems in the targeted countries. Specifically, we analyse whether it is possible to build such a system on agricultural land, if so, whether there is an obligation to change the use or qualification of land in agricultural areas, whether there are specific restrictions for ground-mounted and rooftop photovoltaic installations for irrigation purposes.

As a main conclusion, the results show that installing photovoltaic systems on agricultural land is difficult in many countries, meaning that related regulation is a major barrier to PVIS deployment in Europe.

Possibility to build a ground-mounted PV system on agricultural land

In this sub-section, we map whether the legislation allows the installation of a ground-mounted PV system of significant size (500 kW) on agricultural land, i.e., land used for agricultural purposes. We note that it is possible to build a ground-mounted PV system on agricultural land in Spain, Portugal and Malta whereas it is much more difficult in France, Greece and Italy.

France

The circular of 18 December 2009 specifies that solar power plant projects are not intended to be installed in agricultural areas, particularly those that are cultivated or used for livestock. Consequently, **the installation of a solar power plant on a plot of land located in an agricultural zone**, or on a plot of land used for agricultural purposes in a commune covered by a communal map, **is generally unsuitable given the need to preserve the agricultural vocation of the land concerned**.[7] Photovoltaic parks are not intended to occupy arable land which, from the point of view of sustainable development, should be reserved for food production with a view to relocating agriculture and reducing the ecological footprint of food systems.[8]

Still, photovoltaic parks that only take up part of the land they occupy are compatible with certain agricultural practices such as extensive sheep farming or beekeeping, small-scale market gardening and other ways of using the land. Thus, a ground-mounted PV park can go hand in hand with the maintenance of a pastoral activity, provided that the height of the structures and the layout of the various elements have anticipated this use. For example, in Ortaffa, in the Pyrénées Orientales, juwi EnR (now Neoen) and the mayor of the municipality have set up a photovoltaic plant with a specific approach to ensure that a 25 MW ground-mounted photovoltaic park is well integrated into the local environment[9]. Also, ground-mounted solar installations can be considered on land which, although located in an agricultural zone, has not been used for agricultural purposes in recent times.

It is recalled in France's Integrated Energy and Climate Plan of 2020, which is a ten-year integrated document mandated by the European Union, that measures should “favour ground-

[7] https://www.ecologie.gouv.fr/sites/default/files/Guide_EI_Installations-photovolt-au-sol_DEF_19-04-11.pdf
[8] https://www.photovoltaique.info/fr/preparer-un-projet/quel-type-de-projet/photovoltaique-au-sol/
[9] https://www.photovoltaique.info/fr/preparer-un-projet/quel-type-de-projet/photovoltaique-au-sol/#le_parc_photovoltaique_dans_son_environnement

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 952879

based installations on urbanised or degraded land, or car parks (...) while maintaining high requirements on agricultural land and the absence of deforestation".

The concept of agrivoltaics is emerging in France, but it only refers to mobile shades or vertical panels, and not ground-mounted panels. Promoted in France since April 2017, via the innovation call for tenders, agrivoltaics is presented as installations that make it possible to innovatively couple secondary photovoltaic production to main agricultural production by allowing a demonstrable operating synergy. In this case, the installations must respond to an agricultural need, detailed in the technical brief, by providing an explicit service and being designed to optimise agricultural and electrical production.

Greece

By the 2019 law, the installation of small photovoltaic systems, with a capacity of up to 1 MW, has been resumed on plots that have been characterized as high productivity land. At the same time, **a limit has been set on the stations that can be built per Regional Unit, since they cannot occupy more than 1% of its cultivated areas** – even considering the areas that already occupy photovoltaic systems, which are in operation or have received a binding offer connection. In this way, the power in MW of the photovoltaic plants that can be installed on the highly productive agricultural land of each Unit will be determined.

Italy

The legislative Decree no. 199/2021, in line with the European Commission RED II directive (2018/2001) on the promotion of the use of energy from renewable sources, regulates the areas suitable for the installation of power plants for the production of electricity from renewable sources. Article 2. of the Decree defines "suitable area" as the "area with a high potential to host the installation of electrical production plants from renewable sources, also in case of certain technical-localization conditions." The following are considered appropriate areas:

- sites where installations from the same source are already installed and where non-substantial modification interventions are carried out;
- areas subject to rehabilitation activities;
- quarries and mines that have been closed, unrecovered or abandoned or are in environmentally degraded conditions.

These types of areas are more likely to host energy production systems without significant impact on the territory (limited or no land consumption, presence of tourism, environmental/landscape constraints).

Agricultural areas are not considered by this legislative decree as suitable areas for building PV systems, which could make it more difficult to obtain a building permit.

Malta

It is possible to build a PV system on agricultural land but only after an Environmental Impact Assessment (EIA) has been carried out by the Environmental & Resource Authority. Such EIA is often needed to determine the following:

- If the project could cause any environmental impact;
- If the solar farm fits appropriately in the site topography;
- If the interventions on site are reversible;
- How works would be managed to avoid impact on the site and surrounding land;
- Details on decommissioning and site-reinstatement upon cessation of the work.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

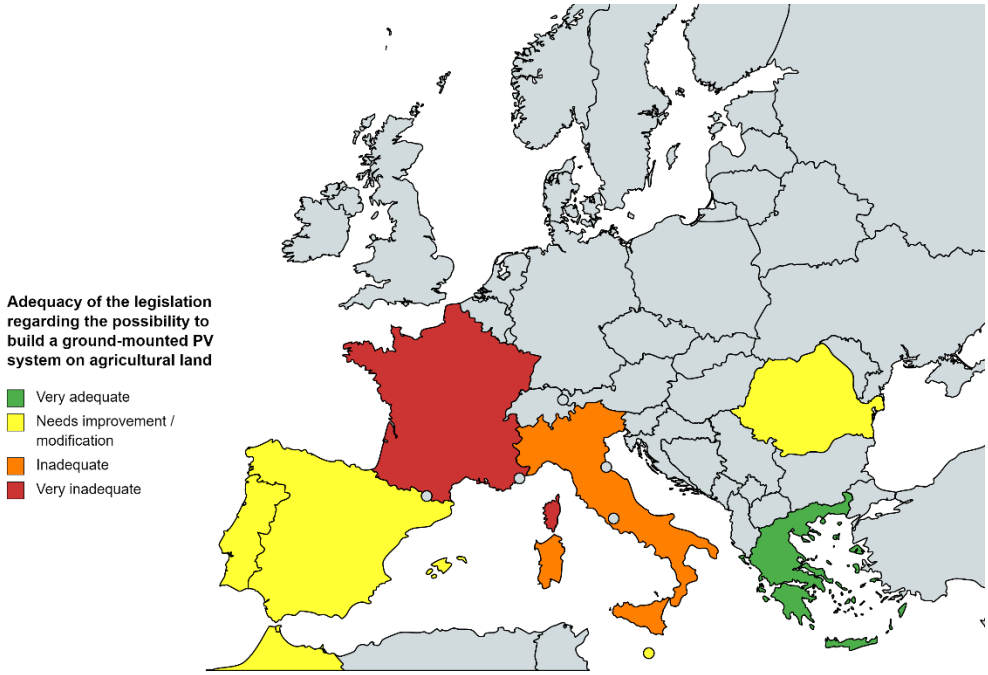
Morocco

There is no restriction for building a PV system on agricultural land.

Spain

In general, there are no specific limitations to install PV systems in agricultural land (*terreno rústico*). However, in the Valencia Region a Declaration of Common Interest (DIC) is mandatory in order to authorize the change of use of land. This DIC authorization must be approved by two public bodies: the Regional Ministry of Infrastructure, Territory and Environment and the Regional Ministry of Agriculture and Environment.

Figure 1. Adequacy of the legislation regarding the possibility to build a ground-mounted PV system on agricultural land



Requirement to change the use or qualification of land to install photovoltaic systems for irrigation in agricultural areas

In this sub-section, we map whether it is needed to change the use or qualification of land to install PV systems in agricultural areas.

France

In the case where a ground-mounted solar system is installed on land which, although located in an agricultural area, has not been used for agricultural purposes in the recent past, **a change of use of the land is required.**

Malta

Only a full development permit is required to install photovoltaic systems for irrigation in agricultural areas. This application is screened by both the Planning Authority and the Environmental and Resource Authority. Furthermore, the Planning Authority can allow the installation of non-intrusive photovoltaic panels, provided they are installed:

i. On rural buildings which are not scheduled or otherwise protected, and
ii. On legally established paved areas within the curtilage of existing rural buildings.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Romania

The change of use or qualification of land to install PV systems for irrigation in agricultural areas is required in Romania. In order to make any investment, the National Agency for Land Improvement, the organizations of irrigators and the federations shall issue, as appropriate, on request, approvals for the removal from the agricultural circuit of the lands served by the land improvement infrastructure from their area of responsibility. The approval of the removal of the lands from the agricultural circuit is made according to the legal provisions in force.

Morocco, Italy and Spain

The use or qualification of land to install PV systems for irrigation in agricultural areas is not required in Morocco and Italy. In Spain, a Declaration of Common Interest is required to authorize the change of land use in the Valencia Region.

Existence of specific restrictions for on-ground photovoltaic installations for irrigation purposes

In this sub-section, we map the existence of specific restrictions for on-floor photovoltaic installations for irrigation purposes.

In Malta, restrictions are related to the fitting to the site topography, limitations of the height of the panels, limitation of the trenching work to existing routes, the guarantee that interventions on site are reversible, the inclusion of a construction management plan and of a decommissioning and site reinstatement plan.

There are no restrictions for on-ground PV installations for irrigation purposes in Spain, Morocco, Romania and Italy.

In France and in Greece, the law does not specify restrictions linked to on-ground photovoltaic installations for irrigation purposes.

Existence of specific restrictions for rooftop photovoltaic installations for irrigation purposes

In this sub-section, we map the existence of specific restrictions for rooftop photovoltaic installations for irrigation purposes. Overall, the law does not specify particular restrictions for rooftop installations linked to irrigation purposes.

In Malta, restrictions for rooftop PV installations for irrigation purposes exist related to the inclusion of reasonable measures for the interception, collection and re-use of water run-off; to the limitation of the height of the photovoltaic panels to not more than 1 meter; to the reversibility of the interventions on site; to the inclusion of a construction management plan and of a decommissioning and site reinstatement plan and finally to the installation of PV panels on freestanding frames whose height does not exceed the parapet wall height.

There are no restrictions on rooftop PV installations for irrigation purposes in Spain and Italy.

In France, Greece, Morocco and Romania, the law does not specify restrictions linked to rooftop PV installations for irrigation purposes.

Off-take models

In this section, we are mapping the existing off-take models suited for PVIS. Off-take models are particularly important to overcome some of the barriers that irrigators find to produce, finance and operate large PVIS systems. A well-designed off-take model can allocate tasks and risks to

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

specialized entities improving the reliability of the systems and increasing the available capital for new projects.

A particularly successful model to introduce energy self-consumption technologies is the PPA model. In this case the off-taker is **an entity that contracts via Power Purchase Agreements (PPAs), to purchase power generated by producers** for a defined time period at a defined price. PPAs are medium- or long-term agreements that provide for the supply of electricity from renewable sources (predominantly wind and photovoltaic) to a specific party, usually an electricity trader (merchant or utility PPA) or a large company (corporate PPA). They include provisions on selling electricity to the buyer at a pre-defined price. In this way, the project becomes financeable and therefore viable, as future revenues can be accurately calculated.

Possibility to commercialize the surplus and PPA

Typically, irrigation systems are not in use during part of the year due to weather conditions or to the crop cycle. Nevertheless, the PV system associated to a PVIS can still produce electricity during such periods that can potentially be valorized by injecting it into the public grid. The resulting income can improve the economic viability of PVIS so the adequation of the regulation to the commercialization of energy surpluses is relevant to the market uptake of the solution. In this section, we are mapping the national legislation regarding the sale of surplus energy from self-consumption photovoltaic systems through the public grid as well as the possibility to contract Power Purchase Agreements for farmers in favorable conditions. What can be observed is that overall, it is possible to sell surplus energy from self-consumption photovoltaic systems. Also, contracting a Power Purchase Agreement is authorized in all the countries under study.

France

Established in 2000, the purchase obligation is a system that obliges EDF (Électricité de France - the French electricity generation and distribution company) and local distribution companies (ELD) to buy all or part of the green energy produced by individuals or independent producers. Households that produce their own energy can sell their production to EDF's solar subsidiary.

With the new tariff decree of 6 October 2021, **it is possible to sell the surplus in France for installations up to 500 kWp**, valid only for PV installations on buildings, shades or hangars. The steps involved in completing the connection request are simplified: the deposit is abolished, and the title deed is no longer required at the time of the connection request but may be required to establish the purchase contract. For installations from 100 kWp to 500 kWp, the sale of the surplus is at the same tariff as the sale of the whole.

Beyond 500 kWp, there is a call for tenders from the “Commission de Régulation de l’Énergie” dedicated to self-consumption, but the dates for submitting applications have not yet been communicated and it is self-consumed electricity that is subsidised and not the surplus electricity.

In France, the PPA contract with EDF allows an owner to benefit from a fixed tariff for 20 years.

Greece

The excess energy in net metering is not reimbursed but is credited to the user for the next three years. More precisely, the PV systems installed in the framework of net metering are connected to the public network. The electricity produced is absorbed by the power manager’s network and then offset by the electricity consumed by the property owner. At the end of each metering period, the amount of debt to the Public Power Corporation, the leading power

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 952879

generation and supply company in Greece engaged in the generation, distribution and sale of electricity to consumers, will be equal to the value of kilowatt hours (kWh), resulting from the difference between the energy we produce and the energy we consume. If the difference between the energy produced and the energy consumed is surplus, then the excess energy is transferred to the next account until the annual cycle is closed and the settlement is made.

