MANUAL FOR IRRIGATORS

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- CONSIGLIO DELL'ORDINE NAZIONALE DEIDOTTORI AGRONOMI E FORESTALI (CONAF)
- UNIVERSIDADE DE EVORA (UEVORA)
- UNIVERSITA DEGLI STUDI DI SASSARI (UNISS)
- INSTITUT AGRONOMIQUE ET VETERINAIRE HASSAN II (IAV)
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This manual is freely available in the webpage of the project and in zenodo platform (in SolaQua community).

For more details, please visit www.sol-aqua.eu

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Content

Acronyms

EU	European Union
FC	Frequency converter
FENAREG	Portuguese Federation of Irrigation Associations
FENACORE	Spanish Federation of Irrigation Communities
ISINPA	Irrigators, SMEs, Investors and Public Authorities
KEMT	Key Enabling Materials and Tools
MP	Motor-pump
RE	Renewable Energy
SI	Solar Irrigation
SME	Small and Medium Enterprise
WP	Work Package
PV	Photovoltaic
PVIS	Photovoltaic Irrigation Systems

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Summary

This Manual for Irrigators, developed under SolaQua project, includes information about Solar Irrigation systems in a user-friendly manner.

The document describes the different types of photovoltaic irrigation systems (PVIS), as well as a way to select between them. It also presents the main characteristics of the financial model proposed by the project.

Finally, SolaQua joint promotion is presented, as well as information about how to know more about PVIS and SolaQua project.

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1. Introduction

1.1. SolaQua in a nutshell

SolaQua's overall objective is to increase the share of **renewable energy (RE)** consumption in Europe by facilitating the market uptake of **photovoltaic irrigation systems (PVIS)** in the farming sector. A PVIS is based on a combination of **photovoltaic (PV)** technology, hydraulic engineering, and high-efficiency water management techniques to optimize irrigated farming.

The consortium of SolaQua, which represents more than 70% of European irrigators, is aware of the potential of PVIS 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 PVIS 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 PVIS market, SolaQua will facilitate a joint promotion of more than 100 MW of reliable and affordable PVIS 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 PVIS 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 awareness and skills of PVIS 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.
3. **Trigger the European PVIS market by facilitating a joint promotion of at least 100 MW of PVIS**, exploiting SolaQua's KEMT and led by the target audiences engaged in PVIS 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 PVIS**: SolaQua will produce a new European Agrarian Fund for Rural Development (EAFDR) financial instrument that will be implemented in 3 European regions and will support more than 40 MW of new PVIS capacity.
5. **Facilitate market uptake of reliable and affordable PVIS in markets outside the EU** that will result not only in increased cooperation but also in business opportunities for European SME´s and investors.

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1.2. Purpose and scope

This document is the manual for irrigators developed under SolaQua project. It includes detailed information regarding PVIS in a user-friendly manner.

By reading this document, irrigators will have sufficient information to allow them to identify what type of PVIS is more suited to its needs and how to discriminate between different offers. It will also contain information regarding SolaQua joint promotion.

1.3. About this document

After this brief introduction, this document includes a background on the importance of PVIS systems, as well as description of this type of systems. Then, a list of typical concerns/ myths of PVIS systems are described, followed by a brief description of the SolaQua financial model. Technical, economic and legal guarantees are briefly mentioned, and the document ends with a description of the SolaQua joint promotion.

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2. Background

Photovoltaic (PV) electricity prices have declined below 0.1 €/kWh [1], which means that PV is currently able to compete with almost any other energy sources and in almost all scenarios. Therefore, the general problem of the PV engineering can be understood as the problem of adapting the characteristics of PV to a specific application and, currently, PV systems are becoming more attractive to the market of large-power irrigation systems since energy is a key input for irrigation services.

Traditionally, most of the irrigation in Europe has consisted of open-channel gravity-based system that consumes a huge amount of water and almost zero energy [1]. More efficient irrigation systems are being implemented within Europe through the change from this kind of systems to pressurized networks (in which water consumption is reduced at the price of increasing energy use) [2], [3], [4], [5]. Spain is the best representative example of this modernization. According to FENACORE (the Spanish Federation of Irrigation Communities), from 2000 to 2020 the share of gravity-based systems decreased from 59% to 23%, while the share of drip systems increased from 17% to 54%, and sprinkler irrigation remains stable at 24% [6].

