



MASLOWATEN

MArket uptake of an innovative
irrigation Solution based on
LOW WATer-ENergy consumption



Large Power Photovoltaic Irrigation Systems

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IT IS WELL BORN....



Horizon 2020



... TO BE GRATEFUL





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IT IS WELL BORN



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MARTIFER
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... TO BE GRATEFUL





ANTECEDENTS

The cost of electricity for farmers and irrigator communities

- FENACORE : increment of costs 627% - 1255%
- 40% - 50% of the total cost of the crop
- 2nd consumer of electricity in Spain

Potential Market

- Southern Europe: 14 millions Ha -16GW – 24.000M€
- Northern Africa (Grid + diesel): 1,5GW – 2.250 M€

Why we know about PV and quality?

PV pumping

RSP (EC, 1993):

- 600 PV pumps; UPM: quality control

Since 1995:

- Morocco, Algeria, Tunisia: 53 pumps
- Egypt: 5 pumps

Irrigation (MICCIN, 2012):

- Prototype in Villena



Technical quality in the framework of Project Finance – Due diligence

Projects:

- 78 PV plants multiMW – 12 countries - 302 MW

Companies:

- Acciona, Guascor, Conergy, Unión Fenosa, Fotosolar, Atersa, Nobesol, Proener, Epuron, Ateia, Element Power, Gehrlicher, Solon, Gadir, Cadmos, Dresser-Rand, Bosch, Gestamp, IM2, Scorpio, Sky Solar, Alten, Lugec, WOK, Abalados

Banks:

- Santander, BBVA, BARCLAYS, BANESTO, Pastor, Caja Navarra, Banco de Vasconia, Sabadell Atlántico, Caja Madrid, Guipuzcuano, Caja Rural de Navarra, Bancaja, Caja Murcia, KUTXA, Espíritu Santo, Zaragozano, Valencia, Caja Laboral Popular, La Caixa, Caja de Galicia
- West LB, Caixa Geral, HSH Nordbank AG, KfW, Leasink, Intesa Sanpaolo, BayernLB,



TECHNOLOGY TRANSFER OF PV IRRIGATION

WHAT IS PV IRRIGATION?



What is not:

- MPPT in the frequency converter
- Plug and play from the factory
- To adapt the irrigation network to the PV system
- Constant pressure= Oversized PV pumping system to a water pool

The poor current state of the art:

- 4 offers to an Irrigator Community:
 - Size: from 90 kWp to 250 kWp
 - Price: from 1€/Wp to 2,7€/Wp
- They are not cheating; it is a new knowledge!

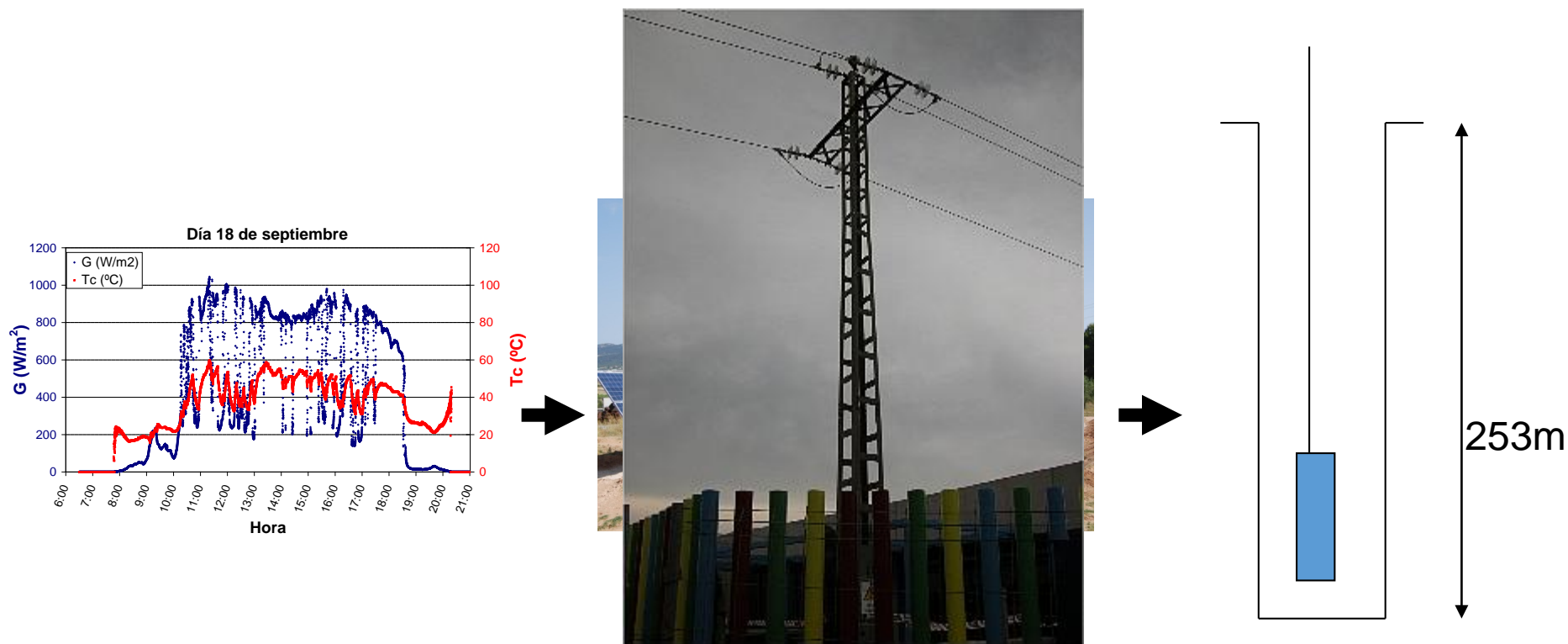


What is:

- To solve the problems associated to PV power intermittences
- To match PV generation to the water needs
- To integrate the PV system in the existing irrigation network
- To ensure the reliability for 25 years



The problem of PV power intermittence:



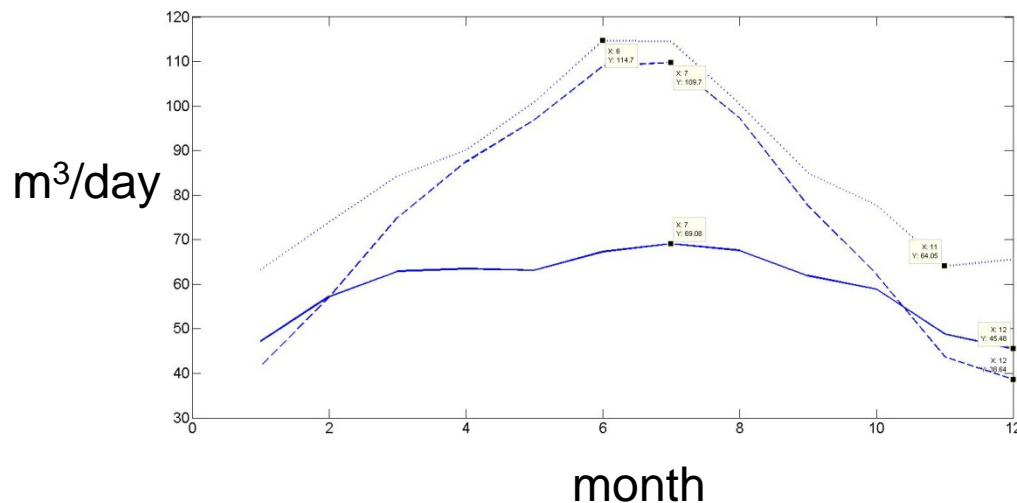
Destabilization and abrupt stop of the frequency converter:

- Water harm: reduces the life time of the hydraulic part
- Overvoltage: reduces the life time of the frequency converter and motor-pump



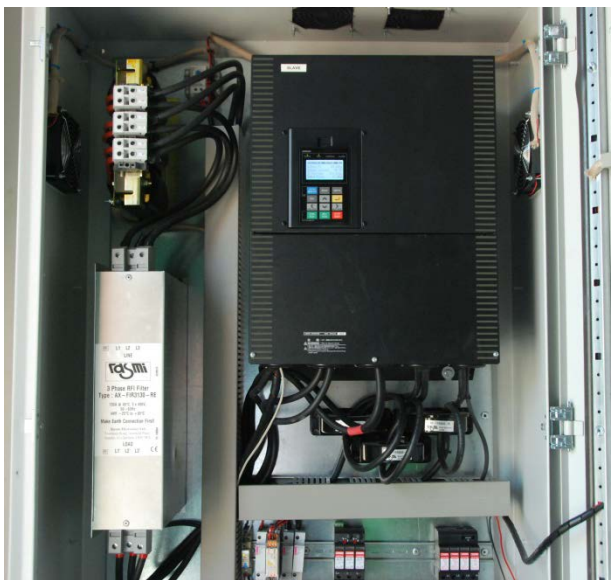
Match PV generation and irrigation needs:

North-South Tracker:





Integrate the PV system in the existing irrigation network



Reduce the degree of novelty:

- The farmer continues doing the same
- Incentive to reduce water consumption

Ensure reliability for 25 years

Quality systems = reliability:

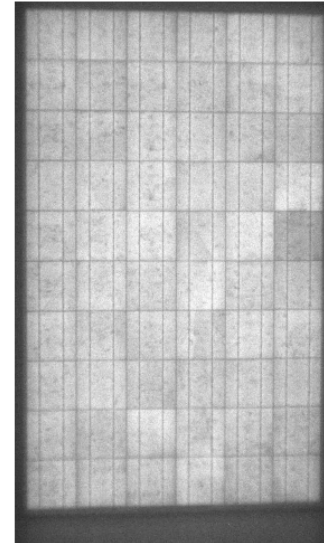
- Technical specifications
- Quality control
- To be included in contracts

Tracker:

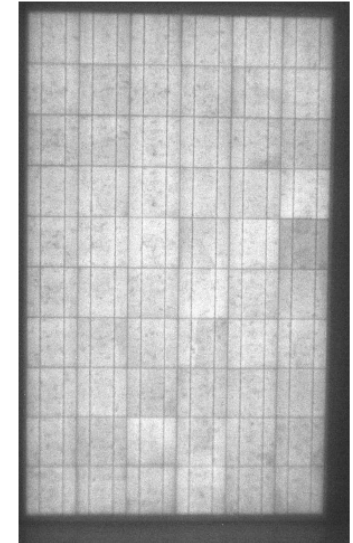
- Proven



Módulo N1041303028116



Electroluminiscencia inicial

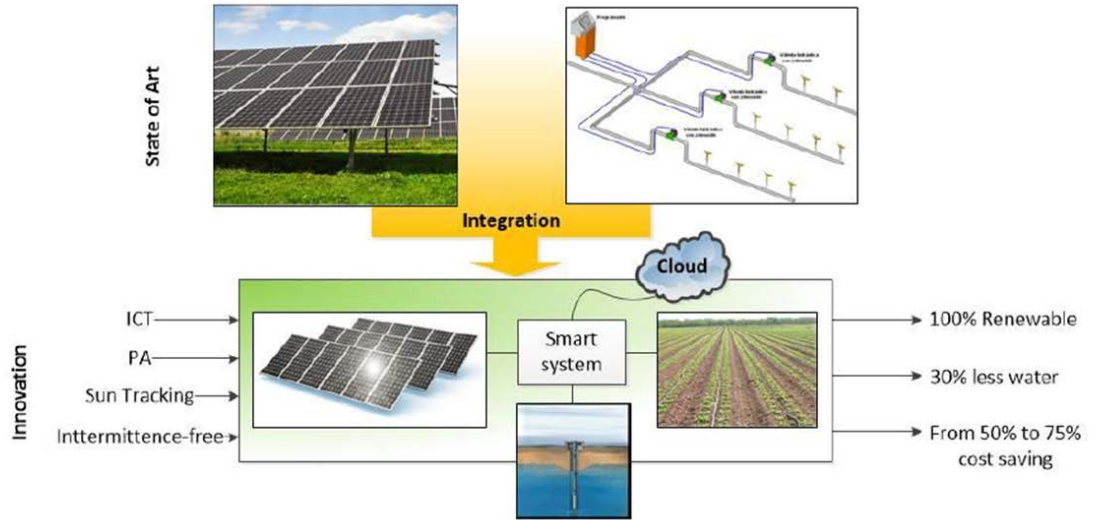


Electroluminiscencia tras 7 días a -1000V

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METODOLOGY:

- 5 demonstrators:
 - Alicante (Spain): 360 kWp
 - Valladolid (Spain): 160 kWp
 - Alentejo (Portugal): 140 kWp
 - Marrakech (Morocco): 120 kWp
 - Sardinia (Italy): 40 kWp
- Technical and economical validation
- Market penetration:
 - Technical visits to the demonstrators
 - Trade exhibitions
 - Accreditations and technical specifications



Technology transfer:

- Transfer to at least 20 SMEs
- At least 5GW in Southern Europe in 2020
- International seminars