Italy

It is possible to sell the surplus, but some problems have been pointed out by the parties related to the PPAs, such as: slow approval procedures, opposition of public bodies to power plants (in this respect, the legislator enacted Decreto Legge D. L. 31 May 2021, No. 77), low electricity prices, lack of long-term hedging instruments in the form of financial instruments from international power exchanges or insurance options (in Italy, agreements have a duration of five to ten years, with coverage reaching five or six years at best), leaving only the conclusion of virtual PPAs and the virtual impossibility for the public administration to purchase electricity on the basis of PPAs.[10]

Malta

For grid connected PV systems, energy generated by the PV system may be consumed at the time of production and **any units that are not consumed instantaneously are exported to the electricity grid. These excess units will be paid at a feed-in tariff according to terms and conductions.**

Morocco

The electrical energy produced by the operator of one or more installations for the production of electrical energy from renewable energy sources is intended **for the national market and for export**. For the marketing of electrical energy from renewable energy sources the operator shall have the right of access to the national medium-voltage, high-voltage and extra-high-voltage electricity grid, within the limits of the available technical capacity of the grid.

Romania

The surplus energy can be commercialized into the electricity market. The selling price of the energy produced by the prosumer is calculated according to the weighted average price registered in the 'day-ahead markets' (DAM) in the previous year. The energy produced and delivered can be sold, based on the connection certificate obtained from the distribution operator. For this, there must be a contract for the sale-purchase of electricity produced and delivered between the prosumer/seller and the supplier/buyer.

Spain

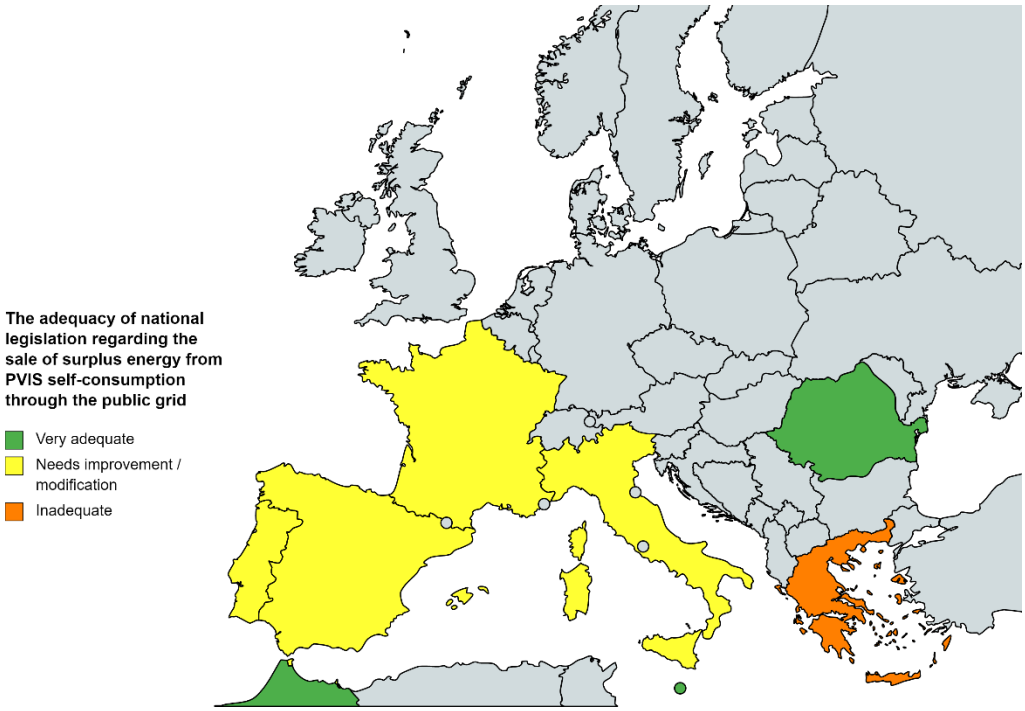
Legislation allows the commercialization of surplus into the electricity market in Spain. This is regulated by the Royal Decree 244/2019 for the self-consumption of electrical energy. It defines two modalities of surpluses: with compensation (similar to the net-metering system), only for power facilities of less than 100 kWp; and without compensation.

Energy surpluses can also be commercialized with third parties throughout PPA, in which the PV facility owner sells electricity to a buyer under a long-term contract.

[10] https://www.roedl.com/insights/renewable-energy/2021/august/ppa-italian-market-2021

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Figure 2. The adequacy of national legislation regarding the sale of surplus energy from PVIS self-consumption through the public grid.



Stability of the legal and regulatory framework

In this section, we analyze the stability of the legal and regulatory framework affecting PV systems, i.e., whether it has changed significantly over the last 20 years. Unstable means that the framework has evolved and changed over the years and stable means that it has not changed over the years.

We find that it is considered stable in Malta, Morocco and Romania while it is considered unstable in France, Greece, Italy and Spain.

Regulations for self-consumption and sale of energy to the grid

In this section, we will analyse the regulation affecting both self-consumption and sale to the grid. Owners of PV systems produce their own energy have two options: they can sell their production to the subsidiary responsible or they can consume it. In the latter case, it is called self-consumption, i.e., when an owner uses the energy produced without recourse to a supplier. There are two forms of self-consumption: Individual self-consumption and collective self-consumption.

In the three first sub-sections, we focus on self-consumption. In the following three subsections, we focus on aspects related to the sale of energy to the grid.

Existence of tolls or restrictions for self-produced and/or self-consumed energy

In this sub-section, we map the existence of tolls or restrictions for self-produced and/or self-consumed energy from a PV system.

Self-production and consumption are not restricted in France, Greece, Malta, Spain and Italy.

In Italy, incentives are provided for on-site exchange and collective self-consumption. By decree of 16 September 2020, the Ministry of Economic Development introduced support tariffs to

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

encourage the development of the self-consumption model: collective self-consumption is eligible for an incentive of €100/MWh on self-consumed energy. For energy communities, the incentive will be increased to €110/MWh to compensate for the higher costs associated with this system. The incentive is granted for a period of 20 years.[11]

Regulation for shared or collective self-consumption

In this sub-section, we map the regulation for collective self-consumption. It refers to a situation when the energy is produced by several producers at the same time and intended for several consumers. This is particularly the case when the installations supplying electricity supply a collective building, several buildings or even a neighbourhood.

France

The Decree n° 2017-676 of 28 April 2017 governs collective self-consumption. Collective self-consumption operations are set by default at the scale of a building which may itself be connected to the low-voltage or medium-voltage network. Collective self-consumers can choose between the standard distribution network tariff (TURPE - tarif national d'utilisation du réseau de distribution) and the TURPE CSC (Enedis 2019). The CSC is allowed if the electricity is produced and consumed by several consumers and producers linked together by a legal entity.

A collective self-consumption operation may be qualified as extensive when the supply of electricity is carried out between one or more producers and one or more final consumers linked together within a legal entity whose extraction and injection points are located on the low-voltage network and comply with the criteria, in particular geographical proximity, laid down by order of the minister responsible for energy. The conditions that extended operations must meet are the following:

The extraction and injection points of the most distant participants must be no more than 2 km apart.

In metropolitan France, the cumulative power of the production facilities participating in the operation must not exceed 3 MW.

The participants must be connected to the public distribution network.

The perimeter of an extended collective self-consumption operation may be extended to 20 km by way of derogation. To do so, the legal entity organising the operation must submit a reasoned request to the Ministry in charge of Energy.

Greece

In 2018, a law on energy communities (Law N4513/2018) was introduced, which extended the scope of virtual net metering to energy communities. The law defines energy communities as urban partnerships with the objective of social and solidarity economy and innovation in the energy sector. Energy communities can produce, distribute and supply renewable energy from installations of up to 1MW.[12]

[11] https://www.roedl.com/insights/renewable-energy/2021/may/new-renewable-energy-business-opportunities-italy

[12] https://www.rescoop.eu/uploads/rescoop/downloads/Collective-self-consumption-and-energy-communities.-Trends-and-challenges-in-the-transposition-of-the-EU-framework.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Italy

The above-mentioned Legislative Decree no. 199/2021 acts that in the case of collective self-consumers:

- the self-consumers must be in the same building or condominium;
- each self-consumer can produce and store renewable electricity;
- the distribution network is used to share the energy produced by the renewable energy plants, also using storage facilities;
- self-produced energy is used primarily for the needs of self-consumers and surplus;
- energy can be accumulated and sold, including through PPA;
- participation in the group of self-consumers of renewable energy acting collectively may not constitute the main commercial and industrial activity of private enterprises.

There are **energy communities,** which are consortia of companies or entities willing to co-produce and co-consume energy from renewable sources. For example, in small rural villages, a set of consumers (10 to 15) can share the use of an electric cabin, thus constituting an energy community and self-consuming renewable energy together. This is also regulated by the Decree-Law of 31 May 2021, n.77 aiming at simplifying procedures in order to achieve the sustainability and innovation objectives included in the national recovery plan. In addition, the National Recovery Plan includes a call for the financing of energy communities in villages with less than 5000 inhabitants. The aim is to innovate the energy production and consumption sector as part of the country's green transition.

Malta

Collective self-consumption is not regulated.

Morocco

The same regulation is applied for collective as the owner is a moral person

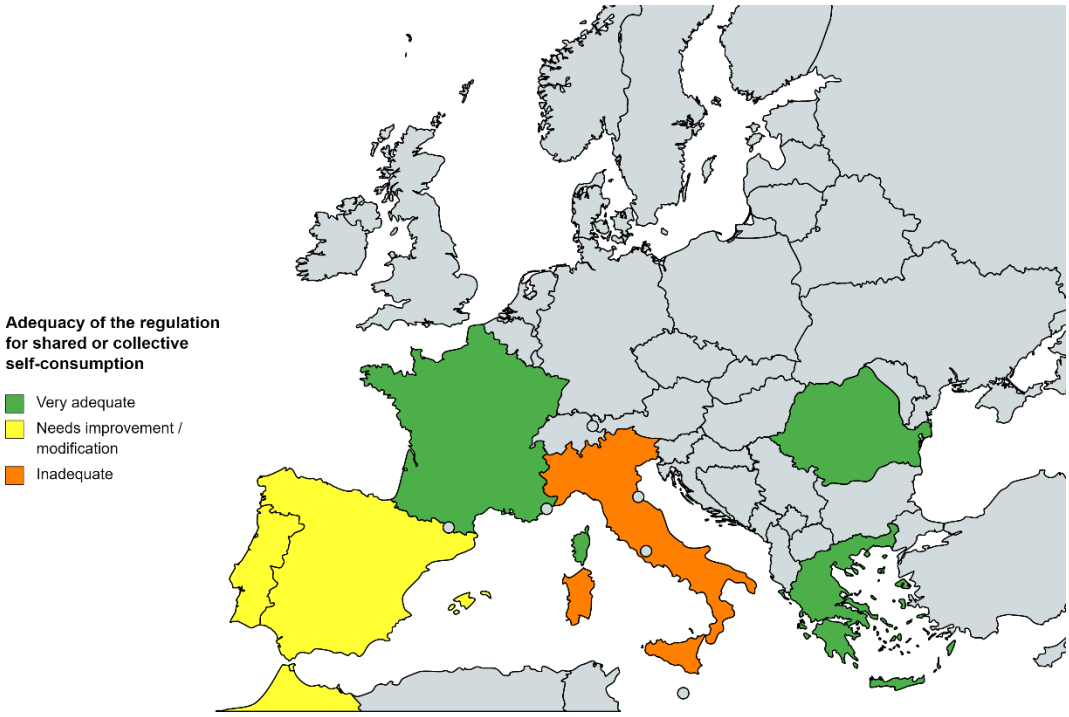
Spain

Collective self-consumption is only allowed within a radius of 500 meters or in the case that both generation and consumption are located in the same cadastral reference, and users must be connected to low voltage.

So far, there is no detailed legislation on energy communities in Spain. Decree-Law 23/2020 of 23 June 2020 first introduces energy communities and aggregators, defining only their general purpose and nature.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Figure 3. Adequacy of the regulation for shared or collective self-consumption



Possibility for the consumer and the owner of the PV self-consumption system to be a different natural or legal person

In this section, we map the legislation regarding the possibility for the consumer and the owner of the PV self-consumption systems to be a different natural (with full legal capacity) or legal person (governed by public or private law). **The results show that in all the countries under study, the consumer and the owner of the PV self-consumption system can be different natural or legal persons.**

France

The consumer and owner of the PV installations can be different. The constitution of an organizing legal entity is mandatory. The main role of the legal entity organizing the operation is to define the distribution key of the production between the different producers and consumers. Many actors are involved in a collective self-consumption operation:

- the organizing legal entity of the operation;
- the producer(s) participating in the operation;
- the consumer(s) participating in the operation;
- the supplier(s) for the complementary supply of the consumers; they also ensure the role of balance responsible and collect the taxes;
- the buyer(s) for the possible sale of the surplus;
- the network operator for the connection to the network and the allocation of the flows with application of the distribution key.

Greece

Producer-consumers are individuals, groups of citizens, households or farms that may operate in organised forms, such as associations, foundations, cooperatives. They are not both by-products and derivatives of energy produced in small-scale activities in the backyards of houses or in residential and commercial buildings (small wind turbines, photovoltaic panels, solar

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

panels, heat pumps). Therefore, **it is possible for the owner of a self-consumption system to rent out his/her production to another consumer for use.**

Italy

The consumer and the owner of the PV installations can be different.

Malta

The consumer and owner of the PV installations can be different. An application for a PV can be done by a natural person or a legal person representing an organization. It all depends on how the electricity service of the electricity consumer to which the PV will be connected to is registered with ARMS Ltd. (entity responsible for sending electricity bills). If the electricity consumer on site is a natural person, then the PV applicant must be the same natural person, whereas if the electricity consumer is an organization (e.g., company) the applicant must be the same organization, and the application has to be signed by who legally can represent the organization.