This modernization has not only increased the water efficiency and productivity but has also improved the operation and maintenance of the irrigation systems and enhanced the working conditions of the farmers [4]. Even so, it also increased both the investment costs and energy demand [4]. Accordingly, higher energy costs are currently observed in the farms.

Moreover, the increase in energy prices is also negatively affecting the feasibility of agriculture in Southern Europe [7], [8]. In Spain, the price of energy for irrigation has risen due to the liberalization of the electricity market in 2003 and the elimination of special irrigation rates in 2008 [2]. According to FENACORE, the price of electricity for the Irrigator Communities increased 1250% from 2008 to 2013 [9]. Similarly, in Portugal, the electricity market was also liberalized, the seasonal electricity contracts were eliminated in 1983 and a 40% discount and a program called "Green Electricity" ended in 2005 [10]. From 1999 to 2014, the energy part of the electricity bill increased by 25% [10].

In Spain, the average price of the power term alone increased by 288% from 2008 to 2014 [2]. In Portugal, from 1999 to 2014, the electricity tariffs just for using the system increased 773% [10]. Currently, the high tariffs of the fixed terms of the electricity bill (which need to be paid for the 12 months of the year even if the system is used only during 6) represent 20 to 30% of the electricity bill in Portugal [3]. The seasonal profile of irrigation is reflected in electricity consumption. For instance, in Portugal, a study performed by FENAREG (the Portuguese Federation of Irrigation Associations), in partnership with IMValores sv and Green Egg, found that 90% of the annual electricity consumption in irrigation is between April and September (with July and August being responsible for 61%) [3].

Following the tendency towards the increase of large farms, higher powers are currently needed. Furthermore, given the modernization of agriculture in Southern Europe, greater energy consumption and hence higher energy costs are becoming a critical matter in this region. Accordingly, productive agriculture needs to decrease its costs to guarantee the sustainability of the sector and to allow competitiveness, while reducing the environmental impact of electricity production.

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As pointed out in [11], research and development projects are needed to promote the use of stand-alone large-power PV systems for irrigation both for communities of irrigators and private farms. According to FENAREG, the current biggest challenge in the agricultural sector is to reduce the energy bill associated with water pumping [12]. Three solutions are proposed by FENAREG: the return to seasonal contracted power tariffs, the real liberalization of the electricity market, and a national program to implement renewable energy systems [13]. In what concerns this last recommendation, FENAREG appealed to the Portuguese Government, in May 2018, to create specific support to the installation of PV systems in the public irrigation sector (for example, through the Common Agricultural Policy or the PDR2020) [12]. FENAREG considers that PV can contribute to the reduction of the irrigation costs [12].

In this framework, the end-users (farmers, agro-industries and irrigator communities) are seeking for alternatives to their conventional energy sources (national grid and diesel generators [14]) that satisfy their needs of large power at reasonable costs, ensuring the profitability of their farms [2].

Furthermore, it can be pointed out that in 2014 electric irrigation pumps consumed around 62 TWh worldwide [15], with the Southern Europe representing almost 40% of this consumption [16], which means a potential market of 16 GWp of PV irrigation systems in this region [17].

Likewise, the north of Africa is also a very interesting market. For instance, in Morocco, in 2011, irrigated land represented 5% of the utilized agricultural area [18] and, in 2009, 15% of the energy consumed in the country was devoted to agriculture and forestry [19]. According to the Ministry of Energy, Mines, Water and Environment, cited in [17], the annual electric consumption in this region is estimated to yield 2500 GWh, which leads to a potential market of PV irrigation system of 1.5 GWp.

Large-power PV irrigation systems are thus becoming more attractive to overcome the problem of increasing energy consumption and electricity costs.

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3. PV irrigation systems

Traditionally, photovoltaic pumping systems of small power, typically less than 40 kW, have been called Solar Pumping or Solar Irrigation. This small power was used to supply drinking water and to irrigate small areas, but it did not satisfy the needs of professional irrigators in southern Europe. High-power solutions were only technically feasible if they were hybridized with the grid or if batteries were incorporated, but they were economically unfeasible due to their high price.

The Polytechnic University of Madrid developed solutions that made it possible to extend the power of solar pumping systems to that needed by European irrigators, solving the problems associated to PV power intermittences without the need for batteries and without hybridizing with the grid and saving up to 70% in electricity costs for the farmers. To distinguish it from previous systems, they have been called stand-alone large-power PV irrigation systems, in short PV Irrigation Systems (PVIS). The PVIS were demonstrated on a real scale and in real operating conditions in the European project MASLOWATEN (www.maslowaten.eu).