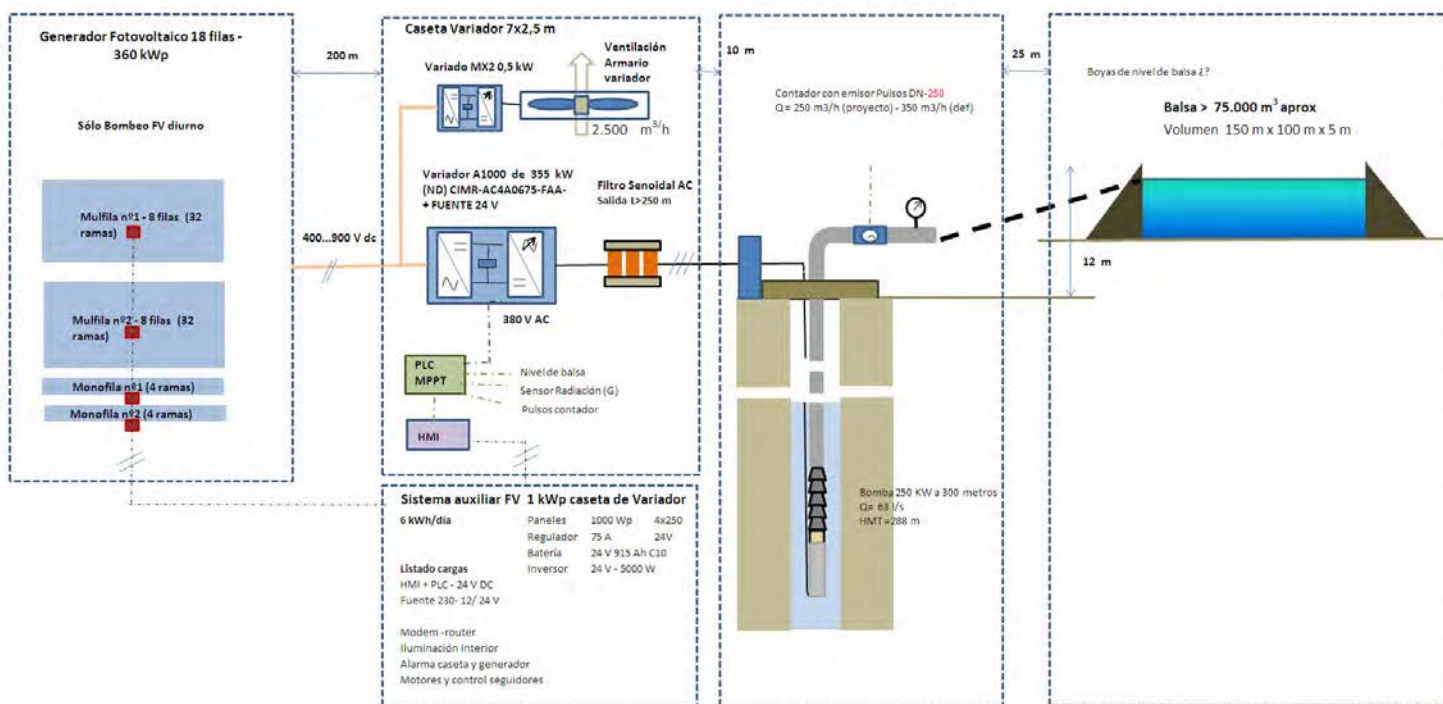
Villena (360 kWp): only PV, Pumping to a water pool