Morocco

The consumer and the owner of the PV installations can be different.

Spain

According to the Royal Decree 244/2019, the **consumer and the owner of the PV installations can be different** as it is stated in the chapter 3, Article 3, Paragraph 2: 'In any type of self-consumption, regardless of the ownership of the consumption and generation facilities, the consumer and the owner of the generation facility may be different natural or legal persons'.

Legislation applying for electrical grid access and connections procedures

In this sub-section, we map the legislation applying for electrical grid access and connection procedures.

France

The Energy Code, and more precisely the Articles L111-91 à L111-96, regulate the electrical grid access and the connection procedures. Contracts are concluded between the operators of the public transmission and distribution networks concerned and the users of these networks.

Italy

According to the Legislative Decree No. 79 of 16 March 1999 (DL 79/99) which aims to liberalise the energy market and includes provisions on access to the grid, **operators of renewable energy plants are entitled to be connected to the national electricity grid upon request** (art. 3.1 and art. 9.1). To this aim, the grid operator and a given plant operator conclude a contract (contratto per la connessione). The grid operator is obliged to conclude this contract and all persons applying for connection are entitled to connection to the grid.

The **grid operator is obliged to grant priority transmission** (utilizzazione prioritaria) **to electricity from renewable sources** (art. 29.1 Annex A ARG/elt 99/08). [13]

The National Decree 387 of 2003 legislates on the authorization of new connections to electricity grids.

[13] http://www.res-legal.eu/search-by-country/italy/single/s/res-e/t/gridaccess/aid/use-of-the-grid-19/lastp/151/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Malta

Granting that the Regulator for Energy and Water Services (REWS) issues Authorisations A and Authorisation B to competent persons under the Electrical Installations Regulations, the PV panel installation is to be tested and certified by either a warranted electrical engineer possessing a valid warrant recognized in Malta or else an electrician with an authorised "license A" for the installation, alteration, extension and certification of single-phase electrical installations or an authorised "license B" for the installation, alteration, extension and certification of single-phase and three-phase electrical installations up to 300 A per phase.[14]

Romania

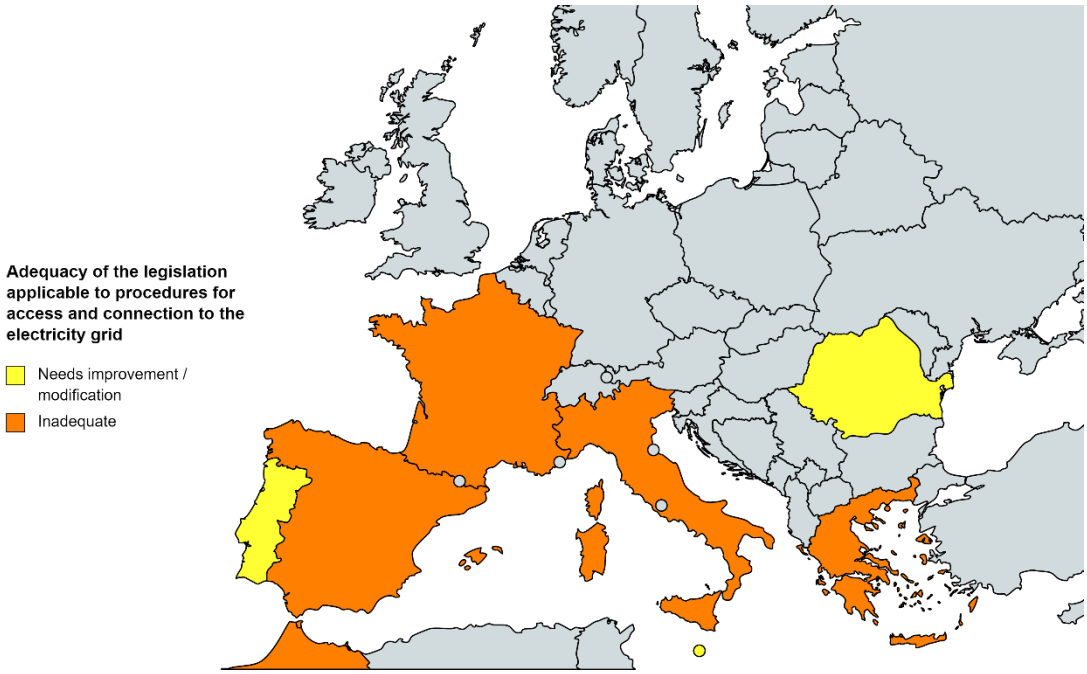
The Law no. 220/2008 regulates the establishment of the system for promoting the production of energy from renewable energy sources with subsequent modifications and completions. Moreover, two orders regulate the connection to the electricity grid:

- The Order of National Authority for Energy Regulation no. 228 from December 28, 2018, for approval of the Technical Norm "Technical conditions for connection to electricity networks of public interest for prosumers with active power injection in the network";
- The Order no. 15 of National Authority for Energy Regulation from 10.03.2021 for the approval of the Procedure regarding the connection to the electricity networks of public interest of the consumption and production places belonging to the prosumers who have installations for the production of electricity from renewable sources with the installed power of at most 100 kW per consumption place.

Spain

The Circular 1/2021, of 20 January, of the National Markets and Competition Commission, establishes the methodology and conditions for access and connection to the transmission and distribution networks of electricity production facilities.

Figure 4. Adequacy of the legislation applicable to procedures for access and connection to the electricity grid



[14] https://www.rews.org.mt/#/en/sdgr/306-authorisations-and-for-carrying-out-installation-alteration-extension-and-certification-of-electrica

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Access to the electricity grid

In this sub-section, we map the technicalities regarding the access to the electricity grid to inject energy production.

France

This resale of produced electricity is done through a **purchase contract, established between the individual and EDF or an authorised structure** (local authority or another supplier). Through this contract, EDF or another energy supplier undertakes to buy the electricity at a rate fixed in advance by the State and valid for twenty years.

The connection request is preferably made directly online or by sending a data collection form that provides the network operator with the information required for connection to the network. On this occasion, the applicant must:

- choose the connection option: injection of all or the surplus or without injection
- specify the will to benefit from the purchase obligation or not.

To submit an application, the equipment must be selected, and the connection power must be sized. Moreover, administrative documents are required by the grid operator (such as the administrative authorisation), and others by the feed-in tariff.

The maximum period for obtaining the connection estimate is 3 months. The producer has 3 months to accept the connection offer.

Italy

The **procedure for connection** consists of the following steps:

- Application
- Estimation of costs: the grid operator must respond to applications for connection and submit an estimate of costs (preventivo per la connessione) within a specific timescale (45 working days for capacities from 100 kW to 1,000 kW).[15]
- Acceptance of cost estimate
- Request for authorisation
- Authorisation procedure: it is ruled under a comprehensive procedure ("procedimento unico") in which all involved administrations participate.
- Commencement of works
- Connection.
-

Malta

To access the electricity grid in Malta, the applicant must submit several forms before and after the construction of the photovoltaic system which are verified by REWS which can issue a Regulatory Clearance.

Morocco

The access to the grid requires a contract between the National Office of Electricity and the operators. Contract between the operator and the consumer.

[15] http://www.res-legal.eu/search-by-country/italy/single/s/res-e/t/gridaccess/aid/connection-to-the-grid-24/lastp/151/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

In Romania

To connect to the electricity grid in Romania, the user is required to submit **a connection request** to the distribution operator and of the afferent.

Spain

For self-consumption installations with a nominal capacity of more than 15 kW and with surpluses modality, the access to the electricity grid in Spain is depending on the obtention of an **access and connection permit** from the dominant electricity distribution company in the area or from the system operator directly. Generation facilities for consumers under the self-consumption **modality without surpluses** are exempt from obtaining access and connection permits.

Existence of tolls or restrictions for energy produced and consumed for PV systems connected to the grid

We look at the tolls and restrictions affecting the energy produced and consumed for PV systems connected to the grid. We note restrictions in France, Italy, Morocco, Romania and Spain, whether it is lower selling prices, taxation on the income, connection fees and/or annual operating tolls.

France

Some disadvantages of creating a purchase agreement with EDF to sell energy to the grid are as follows[16]:

- Lower selling price fixed throughout the contract period with the sale of the surplus
- High profitability only if the producer sells all his production
- Profitability of the investment depends on several factors (location, sunshine, household electricity needs, etc.)
- Taxation of the income generated.

Italy

The **connection fee is borne by the connection applicant**. Renewable energy installations are subject to lower connection fees than installations supplied by conventional sources[17].

The following fees must be paid for connection to the transmission system:

- a fee for the development of the technical solution (Art. 25.1 Annex A ARG/elt 99/08)
- a grid connection charge (Art. 25.2 Annex A TG/ARG 99/08).

Morocco

In Morocco, connection to the grid is subject to annual operating fees.

Spain

In the case of a 500 kW PVIS installation that is intended to sell surpluses a number of fees and taxes must be paid to operate it. The owners of the production facilities must meet the access fees established in RD 1544/2011, only in the case of self-consumption **modality with surpluses not eligible for compensation**.

[16] https://www.mon-energie-verte.com/le-guide-des-energies-renouvelables/obligation-dachat-solaire-principe-et-fonctionnement-avec-edf-oa/

[17] http://www.res-legal.eu/search-by-country/italy/single/s/res-e/t/gridaccess/aid/connection-to-the-grid-24/lastp/151/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

In accordance with the provisions of article 9.5 of Law 24/2013, self-consumed energy from renewable origin, cogeneration or waste is exempt from all kinds of energy system fees.

For irrigation and photovoltaic irrigation

In this section we focus on the **administrative and legislative aspects specific to photovoltaic irrigation systems (PVIS)**, i.e., **combining the use of solar energy for pumping irrigation water with precision farming techniques to save energy and water**. Photovoltaic irrigation systems are commonly perceived as an alternative to conventional electric and diesel-based pumping systems as it can dramatically reduce energy bills while effectively reducing the environmental footprint of agriculture. We will map in the countries under study the legislation governing PVIS, the actors owning the PVIS infrastructure, the dispute resolution procedure, the prerequisite for irrigation projects and the existence of an obligation for reversibility of the infrastructure.

Legal frameworks for the ownership and management of irrigation infrastructure

In this sub-section, we map the legal frameworks governing the ownership and management of irrigation infrastructures.

France

The law on water and aquatic environments of 30 December 2006 led to the creation of the unique collective management organisations (OUGC - Organisme unique de gestion collective) which set up a **collective management of water dedicated to irrigation**. Theses OUGCs are structures in charge of the management and distribution of the volumes of water withdrawn for agricultural use on a given territory. They are responsible for proposing the prefect volume that can be withdrawn from the environment for irrigation for a given geographical sector and the distribution of this volume among the irrigating users.

The OUGC is the single organisation holding the global authorisation to withdraw water on behalf of all the irrigators in the management perimeter, whatever the resource withdrawn (surface water, groundwater, water bodies, reserves, dams). **Requests for authorisation to draw water for irrigation purposes must be addressed to the sectoral OUGC.**

Greece

The Law 3199/2003 (Government Gazette 280/A/9.12.2003) 'Protection and Management of Waters' regulates the legal framework for the ownership of irrigation infrastructures.

Italy

The ownership and management of irrigation infrastructure is a regional competence in Italy through the so-called Consorzi di bonifica. For instance, Regione Lombardia manages it through a public body named *Consorzi di bonifica e irrigazione.*

Morocco

The Agricultural Investment Code (1969) regulates the legal framework for the ownership of irrigation structures. This equipment is paid for by the State, but the farmers who benefit from the irrigation water are obliged to participate in this financial effort, on the one hand, in proportion to the number of hectares irrigated and, on the other hand, by means of an annual and permanent fee for water use.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Romania

The ownership and management of irrigation infrastructures is governed by the Law no. 138/2004 for Land improvement.

Spain

The Royal Legislative Decree 1/2001, of 20 July 2001, approving the Regulations on the Public Hydraulic Domain, regulate the legal framework for the ownership of irrigation infrastructures.

Kind of stakeholders usually owning irrigation infrastructures

In this subsection, we map the actors who own irrigation infrastructures. In terms of methodology, the information was collected from the responses to the survey sent to the technical departments of the regions under study.

The respondent could select all the options he/she wanted from a predefined proposal (individual farmers, associations/cooperatives, communities of irrigators, agro-industries, local authorities). We observe that various stakeholders have the right of ownership, except in Italy, where only agro-industries can own irrigation infrastructures and in Malta only individual farmers.

Country	Stakeholder(s) with ownership
France	Individual farmers, associations/cooperatives (OUGC).
Greece	Individual farmers, irrigators communities, associations/cooperatives.
Italy	Agro-industries
Malta	Individual farmers
Morocco	Individual farmers, Irrigators Communities, associations/cooperatives, agro-industries, local authorities
Romania	Individual farmers, Irrigators Communities, associations/cooperatives, agro-industries, local authorities.
Spain	Individual farmers, Irrigators Communities, associations/cooperatives, agro-industries

Procedure for dispute resolution and law enforcement

In this sub-section, we map the existing procedures for dispute resolution and law enforcement regarding irrigation systems.

Greece

The procedure for dispute resolution is regulated by:

- The Commission's decision No Prot. 1348/28.5.2009 (Government Gazette 1122/B/2009) Regulatory Decision of the Secretary General of the Region of Attica for

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

the adoption of prohibitive, restrictive and other regulatory measures in Attica.