A PV irrigation system is commonly made up of a PV generator, a frequency converter (FC), a standard centrifugal pump and a water pool and/ or an irrigation network (Figure 1) [20]. These systems do not integrate batteries and the grid is not strictly necessary.

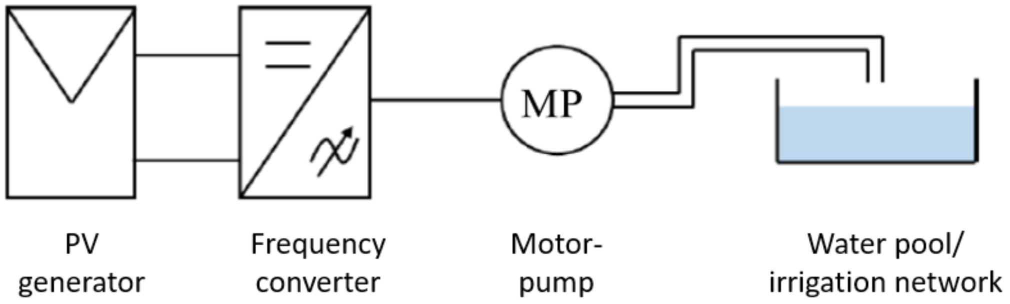

Figure 1 – Components of a PV irrigation system: PV generator, frequency converter, motor-pump and water pool.

It is crucial to keep in mind that a PVIS system is based on a combination of PV technology, hydraulic engineering, and high efficiency water management techniques. A PVIS must [17]:

- Be **integrated in the pre-existing irrigation system**. The PV must be adapted to the previous irrigation components and irrigation needs. This is a key aspect as most of the potential market for PVIS systems is existing irrigation infrastructures.
- **Match PV production and irrigation needs**. The use of North-South horizontal axis tracker (a solar tracker is a device that orients the PV modules toward the Sun) is one of the best solutions to guarantee this match (it maximizes the water volume pumped during the irrigation period, the daily profile of solar irradiance is almost flat, it allows the enlargement of the irrigation hours per day when compared to the typical static structure oriented to the equator (to South in the Northern Hemisphere), and it requires less nominal PV power to pump the same water volume than a PV static structure).
- Be **robust against PV power fluctuations** due to passing clouds. This is another key point to assure the economic feasibility since PVIS systems are large power ones and do not integrate batteries to resist the PV power intermittences associated to passing clouds.
- **Ensure reliability for**, at least, **25 years** to guarantee the compliment of the business plan. Following the best practices developed under SolaQua project will allow this.

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Different **key performance indicators** may be used to evaluate the technical viability of a PVIS[1]:

- The **passing cloud resistance ratio**, which evaluates if the PVIS can support PV power intermittences due to passing clouds.
- The **PV Performance Ratio**, which measure the performance of the system considering only losses strictly related to the PV system itself. It is intrinsic to the technical quality of the PV component, the correct operation of the control and its maintenance.
- The **Utilization Ratio due to the Irrigation Period**, which is the ratio of the total solar irradiation throughout the irrigation period to the total annual irradiation. It is intrinsic to the irrigation period, which depends on water needs of the crop and the climatic conditions, in case of direct pumping, or on the relation between water needs, pumping capacity and pumped water storage capacity, in case of pumping to a water pool.
- The **Utilization Ratio due to the hydraulic system**, which is the ratio of the irradiation strictly required to keep the pump running (according to the conditions imposed by the irrigation system) to the total irradiation throughout the irrigation period. It is intrinsic to the PVIS design and is highly dependent on weather conditions.
- The **Effective Utilization Ratio**, which considers irrigator's decisions like the irrigation scheduling. The irrigation habits acquired by the irrigator are critical to keep this index at adequate values.

3.1. Types of PV irrigation systems

PV irrigation systems can be, according to their energy source:

- **Stand-alone PV irrigation system**.
- **Hybrid PV irrigation system**.

In stand-alone PV irrigation systems, the irrigation system is only fed by the electricity produced by the PV generator using frequency converters (Figure 2).