650.000 m³/year

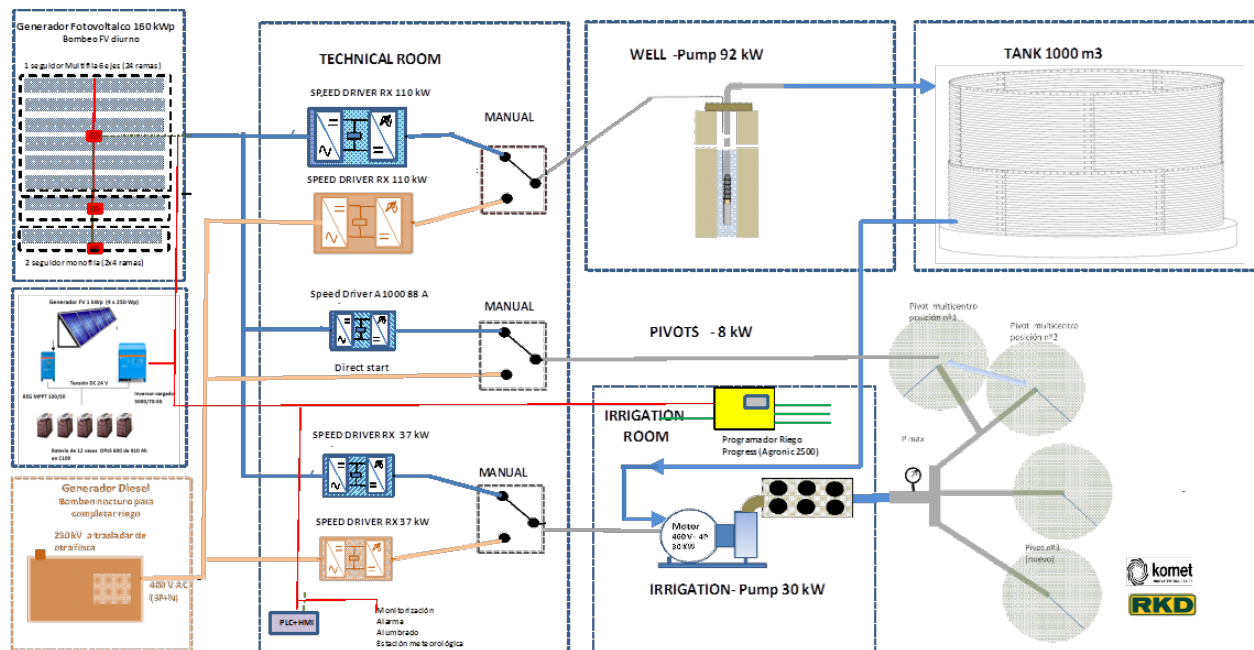
288 m

63 l/s



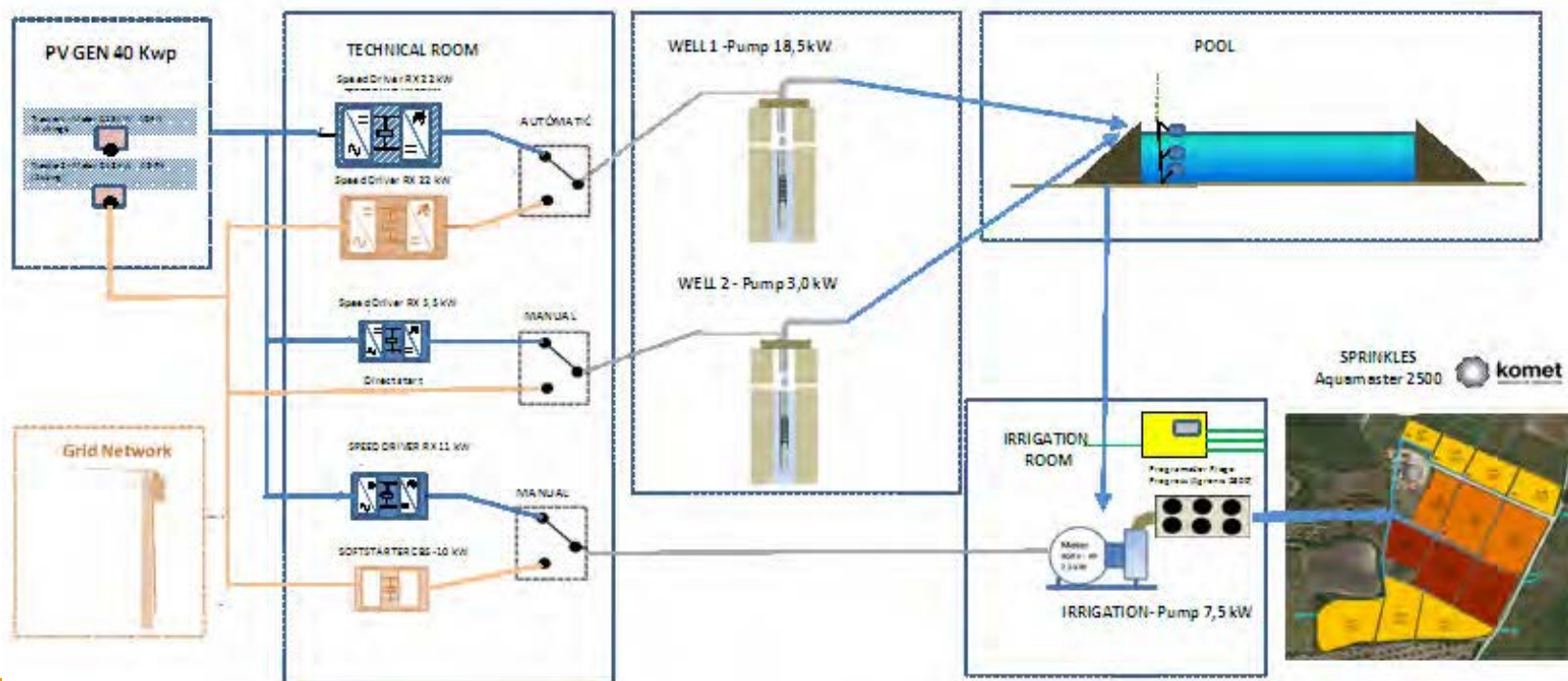


Valladolid (160 kWp): only PV, pivot with low pressure sprinklers, constant pressure