- The No. Prot. Oik. 1268 (Government Gazette 1210/19.7.2009) Regulatory Decision of the General Secretaries of Attica and Central Greece for the protection of the water potential of the Asopos Basin and the adoption of prohibitive, restrictive and other regulatory measures in North, NE and NW Attica (Water District 07 - Asopos Basin).

Italy

The dispute settlement procedure is extensively described in the Resolution ARG/elt 123/08 on the Procedure for the settlement of disputes between producers and grid operators. The **Annex A contains rules for the settlement of disputes between renewable electricity producers and grid operator about grid access.** When a given electricity producer comes into conflict with the network operator, it may request the resolution of the dispute from the Market Directorate (Direzione Mercati) of the Regulatory Authority for Energy, Networks and the Environment (ARERA) (art. 3 Annex A ARG/elt 123/08).

Morocco

The procedures for dispute resolution and law enforcement are governed by the Agricultural Investment Code, the Law 36-15 on water, the Commerce code and the Law 13-09 completed by the law 58-15 on renewable energy.

Romania

The general common law jurisdiction for the settlement of commercial disputes lies with the national courts. If the parties have concluded an arbitration agreement, the settlement of disputes is devolved to the arbitral tribunal.

Spain

The Royal Legislative Decree 1/2001, of 20 July 2001, approving the revised text of the Water Act contain the procedure for dispute resolution as well as the Real Decreto 849/1986, of 11 April 1986, approving the Regulations on the Public Hydraulic Domain.

Requirement of environmental impact assessment preceding irrigation installation projects

In this sub-section, we map the requirement for an environmental impact assessment prior to irrigation installation projects. An impact assessment is here understood as an evaluation of impacts and development of alternatives to predict and identify the likely environmental impacts of a proposed project or development, including the detailed elaboration of alternative.

Only in Greece it is not required to provide a prior impact assessment for irrigation projects.

Obligation of reversibility of infrastructure

In this sub-section, we map whether reversibility of the irrigation infrastructure is required, i.e., the adjustability of the infrastructure to allow it to adapt to changes in behaviour and lifestyle.

Reversibility of the infrastructure is mandatory in France, Italy, Malta, Morocco and Romania, whereas it is not in Greece and Spain.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Conclusion on administrative aspects

In this first part on the administrative aspects of photovoltaic systems and photovoltaic irrigation systems, we have seen that legislation greatly impacts the possibility to implement PVIS. In general, the administrative proceeds are not well suited to large-scale PVIS as it is considered under the same category than the utility-scale PV systems. As such, **the complexity of the regulations and administrative procedures reduces the attractiveness of PVIS for most irrigators**. The limitations that some countries have put in place for PV installations on agricultural land are particularly negative as, in their current form, they can completely hinder the introduction of PVIS and therefore the decarbonisation of the agricultural sector. In order to remedy this situation, it is important that the best practices included in this document are taken into account as soon as possible by the competent public authorities.

Technical Issues

In this second part, we gather information of the technical issues regarding photovoltaic irrigation. These issues are addressed to the aspects such as the electrical storage or the PVIS systems connected to the grid for both injecting energy surpluses and those configured as a PV-grid hybrid system.

The electricity regulation modalities

In this sub-section, we analyze the electricity regulation modalities of photovoltaic systems. In a first moment we look at the modalities affecting self-consumption, then regarding Transmission System Operator and finally regarding net-metering.

Regarding self-consumption

France

In application of the law on the energy transition for green growth, the ordinance n°2016-1019 of 27 July 2016 on self-consumption of electricity has been published. This ordinance provides for:

- the **obligation for network operators to facilitate self-consumption operations** (individual and collective);
- the establishment by the Energy Regulation Commission of a **network usage tariff adapted to self-consumption installations** to take account of the reductions in network usage costs that these operations can bring;
- the **derogation, for small-scale self-consumption installations with injection of the surplus not benefiting from a feed-in tariff, from the obligation to be attached to a balance perimeter,** the production surplus being able to be allocated by default to the distribution network operators' balance perimeter as part of their network losses at no cost in order to facilitate the implementation of projects.[18]

[18] https://www.ecologie.gouv.fr/systemes-dautoconsommation#scroll-nav__2

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

The national regulatory authority (CRE) elaborates a specific grid tariff for self-consumption with an installed capacity of less than 100 kW per producer.

Greece

Several ministerial decisions regulate self-consumption in Greece.

Italy

The GSE (Gestore Servizi Energetici) manages PV self-consumption and communicates about it in the country (See: GSE-Portale Autoconsumo).

Definitions are laid out in the EU Directive 2018/2021. It was adapted to the Italian legislative framework by d.l. 162/19, although the definition of self-consumer was already provided by d.lgs. 79/1999. It specifies that production of energy cannot be the main business activity for self-consumers. Building on d.l. 162/19, decree 16 September 2020 of the Ministry of Economic Development lays out incentives for self-consumers and self-consuming communities.

Malta

In Malta, any PV system installed falls under two feed-in tariff options:

- Option A: Sell all electricity generated by the solar photovoltaic installation to Enemalta plc in accordance with the rates and conditions established by the feed-in tariff (FIT) Regulations. This option signifies that all electricity generated is sold to Enemalta and thus the irrigation plant consumes nothing from the PV system.

- Option B: Generate electricity for own consumption and be paid for electricity not consumed at the time of generation and exported to the distribution system at the rates and conditions established in the FIT Regulations. This option allows the owner of the PV system to consume energy generated by the PV system. This option remunerates all units exported to the grid (i.e., electricity which has been generated by a PV and not consumed internally by the irrigation plant). All units imported normally (i.e., from the grid but excluding anything generated by the PV) are charged as per normal applicable tariffs.

However, current funding from *de minimis* excludes eligibility of feed-in tariff to farmers and operations who claim funding in the agricultural sector.

Morocco

The electricity regulation modalities are regulated by the Law 13-09.

Romania

The prosumers who own units for the production of electricity from renewable sources with an installed capacity of no more than 100 kW per place of consumption may sell the electricity produced and delivered in the electricity network to the electricity suppliers with whom they have concluded electricity supply contracts, according to regulations provided are exempted from the payment of all tax obligations related to the amount of electricity produced for self - consumption, as well as the surplus sold.

Spain

Self-consumption modalities depend on the number of consumers (individual or collective), the connection point (installation close to the internal grid or close to the grid), on the surpluses

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

(without surpluses, with surpluses that receive compensation or with surpluses that do not receive compensation - sale of surpluses).

Regarding Transmission System Operator (TSO)

In this sub-section, we map the regulations regarding the Transmission System Operator. The purpose of the electricity transmission operator is to transport large quantities of electricity over long distances, between regions and to neighbouring countries. We note that there is a TSO in France, Morocco, Romania, Spain and Italy but not in Malta.

France

The RTE (Le Réseau de Transport d'Electricité) is the operator of the French public electricity transmission network. This network consists of almost all the lines operated at a voltage higher than 50 kV in mainland France. RTE guarantees all users of the electricity transmission network fair treatment in a transparent and non-discriminatory manner, under the supervision of the French Energy Regulatory Commission (CRE).

The tariffs for the use of public electricity networks (TURPE) are calculated so that the revenues of the network operators cover the costs incurred for the operation, development and maintenance of the networks.

Italy

Regarding TSO, since 2020 provisions are included in the "Testo Integrato Trasporto – TIT" (Deliberazione 568/2019/R/eel, Annex A). Terna Rete Italia s.p.a. is responsible for transmission services, and producers have to stipulate contracts with it regarding transmission. The ARERA – Authority for Energy, Networks and the Environment - establishes tariffs for the use of infrastructure for energy sectors and guarantees equal access for operators. It has drafted an insightful "Testo Unico" (consolidated text) on all provisions concerning energy in Italy.

Malta

A single distribution system serves all electricity consumers. The function if the distribution system operator (DSO) is carried out by Enemalta plc, a vertically integrated power utility. The requirements regarding the unbundling of transmission system operators and distribution system operators do not apply to Malta, which has derogations by virtue of Article 44 of Directive 2009/72/EC from the requirements of certain articles of this directive. These derogations concern Article 9 on the unbundling of transmission systems and TSOs, Article 26 on the unbundling of DSOs, Article 32 on third party access and Article 33 on market opening. The retail market of electricity is therefore not open for competition and therefore customer switching is not possible in Malta.

Morocco

ONEE: Electricity branch

The National Office for Electricity and Drinking Water (ONEE) is the pillar of the energy strategy in the water and sanitation sector in Morocco. ONEE Missions – Electricity Branch:

- Ensure the public service of the production and transport of electrical energy as well as that of the distribution of electrical energy in the areas where the Office operates;
- Manage the overall demand for electrical energy in the Kingdom;
- Satisfy the country's electricity demand for electrical energy under the best conditions of cost and quality of service;

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

- Manage and develop the transport network;
- Generalize the extension of rural electrification;
- Contribute to the promotion and development of renewable energies.

Romania

According to the Law no. 220/2008, the transmission and system operator and/or distribution operators shall ensure transport, respectively distribution, as well as energy priority dispatching electricity produced from renewable sources, for all producers of energy from renewable sources, regardless of capacity, on the basis of transparent criteria and non-discriminatory, with the possibility to change notifications during the day of operation, according to the methodology approved by NRAE, so that the limitation or interruption renewable energy production to be applied only in cases exceptional, if this is necessary for stability and security.

Spain

TSO operators in Spain are companies that own and operate in exclusive specific areas of the country. These are private companies which in most cases are fully owned by large electricity producers including Iberdrola, Endesa and Naturgy that control more than 80% of the connection points.

Regarding Net Metering

In this sub-section, we map the regulations regarding Net Metering. Net metering allows residential and commercial customers who generate their own electricity from solar power to sell the electricity they do not consume back to the grid. **Net Metering is the subtraction of the exported units from the imported units**, with the final number of consumed units billed according to the applicable tariffs. Net-metering is not allowed in France, Malta and Spain but is in Greece and Italy.

France

Net-metering is not allowed in self-consumption projects (individual and collective). To that end, a consumer cannot be granted more energy (from the generation unit) than the energy consumed instantly.[19]

Under the feed-in tariff, the kilowatt-hour of photovoltaic electricity is sold by the producer at a tariff fixed by decree. The photovoltaic producer injects electricity into the grid; the buyer is obliged to buy the photovoltaic energy at the price set by law. This mechanism ensures a normal return on the capital invested over the lifetime of the installations.

Greece

The installation of storage systems in combination with RES and SITHYA stations from self-generating with energy offset was provided by par. 1 of article 14A of Law 3468/2006 as amended by Article 23 of Law 4513/2018Energy Communities and other provisions while the technical specifications and operating conditions and use of storage systems were determined by article 8 of HA no. YPEN / DAPEEK / 15084/382 (Government Gazette B ‘759 / 5.3.2019).

Italy

Electricity generated from renewable energy sources and fed into the grid can be sold on the free market or to the Gestore dei Servizi Energetici (GSE – Manager of Electricity Services) **at a guaranteed minimum** price ("ritiro dedicato"). If the price on the open market is higher than the

[19] file:///C:/Users/User/Downloads/02_Louise_Oriol_MTES_OFATE_DFBEW.pdf

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 952879

minimum guaranteed price, the price difference will be refunded. Alternatively, **renewable energy producers can opt for net metering** ("scambio sul posto") which provides economic compensation to PV producers for electricity injected into the grid. "Ritiro dedicato" and "scambio sul posto" are not combinable. [20]

Malta

Net Metering is no longer an option for any PV system approved after 2010 as this has **been replaced by a feed in tariff scheme**. Moreover, consumers having a net metering arrangement cannot increase the size of the PV system; but they can connect a new PV system to its grid through a separate meter with the option named "Full export."

Romania

Net Metering is regulated by the Decision of NRAE no. 227 din 28.12.2018 with subsequent modifications and changes:

Art. 6 -The distribution operator shall ensure the measurement of the active electricity and reactive electricity related to the places of consumption / places of consumption and production specified in accordance with the regulations in force.

Art. 7 - The meters related to the places of consumption / places of consumption and production shall be read by the distribution operator with the periodicities agreed between the contracting parties, provided in ANNEX 1B, in compliance with the regulations in force.

Art. 8 - The distribution operator transmits to the supplier the measurement data in order to settle the electricity consumption / quantity of electricity produced and delivered in the network by the prosumers, in the framework format established by ANRE, within maximum 8 working days, calculated from the last day calendar of each contract month.

If the prosumer owns a unit for the production of electricity from renewable energy sources that includes energy storage systems, it will be additionally mount, as appropriate, at least one meter (smart or remote reading) on the storage system, in order to correctly measure energy from renewable sources delivered in network. (art. 20 of the Technical Norm approved by Order of the President of ANRE no. 228/2018).

Spain

In Spain, net metering is not envisaged, only surplus compensation is, which refers to the compensation of the net energy surplus: compensation, either monetary or in the form of a billing credit, at a rate per kilowatt hour. Self-consumption regulation indicates that modalities with surpluses receiving compensation must meet the following conditions:

i. *Total power of the power facilities* **≤ 100 kW**.
ii. The consumer and associated producer must sign a **surplus compensation contract**.
iii. The production facility must be exempt from additional or specific remunerations.

The surplus compensation contract stablishes a simplified compensation mechanism that consists of an economic balance of the energy consumed during the billing period (one month). The economic value of the surplus hourly energy can never be higher than the economic value of the hourly energy consumed from the grid in the billing period. Surplus balances do not accumulate from one billing period to another, but are settled in each corresponding period.

[20] http://www.res-legal.eu/search-by-country/italy/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Authorization of implementation of hybrid PV-grid system

The implementation of hybrid photovoltaic-grid systems (PV vs. electricity grid) is authorized by the legislator and possible in all countries under study.