[1] More details about these key performance indicators can be found both at SolaQua Best Practices Manual and SolaQua Training Manual for Irrigators.

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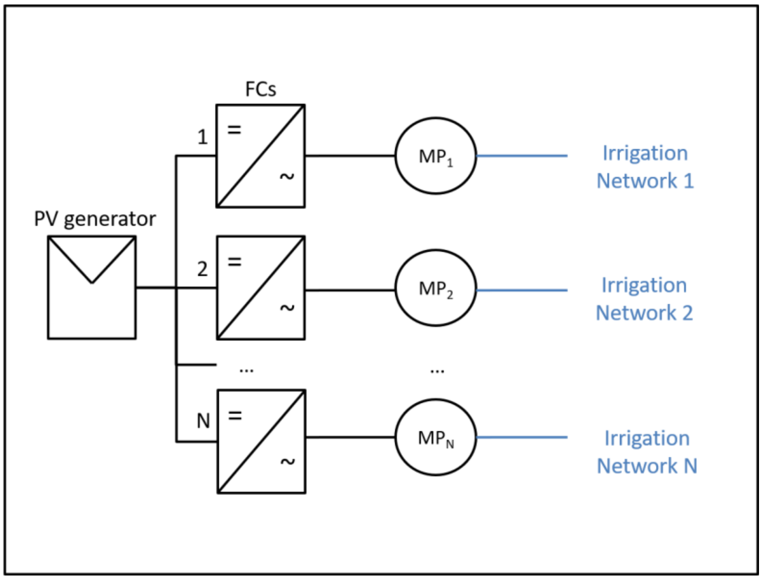

Figure 2 - Stand-alone PV irrigation systems: the irrigation system is fed by energy produced by PV generators. Figures depicted in black represent the electrical part, in blue the hydraulic part. FCs stands for frequency converters, while MP is for motor-pump.

In hybrid PV irrigation systems, the irrigation system is fed both by the energy produced by the PV generator and by other energy source. The other energy source can be diesel generator sets, gas generator sets or the conventional electricity grid.

Two types of hybridization can be found:

- **Hydraulic hybrid systems** (Figure 3): the hybridization is carried out into the hydraulic circuit – the water outflow pipes are associated in parallel, and the sources of energy are not electrically interconnected. These systems can work isolated from the electrical grid and therefore, may be an interesting solution in locations far from the grid.
- **Electric hybrid systems** (Figure 4): The hybridization among the PV generator and the other source is carried out in the electric part of the system. These systems are considered as self-consumption systems and are subject to applicable regulations.

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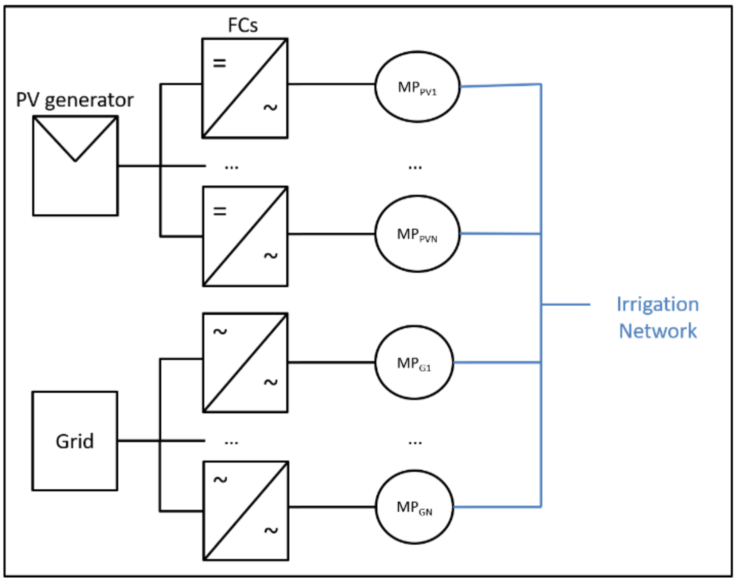

Figure 3 - Hydraulic hybrid systems: the irrigation system is fed by energy produced by PV generators but also from other sources (diesel or gas generator sets and conventional electricity grid), but hybridization is carried out into the hydraulic circuit.