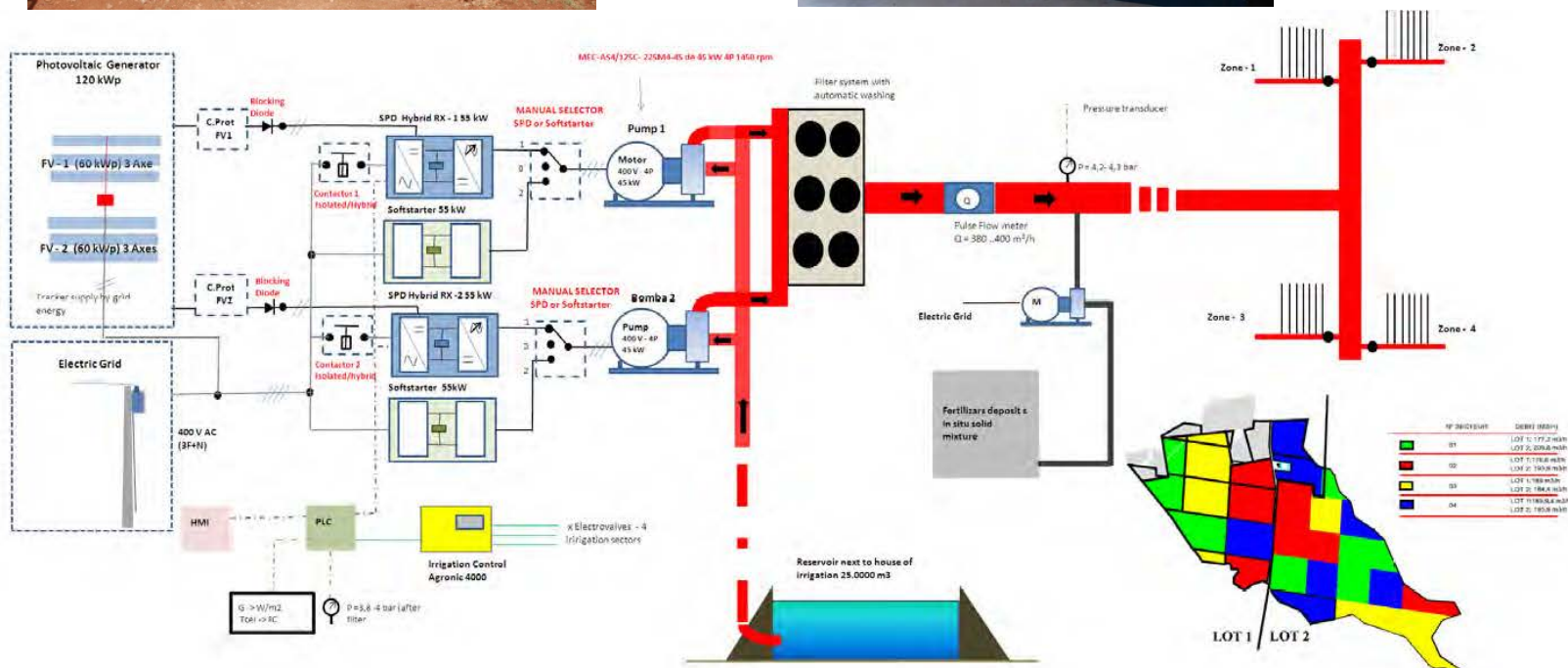


Uri (40 kWp): only PV, to a water pool and sprinklers at constant pressure



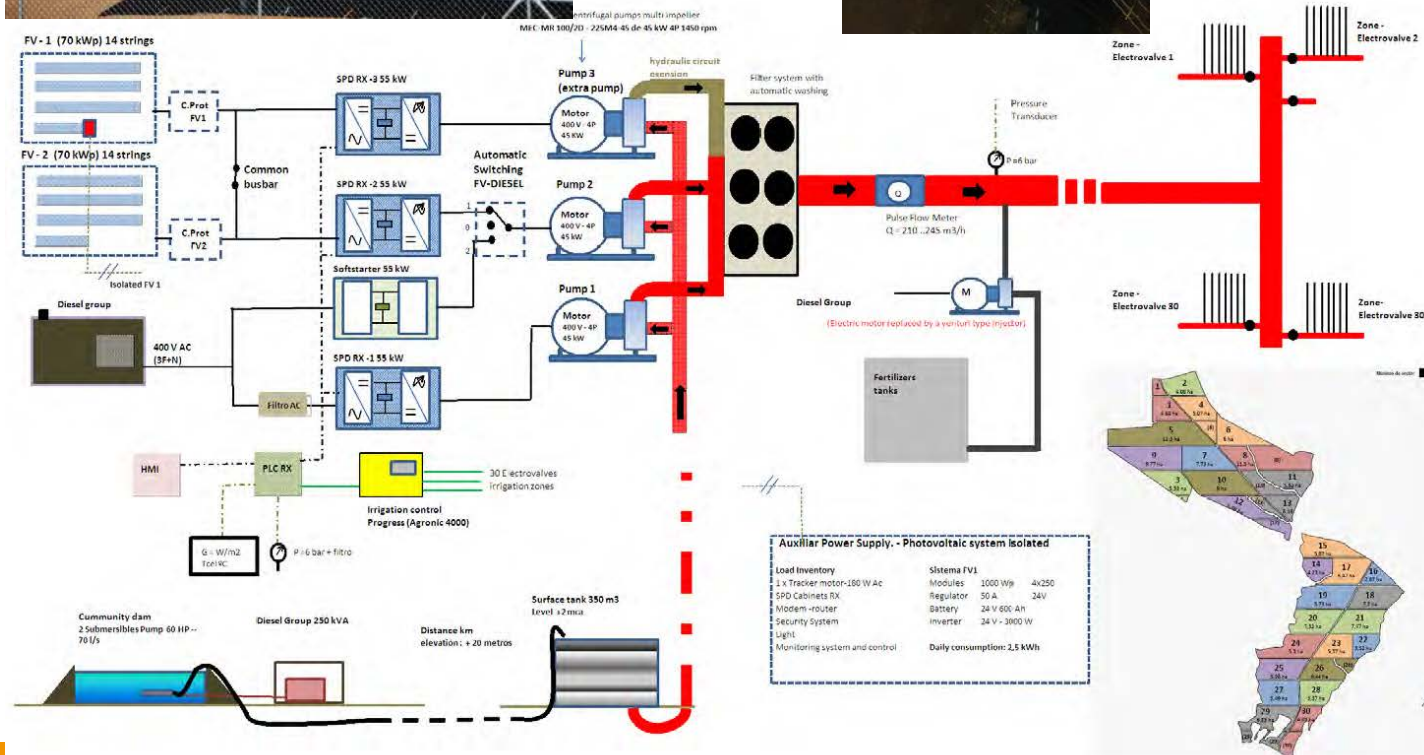


Tamalelt (120 kWp): hybrid PV-grid, drip irrigation, constant pressure





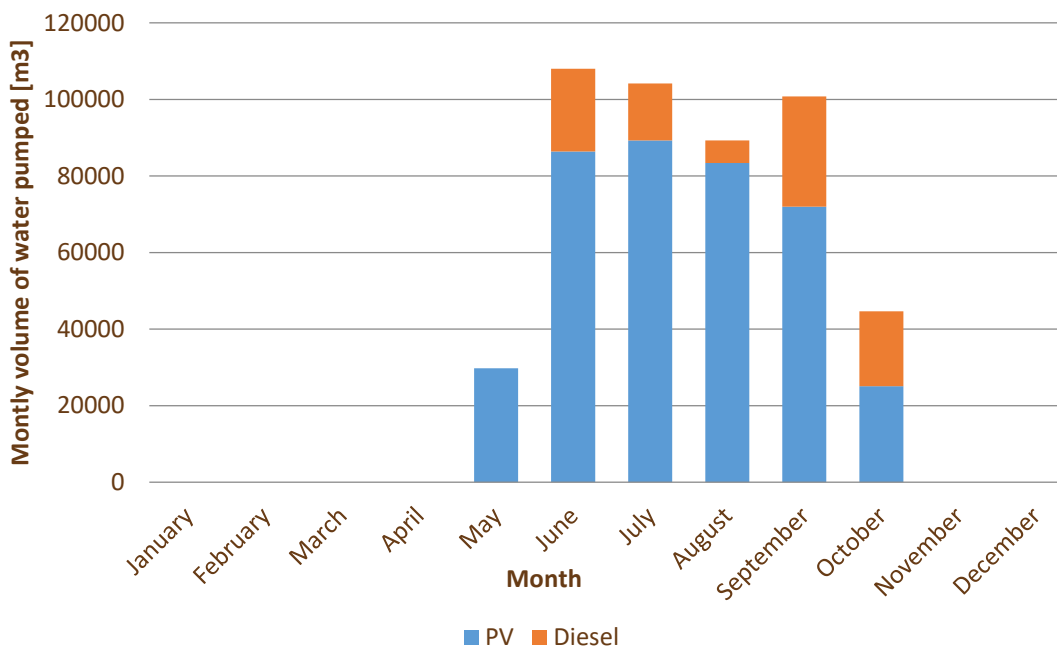
Alter do Chao (140 kWp): hybrid PV-diesel, drip irrigation, constant pressure





Results

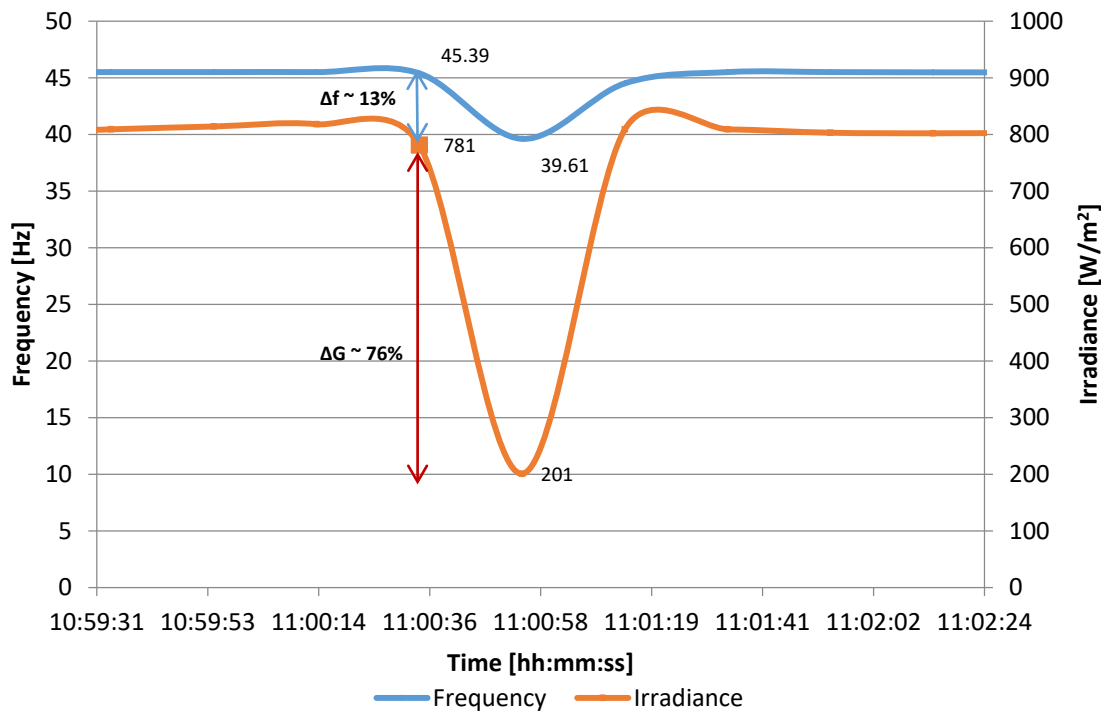
Technical



Portugal (2016): 476.640 m³; 81% FV;



Technical



Villena: 10:59:31 to 11:02:24 19 October 2017








Economic

		Alter do Chão		Villena		Alaejos		Cerdeña		Tamellalt	
Energy cost			Saving [%]		Saving [%]		Saving [%]		Saving [%]		Saving [%]
Previous 25 years	€/kWh	0,33		0,21		0,23		0,54		0,21 €	
PV 25 years	€/kWh	0,13	-61%	0,04	-79%	0,08	-64%	0,18	-66%	0,07 €	-68%