Regulation modalities regarding electrical storage

In this sub-section, we analyse the regulations affecting the modalities regarding electrical storage. Storing allows to take advantage of the electricity produced by the solar panels at any time of the day and year while saving money. The European Union Directive 2019/944/EU underlines the importance of making progress in the seasonal energy storage in order to achieve a completely decarbonised electricity sector that is fully free of emissions. However, we find that in most of the countries surveyed there is no comprehensive legal framework on electricity storage thus hindering its development.

France

There is a **legal framework in French law allowing energy storage, but several regulatory factors are holding back its development**. Indeed, the current legal framework does not encourage operators to develop electricity storage facilities insofar as the operators of certain storage equipment are considered to be "double users" of the network with regard to the tariff for use of the public electricity transmission network (TURPE). Article D. 315-5 of the French Energy Code provides that, for an electricity storage unit produced as part of a self-consumption operation, "the quantities stored by this installation are considered to be those of a final consumer of the operation and the quantities removed from storage are considered to be those of a producer of the operation. The operator of the infrastructure is thus qualified alternatively as a producer and a consumer, which implies that he/she is subject to the tariff for use of the public electricity transmission network twice.[21]

Greece

The introduction and development of storage on the Greek islands that are not connected to the mainland electricity grid is only possible through hybrid stations (i.e. virtual generation stations composed of renewable energy resources and storage units operating as single distribution entities).[22]

Measures to further simplify the authorisation procedure for RES and to establish, for the first time, a comprehensive framework for the development of energy storage projects are underway.

Italy

In Italy, in recent years, the Italian government has passed legislation to allow the Transmission System Operator ("TSO"), Terna S.p.A., and the Distribution System Operators ("DSOs") to develop and manage battery storage facilities on their own networks. Still, the legislative framework is fragmented and does not cover all the main characteristics of this market.[23]

[21] file:///C:/Users/User/Downloads/OFATE_systemes_stockage_electricite_1909.pdf
[22] https://www.nortonrosefulbright.com/en/knowledge/publications/1c93026d/the-time-for-electricity-storage-in-greece-has-arrived
[23] https://cms.law/en/int/expert-guides/cms-expert-guide-to-energy-storage/italy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Malta

It is possible for a conventional PV system to store excess electrical energy into the battery banks for later use instead of exporting it into the grid.

Morocco

Law 82-21 on self-production of electricity has not yet been promulgated, and its implementing texts have not yet been produced. electricity storage is not yet regulated

Romania

Electrical storage is regulated by the Order no. 15 from 10.03.2021. The approval of the Procedure regarding the connection to the electricity networks of public interest of the consumption and production places belonging to the prosumers who have installations for the production of electricity from renewable sources with the installed power of at most 100 kW per consumption shall also apply where the prosumer requests the connection of a storage facility to the place of consumption and production, in which case the provisions of this procedure relating to the place of consumption and production shall apply to the place of consumption and production with storage.

Spain

Electricity storage is allowed in any form of self-consumption. The Royal Decree 244/2019, of 5 April, which regulates the administrative, technical and economic conditions for the self-consumption of electrical energy, states that **storage elements shall be installed in such a way that they share metering equipment and protections with the generation installation**.

Financial issues

In this third part of the report, we analyse the financial aspect linked to PV systems and more precisely to PV irrigation systems (PVIS). Financial aspects are crucial for the development of PVIS in the Mediterranean.

Public financing targeted at rural development is organized at the European level through the **Common Agricultural Policy (CAP)** which **supports the vibrancy and economic viability of rural areas through funding and actions that support rural development**. More precisely, its supporting measures are classified under both Pillar I on support to farmers and markets and Pillar II on rural development. The CAP's contribution to the EU's rural development objectives is supported by the European agricultural fund for rural development (EAFRD). **This Fund supports investment in various areas linked to rural development**. EU countries implement EAFRD funding through rural development programmes (RDPs).

In the first sub-section, we map the supporting measures in the RDP that could be targeted at the support to PV systems in a first moment and to PV irrigation systems in a second moment. In the following sub-section, we analyse the current investment capacity and efficiency regarding photovoltaic irrigation.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Supporting measures in the RDP

RDPs are co-financed by national budgets and may be prepared on either a national or regional basis. At least 30% of the funding of each rural development programme must be spent on measures relevant to the environment and climate change, much of which is channelled through grants and annual payments to farmers who switch to more environmentally friendly practices.

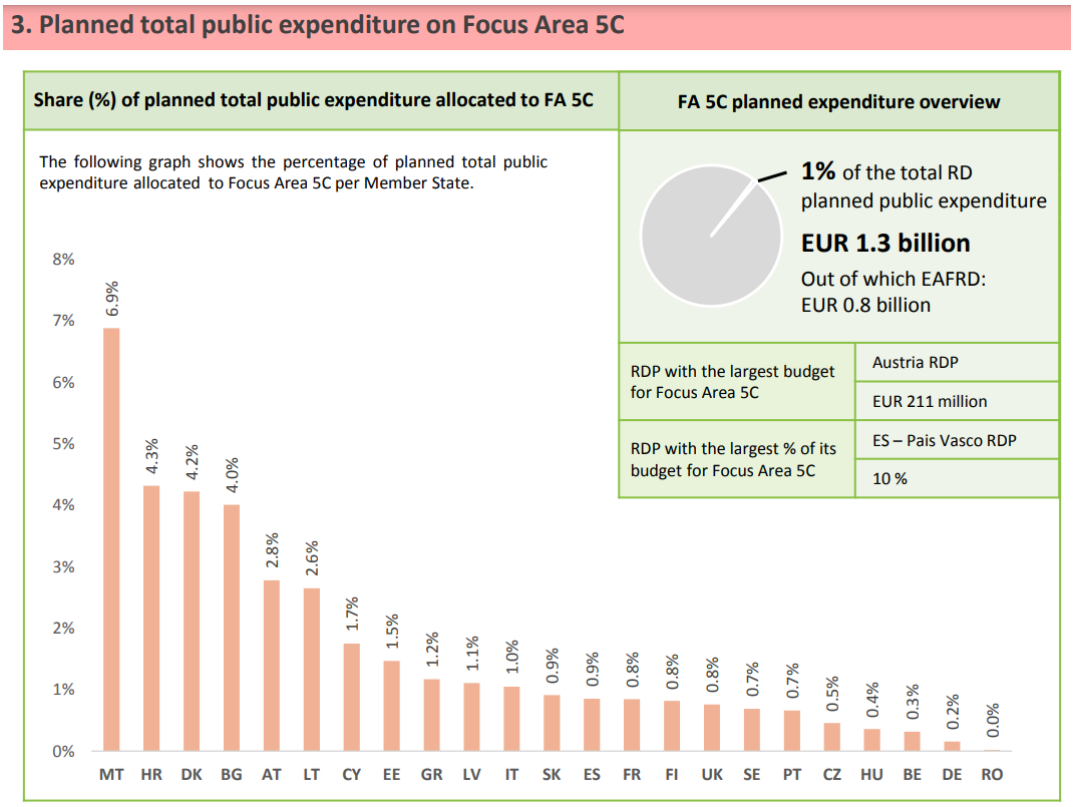
For the 2014-2020 period, six European Rural Development Priorities had been set. The **Priority 5 aimed at promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors** is of interest when tackling the topic of PVIS. These broader policy priorities are broken down into specific areas of intervention, known as Focus Areas. The RDPs set out quantified targets for each selected Focus Areas and outline the programme Measures and their allocated funding that will be used to reach the targets. The RDP's support can take the form of a wide range of measures including investments in physical assets (referred to as measure 04) or in basic services and village renewal, investments in forests (referred to as measure 08). These investments can be complemented by measures for cooperation (referred to as measure 16), knowledge transfer and advisory services. Third parties (e.g., energy service companies) can access these measures.

For Renewable Energies and Photovoltaic systems

The RDPs supporting measures for renewable energies and photovoltaic are located in the Focus Area 5C which covers a wide range of objectives, including **facilitating the supply and use of renewable sources of energy**. Thus, the measures of this Focus Area can be targeted at the development of PV systems, and more precisely the measure 04 which refers to measures allocating budget to investments in physical assets.

The following graph shows the percentage of planned total public expenditure allocated to Focus Area 5C per Member State under the period 2014-2020. This graph allows us to identify whether the RDPs of the countries studied contained measures that could be targeted to subsidise the development of PV systems.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879



Source: https://enrd.ec.europa.eu/sites/default/files/focus-area-summary_5c.pdf

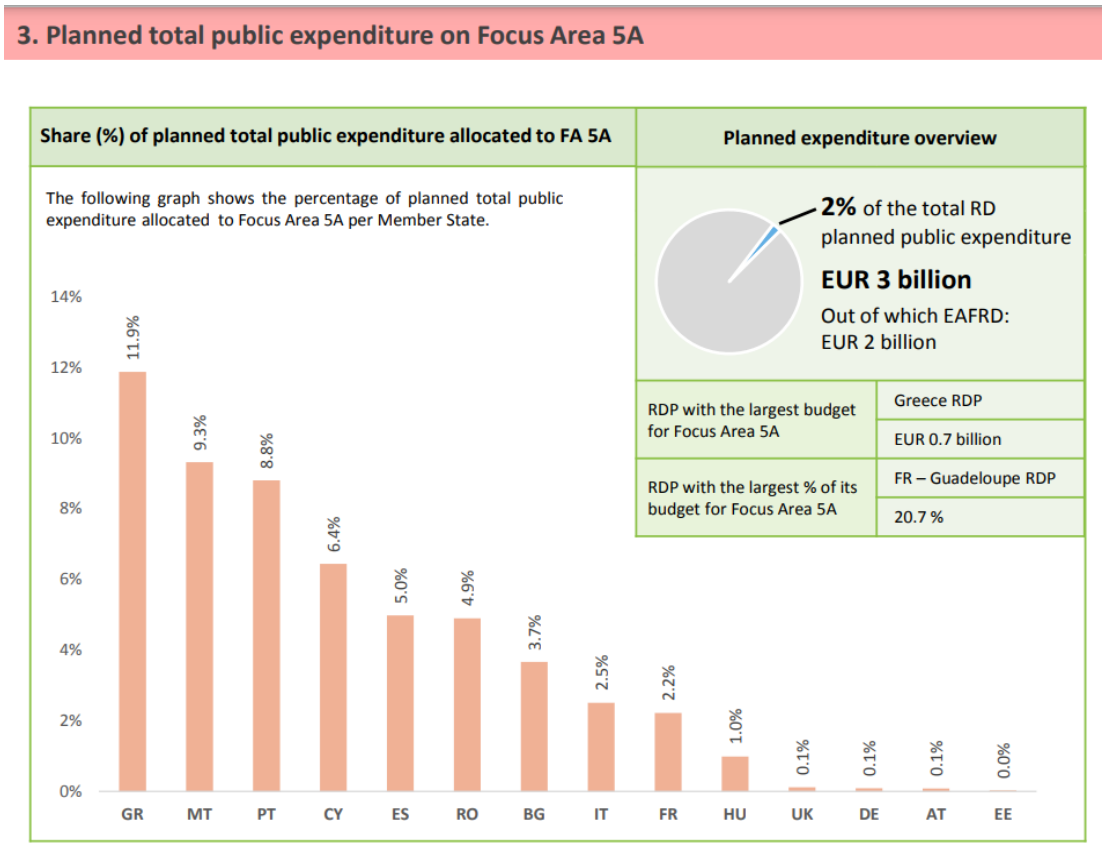
To sum up, we note that the planned public expenditure dedicated to the Focus Area 5C is high in Malta, but low in France, Greece, Italy, Portugal, Romania and Spain.

For Photovoltaic Irrigation Systems

Supporting measures for Photovoltaic Irrigation Systems are included in the **Focus Area 5A** on **Water efficiency** which is **designed to increase the efficiency of water use by agriculture.** Most of the support provided is devoted to physical investment to develop more efficient irrigation systems. These investments are complemented by support for knowledge transfer, training, advise and cooperation.

The following graph shows the percentage of planned total public expenditure allocated to Focus Area 5A per Member State under the period 2014-2020. This allows to identify whether the RDPs of the countries under study contained measures that could be targeted at subsidising the development of PV irrigation systems.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879



Source: https://enrd.ec.europa.eu/sites/default/files/focus-area-summary_5a.pdf

To sum up, we can note that the planned budgets allocated to the Focus Area 5A is high in Greece, Malta and Portugal, moderate in Romania and Spain and low in France and Italy. In all the countries, the budget is mainly allocated to investment in physical assets (M04)[24].

Example of the use of support measures in Focus area 5A

The irrigation cooperative *"Nuestra Señora de la Carrodilla de Estadilla"* in Spain is an **example of how support measures such as investment in physical assets can be applied to Photovoltaic Irrigation Systems**. Indeed, the cooperative made an investment using the Regional Development Programme support to install of a solar photovoltaic farm to produce cheap energy to be used to pump water into the reservoir during the high-cost electricity hours (daytime during the week).

In conclusion, we can argue that financial support for PV systems in the EU Member States is provided through the RDPs. We observe that, overall, the public expenditure foreseen to support the development of PV systems is low. Similarly, the budget foreseen to support the increase of water use efficiency in agriculture and thus potentially to subsidise the development of PV irrigation systems is high in Greece, Malta and Portugal. Overall, financial support for PV irrigation systems is rather low in France, Italy, Romania and Spain.

[24] https://enrd.ec.europa.eu/sites/default/files/focus-area-summary_5a.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Part 2. Regulatory and policy best practices to support PVIS market Uptake

PVIS is a technical and affordable solution to tackle the agricultural irrigation issues in terms of clean energy production, water savings and energy costs reduction in the Mediterranean region. The main stakeholders in agricultural irrigation, such as individual farmers, agri-food industry, irrigation communities and agricultural cooperatives, among others, are now aware of the economic benefits of this innovative solution to the dramatic increase in conventional energy costs, especially those related to fossil fuels and power grids. **However, as this technology is new, there is not yet a mature market in which specific regulations, financing solutions and administrative protocols have been developed ad hoc for this application**. Irrigation actors that want to invest in PVIS are not supported by a clear regulation and financing mechanisms and they are led to start procedures from zero, which in many cases, discourage these initiatives because of lack of well-adapted rules governing the administrative and financing procedures.