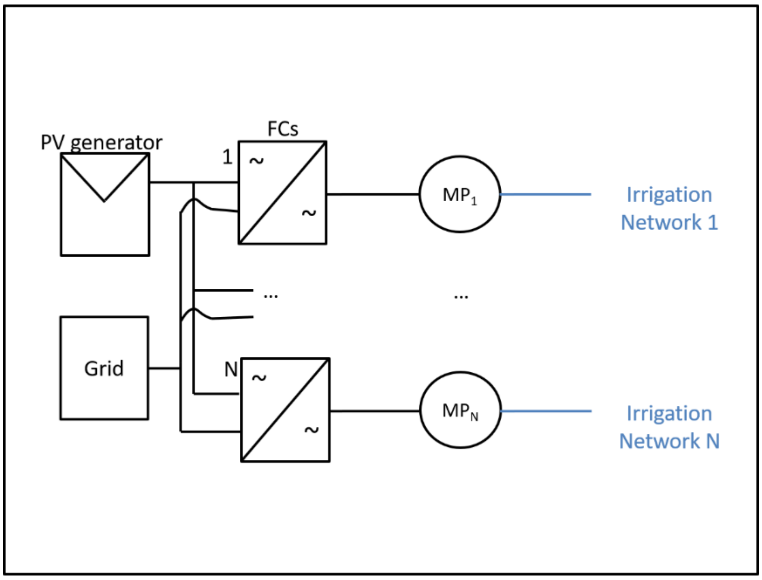

Figure 4 - Electric hybrid systems: hybridization among PV generators and the other sources is carried out in the electric part of the system.

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3.2. The need for hybrid systems

A hybrid PV irrigation system is needed when the irrigation network requires more irrigation hours than those available with PV (usually due to the diameter of the pre-existing water pipes).

Hybrid PVIS are an interesting solution if there is a peak of irrigation in some months of the year[2], avoiding an oversizing of the PV generator just to satisfy a very short period.

A hybrid PVIS can also be considered to get the irrigator operator confidence in the PV system.

3.3. Is it possible to sell electricity to the national grid?

A PVIS is not a photovoltaic self-consumption system, understood as the traditional PV system connected to the grid through an inverter in which the loads (in this case, the motor pumps) are fed from the low voltage grid where the inverters inject the PV electricity. A PV self-consumption installation does not allow to disconnect from the conventional electricity grid, so the savings are limited by having to contract the power terms of the electricity bill. However, the PVIS can work isolated from the grid which allows to obtain greater savings.

But if the irrigation period of a specific crop is only in few months of the year, some countries allow the possibility of export the PV electricity to the national grid in the non-irrigation period. To do this, a grid-inverter must be added to the system, as well as a single pole double throw switch. This way, the system is a PVIS system during the irrigation period (the PV generator is connected to the frequency converters through the switch), while it is a typical grid-connected system outside the irrigation period (the PV generator is connected to the grid-inverter through the switch). This configuration can be seen in the next figure, in which the switch is in the PV irrigation system position.

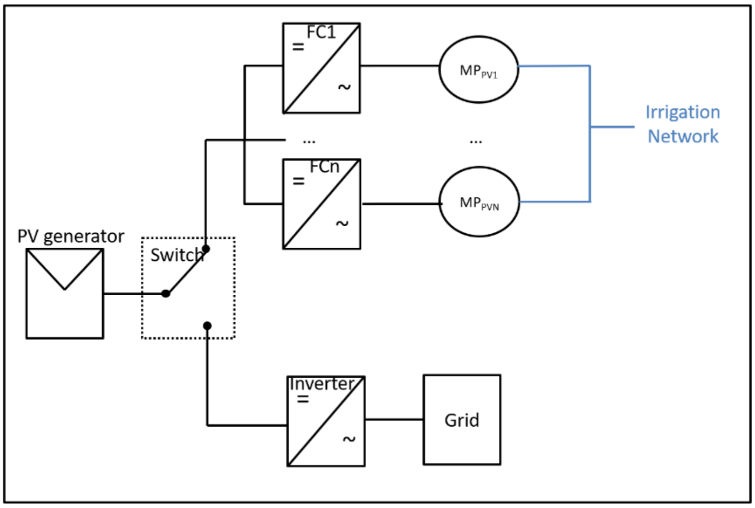

Figure 5 - Mixed systems: the system is a PV irrigation system during the irrigation period, and a grid-connected system outside the irrigation period. The switch allows the change between the two operating modes and, in the case of this figure, the switch is in the PVIS position.

