PV Solar Cooling for Air Conditioning and DHW

Pedro V. Quiles

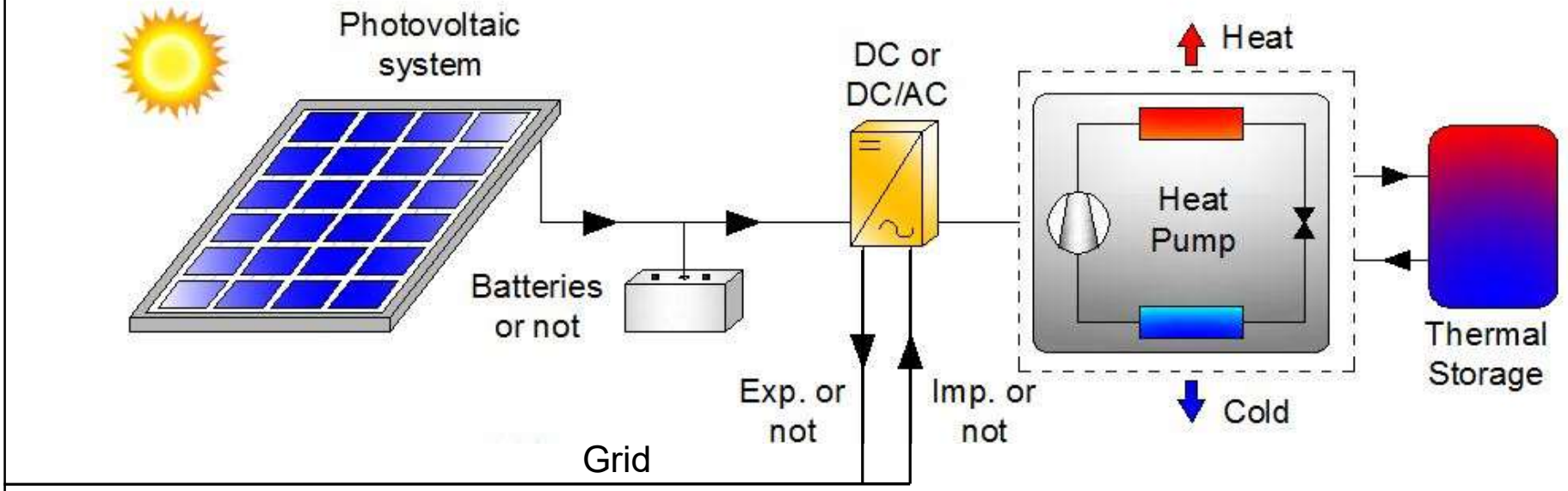
Universidad Miguel Hernández de Elche

pedro.vicente@umh.es

http://dime.umh.e

UNIVERSITAS Miguel Hernández

UMH. Pedro Vicente Quiles
pedro.vicente@umh.es



DESING CHARACTERISTICS

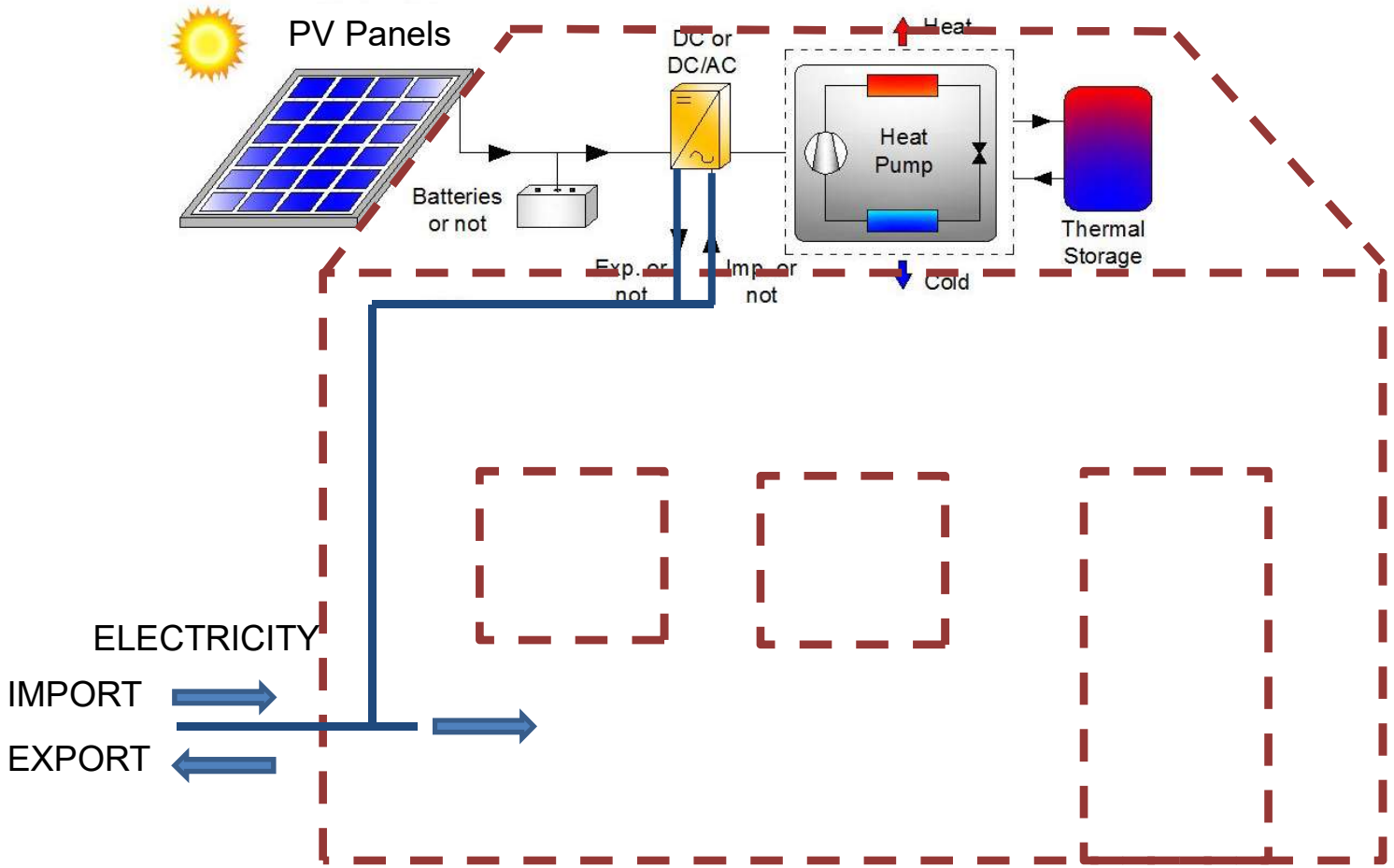
- **ELECTRICITY EXPORT: YES/NO**
- **BATTERIES: YES/NO**
- **THERMAL STORAGE: YES/NO**
- **COMPRESOR: INVERTER, W=CONSTANT**
- **IMPROVED CONTROL (SOLAR)**