Economic

Financial Indicators

		Alter do Chão  [%]	Villena  [%]	Alaejos  [%]	Sardinia  [%]	Tamellalt  [%]
Annual ELECTRICITY / DIESEL consumption before PV system	kWh or L	41.246	598.147	58.671	30.033	273.102
Annual ELECTRICITY / DIESEL consumption after PV system	kWh or L	7.866	0	9.423	0	42.765
<i>dif</i>	kWh or L	33.380	598.147	49.248	30.033	230.337
		-81%	-100%	-84%	-100%	-84%
ELECTRICITY / DIESEL cost	€/ kWh or €/ L	0,580 €	0,105 €	0,460 €	0,270 €	0,104 €
Average annual inflation rate [25 years] ¹	%	4,5%	4,4%	4,4%	4,4%	4,8%
Annual Saving						
Average Annual Saving [2017 - 2041] ²	€	30.924	100.850	35.466	11.633	40.345
Financial Indicators						
Payback Period	years	9	7	9	8	7
NPV	€	355.119	1.337.243	420.826	142.068	452.594
IRR	%	11%	16%	11%	13%	16%
CAPEX	€	170.277	433.098	200.351	57.778	148.704
WACC	%	3%	3%	3%	3%	4%

¹ the average annual inflation rate includes the estimated inflation rate [source: <http://www.inflation.eu/>] + an additional spread of 2%

² 31% is the higher ICT rate in Morocco with the exception of the ICT rate applicable to leasing companies and credit institutions [37%]

Source: Consortium Information - November 2017



STRATEGY

Reduction of the amount of irrigation water and an increase of the marketable yield

Conventional DRIP irrigation



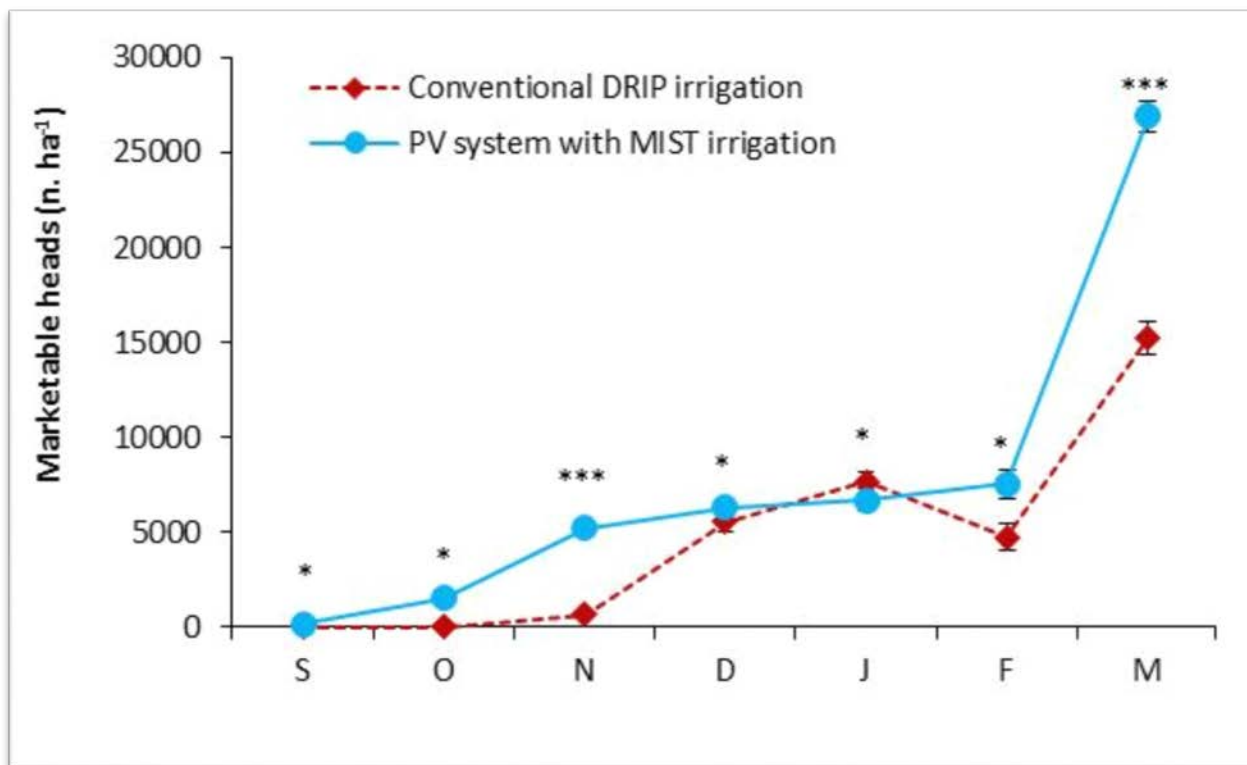
PV system with MIST irrigation

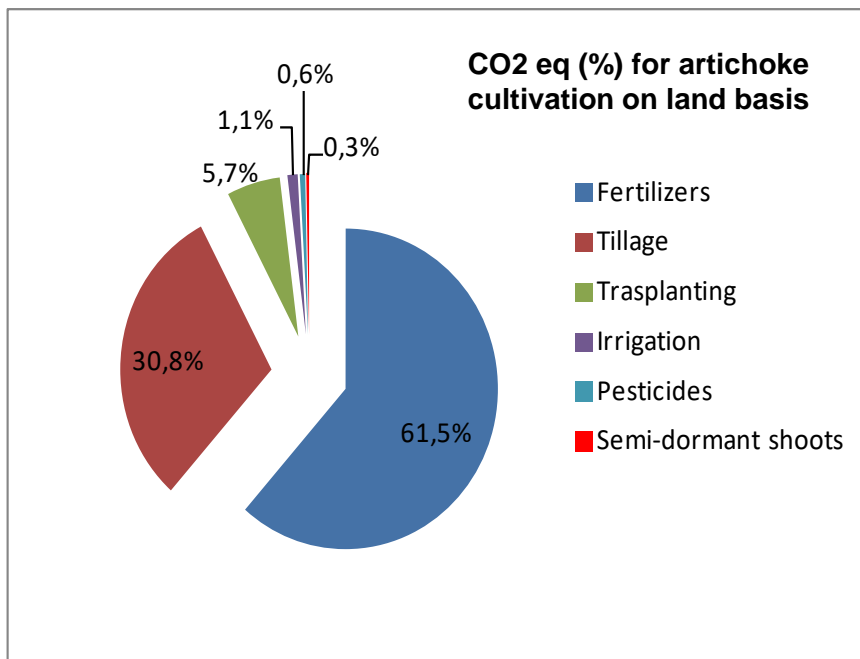


Treatments	Seasonal water volume (m ³ ha ⁻¹)	Heads yield (kg ha ⁻¹)	Water Productivity (kg m ⁻³)	<u>Water saving</u>
MIST	5880	6242	1.03	34%
DRIP	6050	4109	0.69	