In this regard, **Public Authorities can implement actions to develop a stable and dynamic PVIS market**, adapting the existing legal framework and the administrative procedures to the development needs of PVIS. First of all, **a clear, complete and stable photovoltaic legal framework is necessary to give confidence to the irrigation actors and investors**. Retroactive legislative changes as occurred in the past in countries such as Spain, concerning the PV sector, caused serious damages in the profitability of the already executed projects, but specially, it caused a negative impact in the confidence of new investors, who, since that moment, perceived a very high-country risk degree. On the other hand, public authorities can also remove administrative barriers by adapting the administrative procedures to sustain an effective development of PVIS. **The aim is to make attractive those procedures that facilitate permits to install PVIS installations, give access to electricity grids, or facilitate the sharing and marketing of surplus energy, among others.** Clear, simplified and efficient procedures are essential to encourage investors and irrigation stakeholders who, even if they are aware that PV technology is an affordable solution, do not take a decision because of cumbersome administrative procedures.

Thus, **a sound and stable legal framework and a set of effective administrative procedures**, in addition to the existence of adequate investment instruments, **are mandatory to create an appropriate framework for investors and irrigation stakeholders to increase the share of renewable energy in Europe** by using technology that provides energy for irrigation at high efficiency with zero emissions and at a much lower cost than existing fossil fuel-based solutions. In this regard, **some shortcomings have been identified** and are discussed below with the aim of underlining their relevance, explaining how they affect the promotion and adoption of PVIS solutions in the market and how they can be addressed through the action of public authorities.

As reference, this section mentions articles of the Directive (EU) 2018/2001 of the European Parliament, on the promotion of the use of energy from renewable sources. This Directive aims to promote renewable energy as an important part of the package of measures needed to reduce greenhouse gas emissions, as well as security of energy supply, sustainable energy at affordable prices and technological development and innovation. The Directive is expected to be transposed into the national laws of all the Member States of the EU.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Best practices on administrative issues

Facilitate and reduce administrative procedures for PVIS developments and implementations

Laws governing the photovoltaic sector - PVIS Market with simplified administrative procedures.

National and regional laws concerning the photovoltaic sector should be as clear and comprehensive as possible and address the development and implementation of renewable energy, clean energy production and the democratisation of the energy sector.

In accordance with the Directive (EU) 2018/2001 of the European Parliament, on the promotion of the use of energy from renewable sources, "*the increased use of energy from renewable sources or 'renewable energy' constitutes an important part of the package of measures needed to reduce greenhouse gas emissions*".

Moreover, it specifies that *(51) lengthy administrative procedures constitute a major administrative barrier and are costly. The simplification of administrative permit granting processes, and clear time-limits for decisions to be taken by the authorities competent for issuing the authorisation for the electricity generation installation on the basis of a completed application, should stimulate a more efficient handling of procedures, thereby reducing administrative costs.*

Article 15 of this Directive indicates that: "*Member States shall ensure that any national rules concerning the authorisation, certification and licensing procedures that are applied to plants and associated transmission and distribution networks for the production of electricity, heating or cooling from renewable sources, […] are proportionate and necessary and contribute to the implementation of the energy efficiency first principle*".

In addition, "*Member States shall, in particular, take the appropriate steps to ensure that simplified and less burdensome authorisation procedures, including a simple-notification procedure, are established for decentralised devices, and for producing and storing energy from renewable sources*"

Regulations should therefore aim at reducing administrative procedures for a rapid and sustainable development of the photovoltaic sector, guaranteeing technical quality and considering all application areas, i.e. stand-alone and grid-connected systems; domestic, industrial and agricultural applications; as well as rooftop, façades and on-floor installations. In addition, **legal frameworks need to regulate all administrative and fiscal aspects related to the implementation of PV technology**, as well as the interaction with electricity distribution networks regarding PV energy production, individual or collective self-consumption, individual or collective energy sharing, energy commercialization, net balance modalities and others.

Lack of regulation or non-adapted administrative procedures lead to negative consequences: on the one hand, a non-regulated PV sector can lead to low quality installations, which considerably undermines confidence in this technology; on the other hand, inadequate administrative procedures create confusion and misunderstanding of these procedures, the application of which depends on the individual interpretation of each administrative officer, resulting in differential treatment.

Countries must guarantee a legislation certainty

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Regulatory bodies as well as public authorities must ensure a safe legislation avoiding the application of regulatory modifications in a retroactive way, which have a pernicious effect on the confidence of potential investors.

The promotion of renewable energies in past times was developed through subsidies and feed-In the past, renewable energy has been promoted through subsidies and feed-in tariff systems. A few years ago, some European countries changed their national legislation by retroactively abolishing premium systems, which led to an obvious fact of legislative uncertainty, as the expected returns for many investors were dramatically reduced. This type of uncertainty would constitute a huge regulatory barrier to investment in PVIS.

Retroactive legislative changes seriously undermine the profitability of projects and more importantly, significantly reduce confidence in new investments.

Establishment of a "one-stop shop" procedure.

Countries and Regions must provide a "one-stop shop" procedure in order to ensure simplified and less burdensome authorisation procedures for PVIS, as mentioned in Directive (EU) 2018/2001, Article 15.

It is proposed that when applying for PVIS permits, all the necessary supporting documents should be requested on a single application form, so that compatibility can be recognised. This application must be made in a kind of "one-stop shop", where all procedures are processed in parallel, and not, as usually happens, consecutively, i.e. as long as one procedure is not completed, the next one cannot start.

Long terms in administrative procedures discourage PVIS investors and promoters, affecting forecasts and business plans, as well as agricultural prospects, such as crop planning.

As an example, here is a detailed overview of the necessary procedures that were carried out to obtain the administrative authorizations for the construction of a PVIS system in Villena, Alicante (Spain), in the framework of the European project MASLOWATEN (640771) between 2015 and 2016. It should be noted that five different procedures were carried out, each of which was applied in a different administrative body and consecutively. The time taken to obtain all the permits was one year and three months.

Table 2: Construction Procedures for Photovoltaic Generator in Villena, Alicante (Spain) – MASLOWATEN project (European Commission Grant agreement ID: 640771)

Institution	Procedure	Reason	Beginning	Ending	Days
Jucar River Basin Authority	Permission from Jucar River Basin Authority	Location in "Police Zone" of Watercourse (less than 100 meters of flooding zone)	07/Oct/2015	16/Nov/2015	40
City council of Villena	Urban development report	Urban Compatibility. Authorization for land use of a PV generator	22/Oct/2015	24/Nov/2015	33
Regional Ministry of Infrastructure, Territory, and Environment	Consultation: Declaration of Common Interest (DIC) to the Territorial	DIC Consultation. Authorization for rural land use to install the PV system	25/Nov/2015	07/Jan/2016	43

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

	Urban Planning Service				
Regional Ministry of Agriculture and Environment	Consultation: Declaration of Common Interest (DIC) to the Territorial Urban Planning Service	Authorization for construction of the system in non-developable land	24/Nov/2015	04/Mar/2016	101
City council of Villena	Building permission	Authorization for system installation	07/Oct/2015	01/Jun/2016	238
TOTAL days					**455**

Permits to be obtained prior to PVIS installation

*Directive (EU) 2018/*2001 specifies that *(51) "the simplification of administrative permit granting processes, and clear time-limits for decisions to be taken by the authorities competent for issuing the authorisation for the electricity generation installation on the basis of a completed application, should stimulate a more efficient handling of procedures, thereby reducing administrative costs".*

Permits for dealing with a PVIS installation must be proportionate and appropriate to ensure protection of people, conservation of the environment, compliance with relevant laws (buildings, land use, protected natural areas, electrical regulations, quality procedures and others) and focused on the PVIS' own objectives.

Requested permits to install a PVIS must be clear, and all information must be transparent and available to developers who want to invest in such technology. In addition, after the application for a permit, short response times are desirable, both for communicating deficiencies in applications and for informing whether or not permits have been granted. In this respect, the "one-stop-shop" is mentioned above are a good solution for transparency, availability and efficiency of permit processing.

Legislation applying for electrical grid access and connections procedures

Countries must have a clear and certain legislation for PV grid connection applications. In this sense, it should be noted that much of the irrigation facilities are connected to the grid. A PVIS system that makes part of such facilities must be able to be connected to the grid in order to evacuate the energy surpluses, especially during the non-irrigation periods along the year.

In this regard, Directive (EU) 2018/2001 indicates that *(60) "there is a need to support the integration of energy from renewable sources into the transmission and distribution grid and the use of energy storage systems for integrated variable production of energy from renewable sources, in particular as regards the rules regulating dispatch and access to the grid".*

Moreover, connection procedures must be simplified as recommended by the Directive (EU) 2018/2001, article 17: *Member States shall establish a simple-notification procedure for grid connections whereby installations or aggregated production units of renewables self-consumers and demonstration projects, with an electrical capacity of 10,8 kW or less, or equivalent for connections other than three-phase connections, are to be connected to the grid following a notification to the distribution system operator. […] Member States may allow a simple-*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

notification procedure for installations or aggregated production units with an electrical capacity of above 10,8 kW and up to 50 kW, provided that grid stability, grid reliability and grid safety are maintained.

Thus, the regulatory framework must be conceived to allow grid-connected PVIS facilities and procedures have to be simplified for low power capacity installations.

Regulation for shared or collective self-consumption

The article 21 of the Directive (EU) 2018/2001 mentions that "*member States shall ensure that renewables self-consumers, individually or through aggregators, are entitled: (a) to generate renewable energy, including for their own consumption, store and sell their excess production of renewable electricity, including through renewables power purchase agreements, electricity suppliers and peer-to-peer trading arrangements […]".*

Shared or collective self-consumption should be allowed for PVIS, as the beneficiaries of renewable solar energy in agricultural irrigation may be part of a community of irrigators or other organisations composed of a collective of farmers. Thus, if these farmers are users of a collective PVIS, they should be supported by self-consumption regulation adapted to the particularities of agricultural irrigation, such as the possibility of commercializing surplus energy, the application of dynamic partition coefficients and others.

In other cases, energy surpluses generated by a PVIS can be shared by other neighbouring users (e.g. farms, industries or households), which can have a significant impact on the development of the local economy as renewable energy costs are nowadays lower than conventional energy costs (from electrical distribution networks and diesel-fuel).

Possibility for consumer and owner of the PVIS to be different natural or legal persons

Consumer and owner of the generation facility (PVIS) must be able to be different natural or legal persons in order to allow diverse business models in which different stakeholders can participate. This flexible approach contributes to the promotion and development of PVIS as it opens the doors to other market players such as the energy service companies (ESCO), leading to more efficient financing models (PPA contracts, project finance, access to capital markets and others).

In this regard, article 21 of the Directive (EU) 2018/2001 indicates that "*the renewables self-consumer's installation may be owned by a third party or managed by a third party for installation, operation, including metering and maintenance, provided that the third party remains subject to the renewables self-consumer's instructions. The third party itself shall not be considered to be a renewables self-consumer".*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Land regulation. Requirement of changing the use or qualification of land to install PVIS in agricultural areas

In agricultural irrigation, the change of use of land to install a PVIS should be made ex officio, as the purpose of the facility is not an industrial use or other, but its goal is an agricultural application. Thus, the use of land does not really change.

However, large PV generators occupy large areas of land (up to 2 hectares per MWp) and this fact must be taken into consideration as it is a big part of land that will not be used for crop cultivation. So PV generators should occupy, as far as possible, land areas of low agricultural value in order to reduce their impact on the loss of land for crops (infertile lands or rocky areas).

In the case of existing buildings in the farms (warehouses or others) in which can be suitable the installation of a PV generator on the rooftops, regulation must allow such installations in accordance with local building technical standards.

Facilitate the integration of the systems into private and public grids

Laws and norms for photovoltaic stand-alone and self-consumption systems.

PVIS implementation must guarantee cost effectiveness for a massive adoption of PV technology in the irrigation market. PV energy generation must be exploited as much as possible along the year, but in agriculture, crops need irrigation only for a relative short period on the year, leading to PVIS facilities would not be exploited during the non-irrigation months.

PVIS modalities can be grid-connected, if national grid is available, or stand-alone systems for not connected farms. When national grid is available, it is very interesting to sell or share energy surpluses to third parties during the non-irrigation periods. This possibility contributes to the cost effectiveness of the PVIS and makes investments much more attractive for investors.

Self-consumption regulation must consider a set of modalities to cover all the possible cases related with the surpluses management in order to contribute to the profitability of the investments, i.e. individual and collective self-consumption with surpluses, energy sharing, PPA contracts with third parties, energy net-balance protocols and others.

On the other hand, in the case that PVIS is a stand-alone system (off-grid), PV technology replaces diesel generators which produce energy at a very high cost (more than 30 c€/kWh) and, even if much energy is not used during the non-irrigation periods, PV cost effectiveness is assured due to the diesel high prices.

Stand-alone PVIS' regulation must be addressed to facilitate this solution as an affordable, clean, sustainable and profitable technology to replace or, at least, to complement the use diesel generators for irrigation.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

The electricity regulation modalities regarding self-consumption

A complete PV self-consumption regulation is desirable, covering all the possible cases considering every aspect, such as surpluses management, net-metering, PPA contracts, individual and collective typologies, PV power ranges, energy sharing, use of batteries, kind of owners and consumers (natural and legal persons), distribution networks' access, connection procedures and energy system fees, energy meters' installation or administrative registry.