[2] A diesel generator can be rented for only one month (instead of doing it along the whole irrigation period).

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4. Typical concerns of PV irrigation systems

Below, there is a list of the common concerns of farmers and irrigator communities related to PVIS:

1. **The PVIS will occupy a lot of space.**
   With just 3000 m^2 PV generator it is possible to irrigate up to 200 ha.

2. **The use of PVIS is very complicated.**
   The PV system must be integrated in the pre-existing irrigation infrastructure, which means that there is no need neither to change the irrigation network nor the way the farmer irrigates.

3. **With PV, irrigation can be made only during the sunny hours.**
   PVIS allows up to 12 hours of irrigation per day in the summer months. Farms with water tanks/pools can pump water during the sunny hours, accumulate this water into the tank and irrigate later, even during the night hours.
   In addition, a hybrid system can be installed if needed.

4. **The PV irrigation system will NOT work in cloudy days.**
   Incident solar radiation is significantly reduced in cloudy days, but in multi-pump stations, the partial available solar energy can be enough to run one or several motor-pumps.

5. **A PVIS only works for low-power applications.**
   PVIS are modular, reaching tens of MWs. Thus, electric power is not limited, so they can be applied to all kinds of pumping conditions (very deep wells, high water heads or high flow rates and pressures).
   Currently, there are a variety of large-power PVIS working across Southern Europe and Northern Africa. Some examples can be found at www.maslowaten.eu

6. **A PV irrigation system is NOT reliable.**
   If a PVIS obeys to technical standards, it will pass quality control procedures.
   If well designed, with proved structures, and able to support PV power intermittences, the system is very reliable and will last more than 25 years.

7. **Uncertainty in legal regulations.**
   Stand-alone PVIS are not affected by grid-connected PV regulation, since they do not interfere with the electric grid.

8. **Threat of theft.**
   Security in PV facilities is already well-known and standard solutions for surveillance are widespread. In addition, prices of PVIS elements (mainly PV modules) have greatly decreased their price, which is a dissuasion to theft.

9. **The initial investment for a PVIS is very high.**
   PV cost is decreasing in the last years. In addition, under SolaAqua, end-users will not need to do the initial investment and will have a fixed cost of electricity for 20 years.

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10. **PVIS is NOT affordable because it is NOT used throughout the year.**
    Even if the annual irrigation period is short, PV is very competitive compared to diesel or grid systems.
    When the grid is available, there is the possibility of making a PV grid-connection, so that in the months in which there is not irrigation, the system can export the surplus electricity into the grid (see section 3.3).

11. **There are NOT specialized companies to maintain the PV system.**
    Almost 30 SMEs have received technological transfer and training about large-power PVIS. Moreover, SolaQua is planned to transfer the technology to 70 more SMEs.

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5. A unique financing model

Under SolaQua, a Power Purchase Agreement (PPA) contract has been designed with the farmers to protect their interests. This PPA contract means that the farmer will:

- Save up to 60% of the electricity bill since day 1;
- Have a fixed electricity cost for 20 years;
- Have the operation and maintenance for the PV installation along 20 years included the fixed electricity cost.

After this initial period of 20 years, the farm can either extend the agreement or acquire ownership of the installation for 1€.

For more information about the PPA contract, please visit www.sol-aqua.eu.

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6. Technical, economic and legal guarantees

SolaQua project produced 7 KEMTs considering the engineering, economic and legal particularities of PVIS needs and the needs and capacities of ISINPA[3] who will use them. These must be considered to discriminate between different offers, particularly the following:

- **Best practices for planning, installing and operating** (which includes quality control procedures)**;**
- **Environmental assessment methodology;**
- **Economic assessment methodology;**
- **Standard Power Purchase Agreement (PPA) contract.**

Details of these documents can be found at www.sol-aqua.eu

In addition, technical specifications developed under MASLOWATEN project (a previous European project led by UPM) must also be considered to guarantee the long-term quality and reliability of the system.

In summary, from the technical point of view, the PV irrigation system must:

- Support passing-clouds (be able to solve the problems associated to PV power intermittences);
- Match PV generation to the water needs;
- Integrate the PV system in the pre-existing irrigation network;
- Be reliable for, at least, 25 years – quality control procedures (defined in the previously mentioned best practice manual) will be done in the projects developed under SolaQua project.