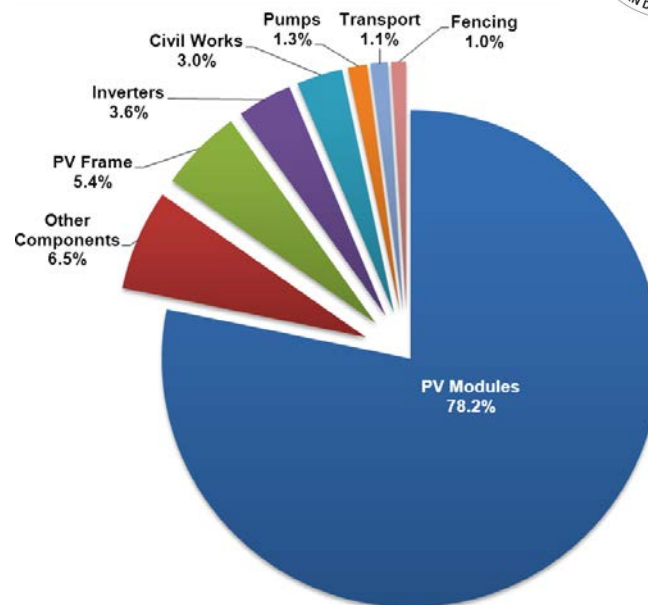
Effects of treatments (MIST and DRIP) on the yield over the 2017-2018 growing season







Distribution of the primary energy embodied in PVIS

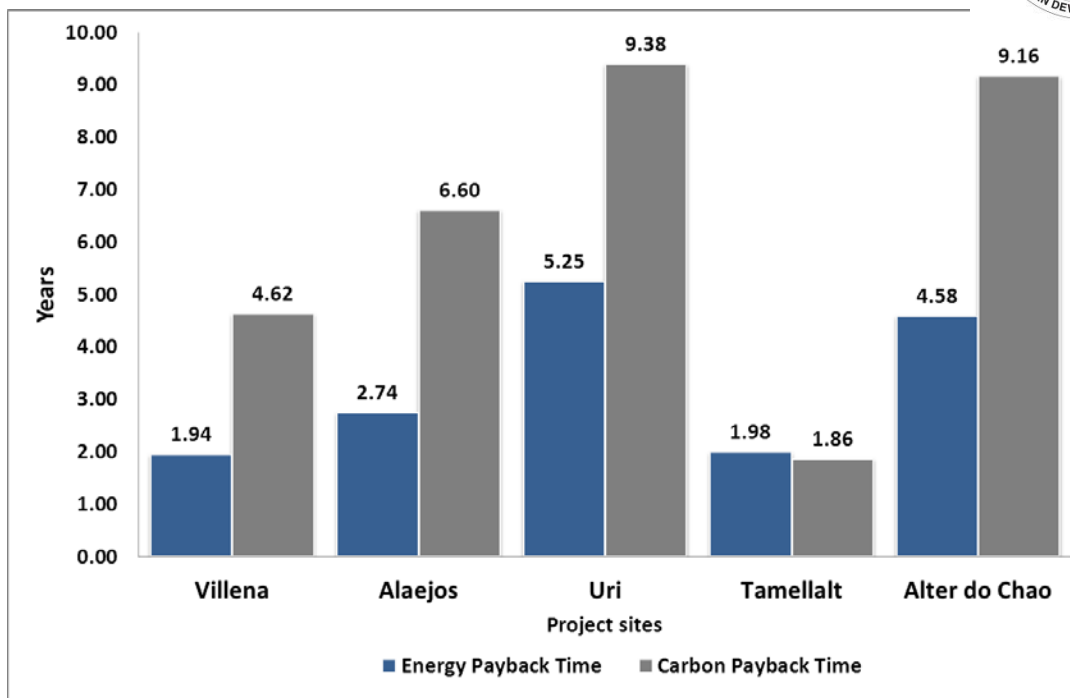


Energy produced, EROI and emission rate of PVIS

	Villena (360 kWp)	Alaejos (160 kWp)	Uri (40 kWp)	Alter do Chao (140 kWp)	Tamellalt (120 kWp)
Electricity produced per PV size (kWh/kWp per year)	1,582	1,213	644	788	1,644
Cradle to grave primary energy embodied in PVIS (GJ/kWp)	29.97	32.41	35.65	33.15	32.33
Energy Return On Investment (EROI)	12.9	9.1	4.8	5.5	12.6
Cradle to grave GHG embodied in PVIS (kg CO ₂ e/kWp)	1,816	1,989	1,996	2,039	1,971
PVIS Emission Rate g CO ₂ e/kWh	45.9	65.6	124.1	103.5	48.0



Energy and Carbon payback times (from cradle to grave) per PVIS



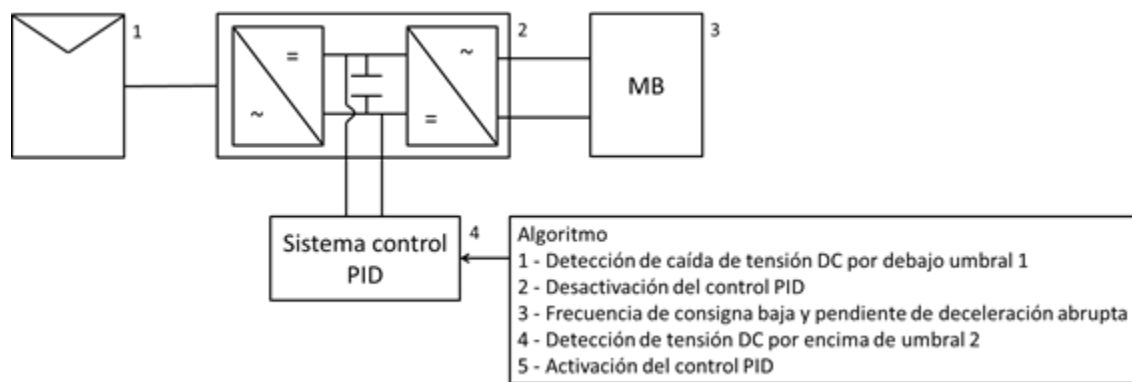
Energy and Environmental performance before and after the installation of PVIS.

The analysis refers to year 2017

	Villena (360 kWp)	Alaejos (160 kWp)	Uri (40 kWp)	Alter do Chao (140 kWp)	Tamellalt (120 kWp)
Fossil fuel saved (GJ)	5,974	2,011	147	436	1,087
Energy saved (%)	100	69	90	41	67
Emissions avoided (kg CO ₂ e)	151,994	137,015	5,038	19,701	70,749