As mentioned above, PVIS investments must be as profitable as possible. For grid-connected farms, the management of the energy surpluses generated by the PVIS during the non-irrigation periods is mandatory. In this regard, a good self-consumption regulation that allows sharing, selling or self-consuming energy will let to keep a reasonable profitability for PVIS investments.

In this regard, a good net-metering mechanism can be very advantageous for PVIS. There are several modalities in which a net-metering procedure can be established. It must be based on a fair way that allows owners/consumers who generate electricity to use such electricity anytime. For example, an annual net-metering can roll over an energy credit to any other month, allowing solar power that was generated in winter to be used in summertime.

Authorization of implementation of hybrid PV-grid systems

PVIS technology is a very flexible application which allows the hybridization with other technologies, such as PV-diesel or PV-electrical grid in both modalities, electrical or hydraulic hybridization. This versatility allows expanding PVIS to any particular case, e.g., stand-alone and grid-connected farms, individual or multi-pump systems, irrigation schedules during low solar radiation periods and many others.

Thus, the hybridization of the electricity grid and diesel with PVIS must be allowed to have a wide range of technical solutions based on the production of renewable energies, on the basis that each kWh generated by the PVIS facility represents a saving compared to conventional energy sources.

The PVIS-grid hybridization must be regulated by the self-consumption laws, as it represents a case in which electrical pumps are powered by solar energy and electricity from the grid.

Regulation modalities regarding electrical storage

Directive (EU) 2018/2001 indicates that *(60) "there is a need to support the integration of energy from renewable sources into the transmission and distribution grid and the use of energy storage systems for integrated variable production of energy from renewable sources […]".*

One of the key technical and quality issues that any PVIS must incorporate into its control system is protection against intermittent radiation on days with alternating cloudy and sunny skies. This protection is mandatory because these energy intermittences can cause serious damage to the hydraulic network and the electronic devices. The energy intermittence protection is an algorithm programmed into the PVIS control which is able to mitigate the effect of such phenomenon to protect the system.

One of the possible solutions for the energy intermittence phenomenon is the installation of an electrochemical battery bank in order to supply instantaneous energy to the system when intermittences occur.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

In this regard, a favorable regulation is needed in order to allow the integration of batteries in PVIS in both stand-alone and grid connected installations, respecting all the security and protection measures for the electrical integration of these elements.

Limits regarding PV power installation

PVIS technology has the advantage to be feasible for a very wide range of power applications, from small systems of a few kilo-watts to large mega-watts pumping stations. Thus, PVIS regulation has to consider this feature to face aspects such as the requirements for accessing to the electricity networks, energy system access tolls, the energy surpluses management, permits, energy meters, administrative registry and others.

It is desirable removing any PV power limitation for PVIS facilities in every administrative, tax and legal frameworks, especially for stand-alone systems and keeping only the technical restrictions for electricity network access in grid-connected installations. In any case, PVIS of up to 2MW should be considered as small-sized systems to legal and regulatory issues.

Allow innovative business models for PVIS

Directive (EU) 2018/2001 indicates that "*Member States shall assess the regulatory and administrative barriers to long-term renewables power purchase agreements, and shall remove unjustified barriers to, and facilitate the uptake of, such agreements. Member States shall ensure that those agreements are not subject to disproportionate or discriminatory procedures or charges*".

As indicated above, PVIS runs pumping systems during the irrigation periods, but during the rest of the year PVIS is able to produce energy that can be injected to the electrical networks if available. One of the modalities to manage these energy surpluses is commercializing them with third parties throughout a power purchase agreement (PPA), in which the PVIS owner sells electricity to a buyer under a long-term contract.

The sale of PVIS energy surpluses is a win-to-win agreement, as the seller has a revenue for its electricity surpluses and the buyer can buy electricity at a price significantly lower than market rates.

Thus, a legal framework to facilitate such commercial exchange is desirable and necessary in order to keep the PVIS investment profitability. These agreements are already widely extended in many countries of Europe in a wide range of modalities.

The key points in these agreements are the grid access conditions, fees and taxes, which must be proportional, affordable and adapted to PVIS power sizes.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Tolls or restrictions for self-produced and/or self- consumed energy

Access tolls for the produced and self-consumed energy from PV systems connected to the grid must be removed as such energy is not injected to the grid. Generated and self-consumed renewable energy must be exempt from any type of charge or tax. Otherwise, it should be understood as a dissuasive measure towards the use of renewable energies, which is the opposite of our purposes and the EU objectives.

In PVIS systems connected to the grid, the energy used to run the motor-pumps can be considered as self-consumed energy, then, such energy must be free of any charge or tax. On the other hand, when surpluses are injected to the grid, such energy must be managed under energy access conditions and restrictions applied in a proportional, affordable and adapted way according to the PVIS power sizes.

Access to the electricity grid. Existence of tolls or restrictions for energy produced and consumed for PV systems connected to the grid

In grid-connected farms, PVIS facilities will manage their energy surpluses injected to the grid by net-metering or commercialization modalities. The use of the electrical distribution networks needs the agreement from the networks' managers which can request permits and tolls to access them. In this regard, some aspects must be considered:

PVIS facilities under the self-consumption modality without surpluses must be exempt from obtaining access and connection permits, as this modality does not inject any surpluses in the grid.

In the case of self-consumption PVIS modality with surpluses, with a low power capacity (e.g. up to 2 MWp), they must be exempt from obtaining access and connection permits, as such power capacities are very low compared with the high power capacity of the electrical network and then, their impact in terms of network saturation is null.

In other cases, in self-consumption modalities with surpluses, corresponding access and connection permits can be requested for both the consumption facilities and the production facilities.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Best practices in financial issues

PVIS technology has matured and become a reliable option for most irrigators. However, **widespread adoption of PVIS will depend on achieving a competitive energy cost compared to existing alternatives: diesel generators and grid connections**. In this respect, the cost of PVIS energy is the result of the addition of many technical and non-technical inputs that are necessary for the planning, production and operation of systems. A number of these factors are determined by the legal and regulatory framework, including taxes, permits, subsidies and administrative requirements. Furthermore, from the point of view of public authorities, externalities should also be taken into account when assessing the cost of PVIS and existing alternatives, including the avoidance of CO_2 emissions and the economic impact at local and national level. This type of assessment should be carried out in order to identify the impact of support programs and regulations while defining relevant policies.

Thus, **public authorities can facilitate the market uptake of photovoltaic irrigation by implementing actions to improve the financial viability of projects.** These actions range from introducing appropriate subsidies for PVIS projects to adapting existing regulations to reducing the cost of PVIS compared to existing alternatives. From a more general point of view, it can be argued that, **as the introduction of PVIS is essentially a substitution process, support policies should focus on ensuring that the levelized energy cost of PVIS is lower than that of the existing alternatives.** This approach, focusing on the actual cost of energy, differs from the more common policy objective of achieving a certain level of investment/installed capacity over a given period.

Thus, **while fossil fuel-based energy alternatives for irrigation require low capital investment but high operating costs, PVIS projects are characterized by relatively high initial expenditure and relatively low operating and maintenance costs.** In addition, the return on investment of the PVIS, consisting of avoided energy bills, is achieved over a long period of time equivalent to the life of the PVIS system, typically 25 years or more. This means that the cost of financing has a significant impact on the resulting cost of PVIS energy, while it has little or no impact on the cost of fossil fuel-based energy. Therefore, **facilitating access to affordable and long-term financing is essential to ensure the competitiveness of the technology**. **Public authorities, including managing authorities, can do this through several measures that have proven effective in other sectors to stimulate investment in infrastructure, including clean energy systems.** In particular, a LCOE-based support strategy means that subsidies need to be complemented (or even replaced) by market-friendly support measures based on de-risking PVIS projects, facilitating quality-based competition, ensuring quality and transparency, and increasing the attractiveness of the investment for a wide range of investors.

Contribute to de-risk PVIS projects

Supplying irrigation infrastructure with photovoltaic energy has several economic and environmental benefits, but also adds a number of risks to the operation. These risks can occur at any time during the 25 years of operation of the systems and can be due to both technical and non-technical reasons. Some of these risks can be managed through adequate operation and maintenance and insurance, but others cannot, as they are intrinsic to the project. The higher the risk of the projects, the more expensive the necessary capital is, as investors demand a higher return to compensate for it. As mentioned, the cost of capital of PVIS projects has a large impact on the cost of the resulting energy. This cost of capital is determined by the riskiness

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

that investors perceive in the projects results so reducing sources of uncertainty will reduce the cost of capital. **A number of these risk factors are directly related to the regulatory and administrative framework, so PAs can promote actions to eliminate or mitigate them.**

Stable regulation

As previously mentioned, the competitiveness of PVIS requires access to long term, affordable finance. The availability of this type of finance depends, among other factors, on the perception that the regulatory framework related to the investment is sound, stable and enforceable. The related regulatory risk has a very relevant impact on the viability of the projects. In this regard, the perception that PVIS related regulation is unstable is particularly negative to attract long term investments. For that reason, it is particularly relevant to produce assurances that any change in the regulation will improve, rather than reduce, the opportunities for PVIS projects.

Tailored business models

PVIS projects, and in particular large scale PVIS, presents inherent technical and financial risks including ill-design, component failure and over costs. Irrigators are not always well suited to manage such risks, which are less relevant in incumbent energy solutions. In particular, the prevalent PVIS business model, based on the direct ownership of the system by the irrigators, allocates most of the risks on the farmers themselves. A more efficient risk allocation, that allows to allocate different risks to stakeholders that are specialized in managing them, can reduce the total risk and, consequently, improve the competitiveness of PVIS. In this regard facilitating the introduction of new business models can have a relevant potential to achieve this goal. In particular, third-party ownership business models have shown their potential to foster energy self-consumption by better allocating the related tasks and risks. To promote such models, among other things, tax regulation should be adapted to limit additional costs of recognizing and transferring contractual obligations between the parties for example, those related with public registering.

Support PVIS risk assessment

PVIS is a new technology, so the performance history of PVIS projects is limited. This lack of references makes it difficult to assess the risks of new PVIS projects, not least because of the need for lenders to carry out such assessments in order to provide equity or loans to developers. Banks have not previous experience with PVIS projects and have therefore not developed a specific risk assessment methodology. As a result, the availability of funds for new projects is reduced and their cost is higher.

<u>What can Managing Authorities (MA) do to de-risk PVIS projects?</u>

Multiple legal and regulatory aspects exist related to PVIS that arise from different areas, including energy production and distribution, land use and environmental protection, among others. CAP managing authorities usually do not have direct capacity to adapt such regulations and policies to their specific objectives. Nevertheless, **a number of actions can be taken by MAs to have a positive impact on the risk reduction of PVIS projects under the Rural Development Plan (RDP).**

The power purchase agreement (PPA) business model is very common in the renewable energy industry because it facilitates risk allocation and the obtention of finance. Under a PPA for PVIS, the irrigator commits to purchase a pre-established amount of energy at an agreed price from a promoter. In order to produce and supply the energy, the developer builds and

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

operates the PVIS and charges the irrigator the agreed price for the energy. As the promoter is a specialized entity, it can take advantage of economies of scale and accumulated know-how while the irrigator avoids initial investments and operating risks. **In order to allow this model to be implemented, the RDP measures must include PVIS promoters as potential beneficiaries.**

Furthermore, in order to support PVIS´s risk assessment, **RDPs can include actions to support access by banks and other financial providers to the existing track-record of PVIS projects and specific risk assessment methodologies.**

Ensure the quality of PVIS projects and the availability of key competences

As mentioned, PVIS is a reliable technology, but it also requires specific designs, components, monitoring and operation proceeds to ensure adequate and lasting performance. Large-scale PVIS are connected to highly pressurized pipelines and wells that are exposed to damage in case of malfunction. PVIS' incorrect design or operation can result in water hammer episodes that can easily damage or even destroy wells, potentially causing loses worth several € millions. In order to prevent such events from occurring, **it is of utmost importance that adequate quality standards are introduced and demanded by consumers and authorities**. Also, PVIS providers must count with the sufficient competences and know-how as to ensure that they can correctly assess the needs of the irrigators and identify the most suitable configuration in terms of efficiency during the planning phase as well as to guarantee PVIS operation and the implementation of effective contingency plans if needed.

Introduce quality standards

PVIS can provide clean energy at competitive prices to irrigators but their reliability depends on ensuring that quality standards are met when planning, producing, operating and maintaining the systems. Otherwise PVIS projects will most likely underperform and even produce failures that can affect the integrity of the irrigation infrastructure. For that reason, it is of the utmost importance that PA include measures to protect PVIS consumers from substandard PVIS providers.

Disseminate know-how

The availability of affordable PVIS depends on the existence of a sufficient pool of local providers so quality-based competition can take place. In the case of PVIS, there is a risk that non-qualified providers produce offers for irrigators assuming that general PV solutions can be directly applied to irrigation infrastructures. In order to reduce this risk, it is important to produce and disseminate relevant and independent information and training among consumers and potential installers.

Promote certification and labels

In relation with the introduction of quality standards and know-how, the use of certification schemes can be particularly relevant. In the case of PVIS such schemes can be useful to introduce the right incentives among providers and to support consumer protection. Independent auditors could provide certification in order to ensure compliance with best practices in planning, installing, operating and maintaining PVIS.

<u>What can MAs do to ensure quality of PVIS projects and the availability of competences?</u>

RDPs can be a powerful tool to support quality standards in agrarian sector´s projects. Measures oriented to modernize equipment and infrastructures can be related to a specific quality

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

standard, for example by conditioning grants to projects presenting such standards. PVIS quality standards are available based on experiences such as Maslowaten and SolAqua.

Furthermore, in order to support the acquisition of skills and experience among potential PVIS providers, MAs can support the organization of dissemination and communication actions on PVIS specifically addressed to local SMEs and training centers.