Some particularities must be highlighted:

- The tracker must have been proven in real operating conditions;
- The system must be robust against PV power intermittences due to passing-clouds;
- The frequency converter tunning must be done in-situ during the installation of the system, avoiding pre-defined tuning;
- A direct pumping system is not a water pool system with a bigger PV generator – the direct pumping system must be carefully sized and designed carrying out the necessary engineering to meet the real needs of the crop.

In addition, SMEs installing the PV systems must have received training under SolaQua project. This is the perfect way to guarantee that they have the needed knowledge to guarantee the long-term performance of the system.

SolaQua partners will coordinate the interaction between ISINPA and guarantee that technical, economic and legal issues are considered.

[3] ISINPA are the relevant PVIS stakeholders: Irrigators (who are the end-users of the results of the project), SMEs with the potential to become installers and operators of PVIS; Investors (looking for low-risk, long-term investments), and Public Authorities involved in the regulation and supporting of the farming and the RE sectors.

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The financial model of SolaQua will allow estimated electricity prices to be paid by the end-users between 3.9 c€/kWh and 9.0 c€/kWh. These values are a consequence of the PV peak power of the system, as well as its energy productivity (see Table 1). For example, the estimated electricity price for systems with more than 1 MWp and a productivity higher than 1600 kWh/kWp can be in the 3.9-5.5 c€/kWh range, while in smaller systems this value can increase up to 9 c€/kWh.

Table 1 - Type of systems, power and productivity range, and electricity price.

Type of system	Power range [kWp]	Average Productivity [kWh/kWp]	Estimated Electricity Price [c€/kWh]
A	100-300	1000-1400	6.1 – 9.0
B	300-500	1400-1700	5.1 – 7.5
C	500-1000	1500-1800	4.4 – 6.5
D	>1000	1600-2000	3.9 – 5.5

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7. SolaQua joint promotion

To exploit the results of the project and to trigger the PVIS market, SolaQua will facilitate a **joint promotion of more than 100 MW of reliable and affordable PVIS led by the farmers/ irrigators/ irrigator communities**. To do this, SolaQua will facilitate action-oriented dialogue among the relevant PVIS stakeholders.

Once the technical, economic and legal issues which are acting as barriers for the market uptake are tackled by SolaQua project, and once enough ISINPA are aware and trained, the objective of SolaQua will be to induce Action towards the introduction of PVIS. This will be done by presenting already interested ISINPA with a clear and ready-to-take path of action. That path of action will include activities that will create engagement among ISINPA in participating in a joint promotion of 100 MW of PVIS that will serve as a reference for the market uptake of the technology. This joint promotion will act as a flagship of PVIS, contributing to initiate a well-functioning market in Europe and Northern Africa. It will be a quality reference in PVIS for ISINPA.

Irrigators will be able to:

- Obtain 200 MW of PVIS preliminary projects, produced by a self-assessment tool available at www.sol-aqua.eu;
- Obtain 150 MW of PVIS detailed projects, produced by 15 SMEs;
- Introduce 100 MW of new PVIS projects, with 10 SMEs executing the projects, and with investors and Public Administrations providing 120M€.

SolaQua consortium will conduct preliminary negotiations to secure letters of interest for at least € 150 MM in investments suited to the KEMT with approximately 15 investors. Once the database of PVIS preliminary projects will be available, preliminary financial and technical plans will be produced.

Those projects selected to the detailed planning will be object of a detailed financial analysis and presented to the investors to be funded using mechanisms suited to ISINPA needs and compatible with the EAFRD financial instrument designed during the project. SolaQua project will stablish a dialogue with European Commission's DG-Agri to ensure that the PVIS financial instrument suits the policy and regulatory requirements. In addition, a risk assessment of the projects will be at disposition of farmers and SMEs during the planning process.

In the final process, SolaQua partners will coordinate the interaction between ISINPA to secure affordable and suited financing resources sufficient to produce at least 100 MW of PVIS projects under the model of PPA contracts.

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8. Do you want to know more about PV irrigation systems?

Visit www.sol-aqua.eu and learn more about PVIS systems and the SolaQua Project.

Do not miss the upcoming events and learn what solar irrigation can do for your crops!

- **20 conferences** where the benefits of PVIS will be explained.
- **12 visits** to real large-scale PVIS.
- **6 Training courses** where you will be able to develop the required skills to successfully evaluate PVIS solutions.

Follow us on our social networks and subscribe our newsletter to keep up to date with dates and sign up for events!