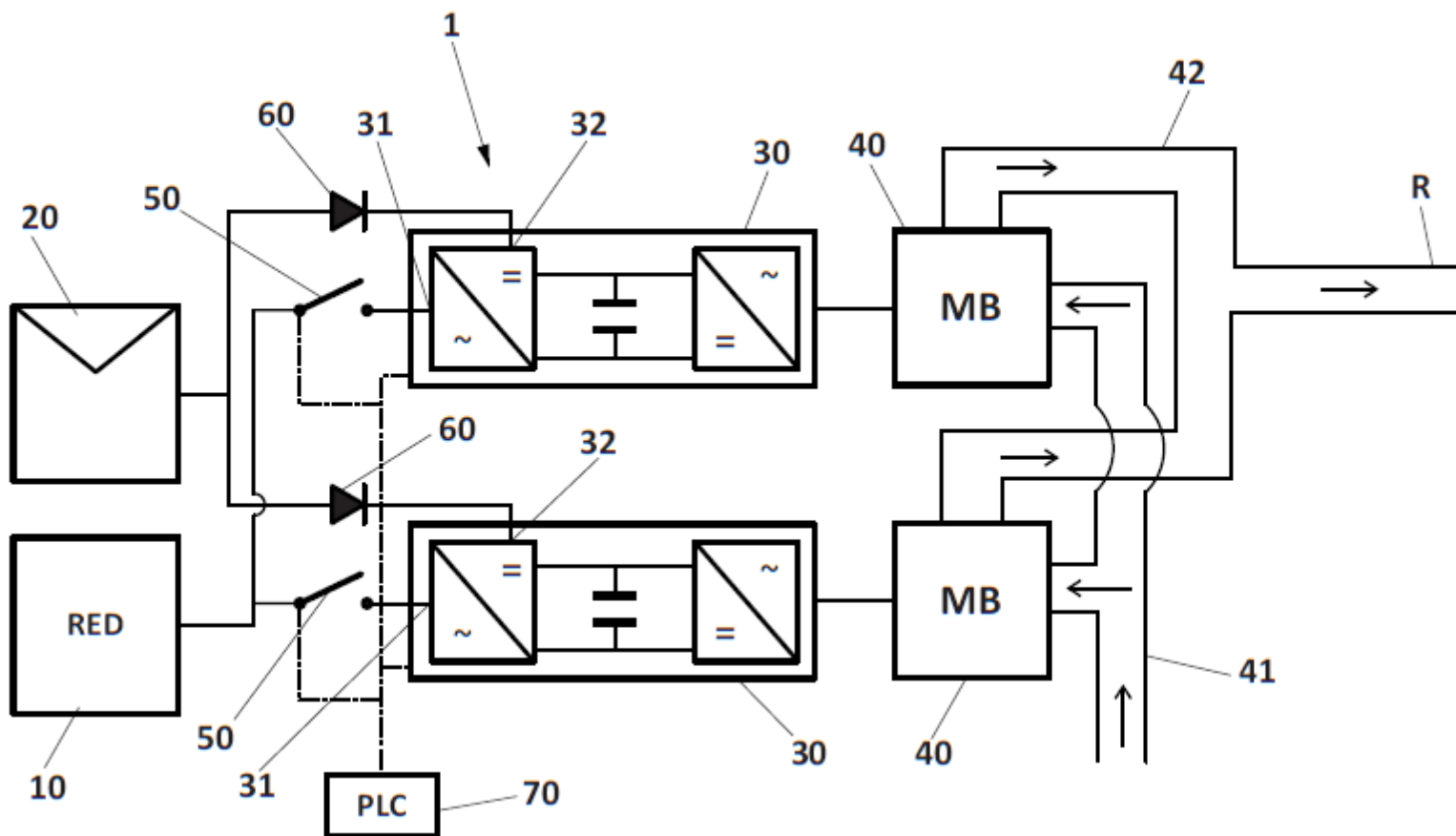


Procedure and control device for PV pumping systems



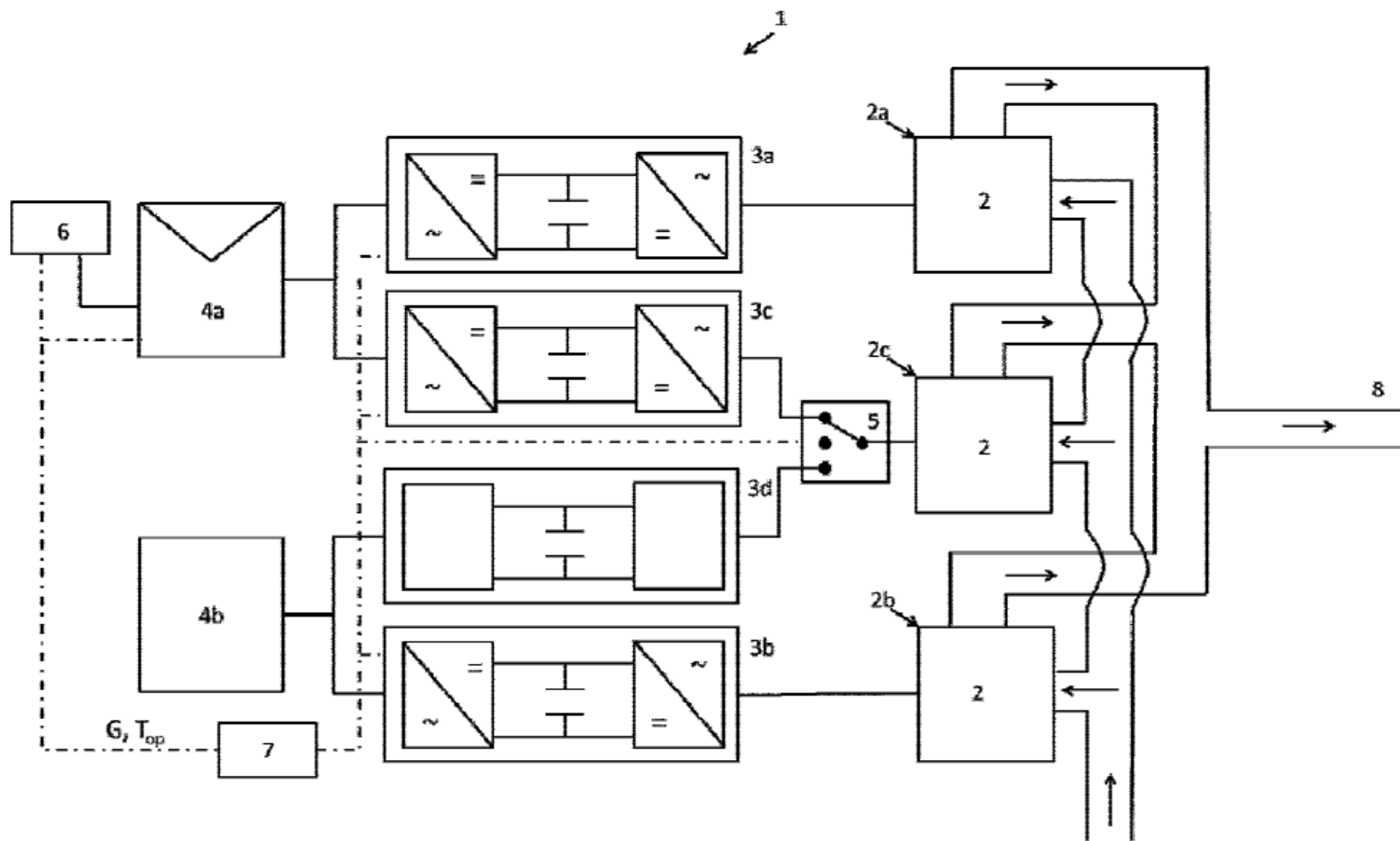


Electrically hybridized PV pumping irrigation systems





Hydraulically hybridized PV pumping irrigation systems





www.sisifo.info



Ayuda

Simulación

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SISIFO

SISIFO es un entorno web libre que permite simular Sistemas Fotovoltaicos.

Simulación de la Calidad y Financiabilidad de sistemas FV.

SISIFO es una herramienta de simulación que permite diseñar plantas FV conectadas a red, así como sistemas de riego FV, utilizando modelos y mostrando resultados orientados a asegurar su calidad y a incrementar su financiabilidad..



SISIFO: An online simulator of PV systems



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