Increase the attractiveness of PVIS projects to a wide range of stakeholders

Decarbonizing irrigation will require multi-billion investments to finance the deployment of PVIS. To attract such amounts of capital, **PVIS projects must present a positive financial return** to as many types of investors as possible. Furthermore, in order to allow a competitive cost of resulting energy, **PVIS projects must have access to low-cost and long-term capital**, so the resulting cost of capital does not hamper their financial viability. Also, the **mass introduction of PVIS requires broad public support**, which can only be achieved by identifying and communicating the benefits that society as a whole will gain from decarbonizing irrigation. **Public authorities can facilitate these aspects by implementing a number of actions tailored to PVIS projects.**

Improve the expected return of PVIS for investors

PVIS projects, as any other investment, are normally carried out after conducting an economic appraisal that resulted in the estimation of a positive and sufficient expected return for investors. There are many factors that affect the level of return of a PVIS projects and the legal and regulatory framework can have an impact on many of them. In this regard, the availability of grants and subsidies for PVIS projects can increase the return of the project by generating additional income for developers. Grants and subsidies are widely employed to support green projects but should be completed by other actions, specially to avoid market distortions that can result from an ill designed, grant-based supporting scheme. Such complementary actions can include the use of tax incentives, including tax leases, access to dedicated loans and financial instruments and the facilitation of the valorisation of PVIS´ surplus energy.

Facilitate local stakeholders to benefit from PVIS deployment

The development of a new energy model based on electrification and renewables can provide opportunities to many stakeholders. Nevertheless, local communities and SMEs are not always sufficiently involved in RE projects that tend to be carried out by large companies with little or none implication at local level. This situation can affect negatively the attractiveness of PVIS deployment. In this regard PAs can act in order to facilitate that PVIS projects involve local communities and, in particular local SMEs, in fair conditions. As large companies have a number of inherent advantages related to their economies of scale and access to technical and financial resources, PAs can act to create a leveled playfield where SMEs can also compete and take advantage of business opportunities. In order to facilitate such playfield PAs can ensure that the regulatory framework is not to complex or costly to navigate for SMEs and introduce specific supporting schemes for such companies.

Increase citizens´ support to PVIS projects

The decarbonization of irrigation that would result of the massive introduction of PVIS can have a number of positive impacts that will benefit other stakeholders than the promoters of the projects themselves. GHG reductions will reduce the environmental impact of the agriculture and the avoidance of fossil fuel imports will improve the general economic conditions. These are

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

only some examples of the positive externalities of PVIS that can be presented to the general society in order to create support on the technology. Such support will result in a more friendly environment for new projects which is needed to facilitate attracting the necessary financial resources. PAs can support the production of related assessments such as Life Cycle Assessment and Cost-Benefit Analysis and the dissemination of the results to the public, as well as to use them to design and create support to policy actions oriented to support PVIS.

Allow access to affordable, long-term finance

PVIS projects have a relatively long lifespan of 25 years or more. As a result, the cost of capital of the projects has a large impact on the resulting cost of the energy. For this reason, reducing the cost of capital for PVIS projects is a particular effective manner of increase the competitiveness of the technology. In order to reduce the cost of capital of PVIS projects PAs can act in several different manners including providing dedicated lines of credit and financial instruments and facilitating the aggregation of projects so access to capital markets is easier. In this regard, the promotion of green bonds markets can have a very positive impact in access to capital for PVIS projects as they qualify as collateral for such bonds.

What can do MAs to increase the attractiveness of PVIS investments?

MAs can introduce specific measures to support PVIS in the RDPs including dedicated grants. A particular relevant action would be the use of EAFRD financial instruments to support PVIS projects. EAFRD FIs are particularly well suited because they can leverage private investments while avoiding most of the market distortions that grants can cause.

In order to facilitate the participation of local SMEs, RDP measures can be designed to ensure that local SMEs can use to support their competitiveness with large companies. The positive impact resulting in local communities have to be highlighted by supporting dissemination and communication measures.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Part 3. Conclusions

The analysis of the regulatory and administrative framework affecting PVIS in the targeted countries indicates a number of shortcomings that can negatively affect the market uptake of the technology. The specific problems vary in nature and intensity depending on each country and even between different regions within the countries. Most of the problems identified stem from the barriers to the installation and operation of the large-scale PV systems required in most PVIS projects, as well as the inadequacy of existing promotion programs to introduce suitable business models for this solution. The regulatory action needed to improve the situation is country specific, however several common aspects can be highlighted as a result of collective action, notably those concerning the adaptation of the Common Agricultural Policy measures to the specific needs of PVIS.

In particular, the general recommendations to establish an appropriate regulatory and administrative framework for the PVIS are as follows:

SET OF RECOMMENDATIONS

Facilitate and reduce administrative procedures for PVIS developments and implementations.

Laws governing the photovoltaic sector - PVIS Market with simplified administrative procedures.

- Photovoltaic sector must be regulated by laws that cover all the PV modalities and applications, among them, grid-connected and stand-alone photovoltaic installations.
- Laws must ensure that simplified and less burdensome authorisation procedures, including a simple-notification procedure, are established for PV applications.
- Administrative procedures to obtain permits and authorizations have to be simple and efficient ensuring short time-limits for decisions

Countries must guarantee a legislation certainty

- Legislation must be certainty, to avoid the application of regulatory modifications in a retroactive way.

Establishment of a "one-stop shop" procedure.

- Countries and Regions must provide a "one-stop shop" procedure for PVIS permit applications.
- Laws should limit the terms, setting a deadline, after which permits are granted ex-officio. A guideline is that all terms take a maximum of 1 month.
- One-stop shops must work under the principles of equality, transparency and efficiency, offering a service to customers focused to the optimization of procedures.

Permits to be obtained prior to PVIS´ installation

- Administrative permit granting processes must be simple and time-limits for decisions very clear.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

- Requested permits for PVIS installations must be proportional and aligned with those required for similar applications.
- Obtaining permits should not be costly.

Legislation applying for electrical grid access and connections procedures

- PVIS facilities must be able to access the electrical grid.
- Connection procedures have to be simplified for PVIS facilities.
- A simple-notification procedure must be established for grid connections of low power capacity PVIS installations (less than 2 MWp).

Regulation for shared or collective self-consumption

- A PV self-consumption regulation must be established allowing shared and collective self-consumption of generated electrical energy.

Possibility for consumer and owner of the PVIS to be different natural or legal persons

- Regulation must contribute to the establishment of PV facilities by individual and collective promoters.
- Consumer and owner of the generation facility (PVIS) must be able to be different natural or legal persons

Land regulation. Requirement of changing the use or qualification of land to install PVIS in agricultural areas

- For PVIS installations, the change of use of land to install a PV generator must be made ex officio, as the agricultural use of land does not really change.

Facilitate the maximum energy exploitation of PVIS facilities.

Laws and norms for photovoltaic stand-alone and self-consumption systems.

- Regulation must allow that PVIS facilities work as self-consumption energy system, as well as a grid-connected one.

The electricity regulation modalities regarding self-consumption

- PV self-consumption regulation must cover all the following aspects:
    - energy surpluses management,
    - establishment of a net-metering procedure,
    - permission to make PPA contracts,
    - permission of individual and collective typologies,
    - wide PV power ranges, from few kilowatts to multi-megawatts power plants
    - permission for energy sharing,
    - use of batteries,
    - permission for all kind of owners and consumers (natural and legal persons),

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

- permission to access to the distribution networks,
- simplification of the connection procedures and proportional energy system fees,
- energy meters' installation,
- simplification of the administrative registry.

Authorization of implementation of hybrid PV-grid systems

- Hybridization of the electricity grid and diesel generators with PVIS must be allowed.

Regulation modalities regarding electrical storage

- Regulation must allow the integration of batteries in PVIS facilities in both stand-alone and grid connected installations.

Limits regarding PV power installation

- Regulation must remove any PV power limitation for PVIS in every administrative, tax and legal frameworks, especially for stand-alone systems and keeping only the technical restrictions for electricity network access in grid-connected installations.

Possibility to commercialize the surpluses. Permission of Power Purchase Agreement

- Regulation must facilitate the uptake of long-term renewables power purchase agreements (PPA).

Facilitating the introduction of PV facilities specific to PVIS

Tolls or restrictions for self-produced and/or self- consumed energy

- Access tolls for the produced and self-consumed energy from PVIS connected to the grid must be removed.
- Generated and self-consumed renewable energy for irrigation must be exempt from any type of charge or tax.

Access to the electricity grid. Existence of tolls or restrictions for energy produced and consumed for PV systems connected to the grid

- PVIS under the self-consumption modality without surpluses must be exempt from obtaining access and connection permits.
- In the case of self-consumption PVIS modality with surpluses, with a low power capacity (up to 2 MWp), they must be exempt from obtaining access and connection permits.

Contributing to de-risk PVIS projects

Facilitate the introduction of tailored business models for PVIS deployment

- By allowing the use of community-owned and third-party ownership business models of PVIS (for example by including them as potential beneficiaries of RDP´s measures).
- By eliminating or limiting costs and taxations related with recognizing and transferring contractual obligations.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Support PVIS risk assessment

- By supporting banks and development agencies to build know-how and skills in PVIS projects assessment and modelling.

Ensuring the quality of PVIS projects and the availability of key competences

Introduce and support the use of quality standards in planning, constructing and operating PVIS

- By officially endorsing and disseminating specific and validated sets of best practices and quality standards (for example, those produced by the SolAqua Project).
- By creating certifications and labels to identify suited PVIS providers on the basis of quality standards.
- By conditioning the access to grants and subsidies for PVIS projects to compliance with quality standards.

Increase the attractiveness of PVIS projects to a wide range of stakeholders

Improve the expected return for investors of PVIS projects

- By introducing direct subsidies and grants for PVIS projects but also by using other type of measures designed to support the financial suitability of the projects such as tax deductions, access to electricity public grids and dedicated credit lines.

Facilitate local stakeholders to benefit from PVIS deployment

- By introducing specific supporting actions addressed to local SMEs that can act as developers or suppliers of PVIS projects.
- By organizing training activities at local level to introduce know-how on PVIS and project development skills among professionals.

Increase citizens´ support to PVIS projects

- By identifying the positive impact of PVIS projects among the entire community for example producing and disseminating PVIS´ Life Cycle Assessment and Cost-Benefit Analysis.
- By promoting the use of collective forms of ownership of PVIS projects (such as SPVs) prioritizing local investors and community schemes.

Allow access to affordable, long-term finance

- By using tailored EAFRD financial instruments to support the introduction of high quality PVIS.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Bibliography

Document with regulatory and political recommendations to drive the market of PV pumping for irrigation (D5.3), MArket uptake of an innovative irrigation Solution based on LOW WATer-ENergy consumption (MASLOWATEN – 640771), 2017, https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5c087d244&appId=PPGMS

Directive (EU) 2018/2001 of the European Parliament, on the promotion of the use of energy from renewable sources, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0082.01.ENG

L. Narvarte, J. Fernández-Ramos, F. Martínez-Moreno, L. M. Carrasco, R. H. Almeida, and I. B. Carrêlo, "Solutions for adapting photovoltaics to large power irrigation systems for agriculture", Sustainable Energy Technologies and Assessments, vol. 29, pp. 119-130, 2018, doi: https://doi.org/10.1016/j.seta.2018.07.004.

G. Todde, L. Murgia, I. B. Carrêlo, R. H. Almeida, A. Pazzona, L. Ledda, and L. Narvarte, "Embodied energy and environmental impact of large-power stand-alone photovoltaic irrigation systems", Energies, vol. 11, no. 8, p. 2110, 2018, doi: https://doi.org/10.3390/en11082110.

I. B. Carrêlo, R. H. Almeida, L. Narvarte, F. Martinez-Moreno, and L. M. Carrasco, "Comparative analysis of the economic feasibility of five large-power photovoltaic irrigation systems in the Mediterranean region", Renew. Energy, vol. 145, pp. 2671-2682, Renewable Energy, Sustainability and the Environment 2020, doi: 10.1016/j.renene.2019.08.030.

Sitography

https://enrd.ec.europa.eu/sites/default/files/es_natprog_rdp_qnt_summary_v1_2.pdf

https://enrd.ec.europa.eu/sites/default/files/it_nat_rdp_qnt_summary_v1.pdf

https://enrd.ec.europa.eu/sites/default/files/ro_rdp_qnt_summary_v1_0.pdf

https://enrd.ec.europa.eu/sites/default/files/gr_rdp_qnt_summary_v1.pdf

Reducing energy costs for irrigation | The European Network for Rural Development (ENRD) (europa.eu)

Priority & Focus Area Summaries | The European Network for Rural Development (ENRD) (europa.eu)

PowerPoint Presentation (europa.eu)

EUR-Lex - 32013R1305 - EN - EUR-Lex (europa.eu)

*Irrigation in EU agriculture (europa.eu)

https://www.ecologie.gouv.fr/sites/default/files/Guide%20instruction%20demandes%20autorisation%20urbanisme%20-%20PV%20au%20sol.pdf

https://www.bulletin-officiel.developpement-durable.gouv.fr/documents/Bulletinofficiel-0024005/met_20100002_0100_0024.pdf;jsessionid=FED27AC38BCEEC49306B51A6C4801558

https://www.jdsupra.com/legalnews/new-decree-implements-red-ii-directive-4550584/ (consulted on 22/02/2022).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

https://www.compile-project.eu/wp-content/uploads/COMPILE_Collective_self-consumption_EU_review_june_2019_FINAL-1.pdf (consulted on 22/02/2022).

https://fr.le360.ma/economie/autoproduction-electrique-le-projet-de-loi-82-21-difficile-a-appliquer-249430

https://www.amee.ma/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879