Any questions?

Send us an email to info@sol-aqua.eu and we will be happy to help you!

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9. References

[1] Institute for European Environmental Policy, London; Polytechnical University of Madrid; and University of Athens, “The environmental impacts of irrigation in the European Union - A report to the Environment Directorate of the European Comission,” 2000.

[2] I. Fernández García, P. Montesinos, E. Camacho Poyato and J. A. Rodríguez Días, “Energy cost optimization in pressurized irrigation networks,” *Irrigation Science,* vol. 34, no. 1, pp. 1-13, 2016.

[3] J. Nuncio and C. Arranja, “Regadio: binómio água e energia,” *Recursos Hídricos,* vol. 38, pp. 17-23, 2017.

[4] J. M. Tarjuelo, J. A. Rodriguez-Diaz, R. Abadía, E. Camacho, C. Rocamora and M. A. Moreno, “Efficient water and energy use in irrigation modernization: Lessons from Spanish case studies,” *Agricultural Water Management,* vol. 162, p. 67*77, 2015.

[5] B. Werner and R. Collins, “Towards efficient use of water resources in Europe,” European Environment Agency, Copenhagen, 2012.

[6] Subsecretaría de Agricultura, Pesca y Alimentación, Ministerio de Agricultura, Pesca y Alimentación, "Encuesta sobre superficies y rendimientos de cultivos," [Online]. Available: https://www.mapa.gob.es/es/estadistica/temas/estadisticas-agrarias/regadios2020_tcm30-562249.pdf. [Accessed 15 06 2021].

[7] M. Abu-Aligah, “Design of Photovoltaic Water Pumping System and Compare it with Diesel Powered Pump,” *Jordan Journal of Mechanical and Industrial Engineering,* vol. 5, no. 3, pp. 273-280, 2011.

[8] R. Langarita, J. Sánchez Chóliz, C. Sarasa, R. Duarte and S. Jiménez, “Electricity costs in irrigated agriculture: A case study for an irrigation scheme in Spain,” *Renewable and Sustainable Energy Reviews,* vol. 68, pp. 1008-1019, 2017.

[9] FENACORE, “September Bulletin,” FENACORE, Madrid, 2013.

[10] I. Martins and C. Arranja, “Água e energia no regadio - perspetiva do setor,” 4 12 2014. [Online]. Available: http://pagina-web.arbcas.pt/images/DOCUMENTOS/FENAREG_custo_energ_agricultura.pdf. [Accessed 21 9 2018].

[11] Instituto para la Diversificación y Ahorro de la Energía (IDAE), “Ahorro y Eficiencia Energética en Agricultura de Regadío,” Instituto para la Diversificación y Ahorro de la Energía, Madrid, 2005.

[12] FENAREG (Press Release), “Regantes pedem apoios ao investimento em energias limpas - FENAREG,” 21 05 2018. [Online]. Available: http://www.fenareg.pt/wp-content/uploads/NOTA-DE-IMPRENSA_FENAREG_21_Maio_2018.pdf. [Accessed 25 09 2018].

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

[13] J. Nuncio and C. Arranja, “Regadio: água e energia,” in *VI Congresso Nacional de Rega e Drenagem*, Beja, 2016.

[14] J. Carroquino, R. Dufo-López and J. L. Barnal-Augustin, “Sizing of off-grid renewable energy systems for drip irrigation in Mediterranean crops,” *Renewable Energy,* no. 76, pp. 566-574, 2015.

[15] IRENA, “Solar pumping for irrigation: Improving livelihoods and sustainability,” The International Renewable Energy Agency, Abu Dhabi, 2016.

[16] FENACORE, “Las tarifas eléctricas del regadío. Cronología, problemática y soluciones,” FENACORE, 2017.

[17] 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.

[18] FAOSTAT, “Total area equipped for irrigation,” FAOSTAT, 2011.

[19] FAOSTAT, “FAOSTAT - Energy - Percentage of total energy used/production in agriculture and forestry,” 2009. [Online]. Available: http://www.fao.org/faostat/en/#data/EE. [Accessed 24 09 2018].

[20] M. A. Abella, E. Lorenzo and F. Chenlo, "PV Water Pumping Systems Based on Standard Frequency Converters," *Prog. Photovolt: Res. Appl.,* vol. 11, pp. 179-191, 2003.

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