DIMENSIONS:

- **NUMBER OF PV PANELS**
- **COMPRESOR POWER**
- **BATTERIES: Ah**
- **STORAGE CAPACITY**

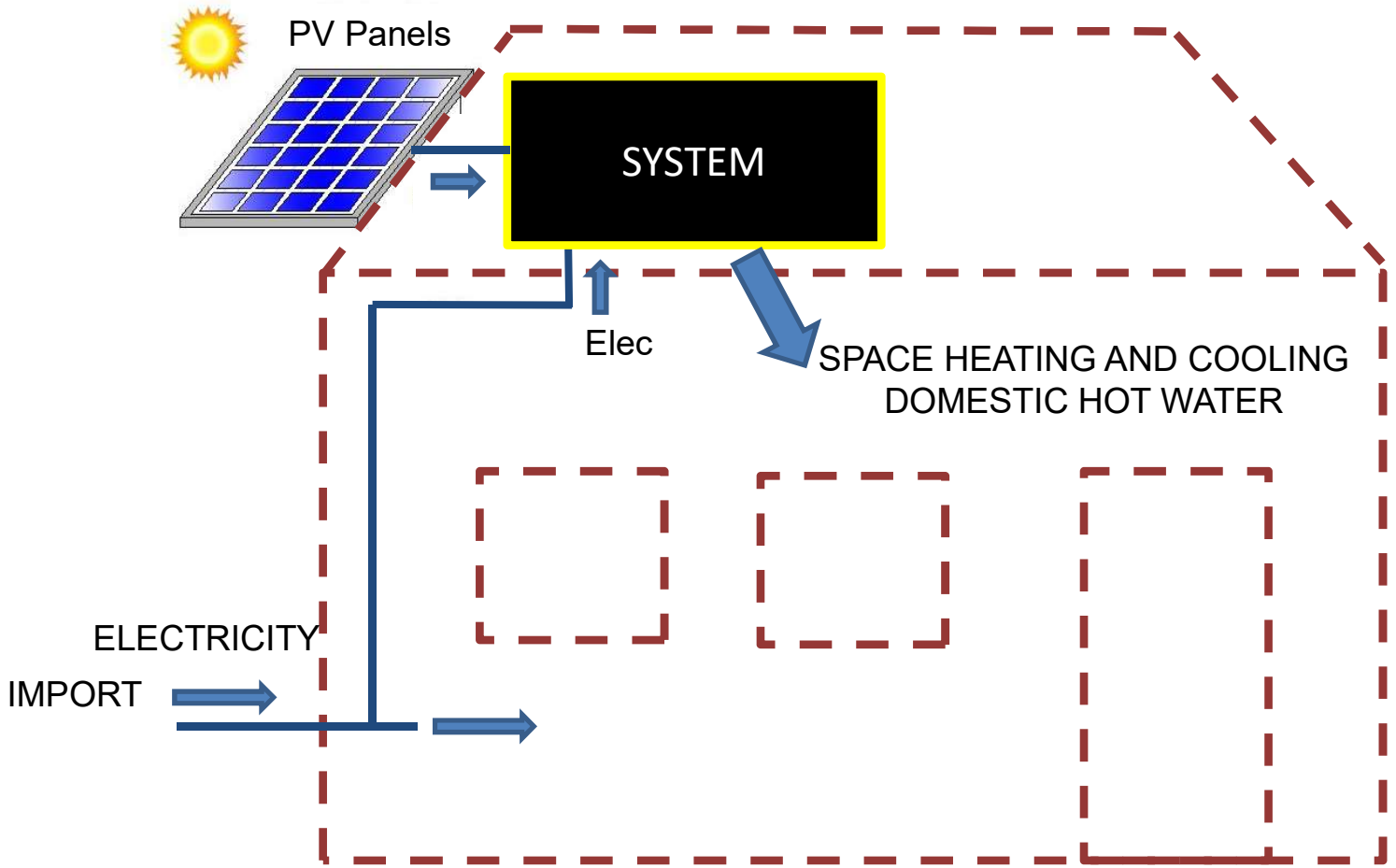
UMH. Pedro Vicente Quiles
pedro.vicente@umh.es

GENERAL APPROACH



UMH. Pedro Vicente Quiles
pedro.vicente@umh.es

OUR APPROACH



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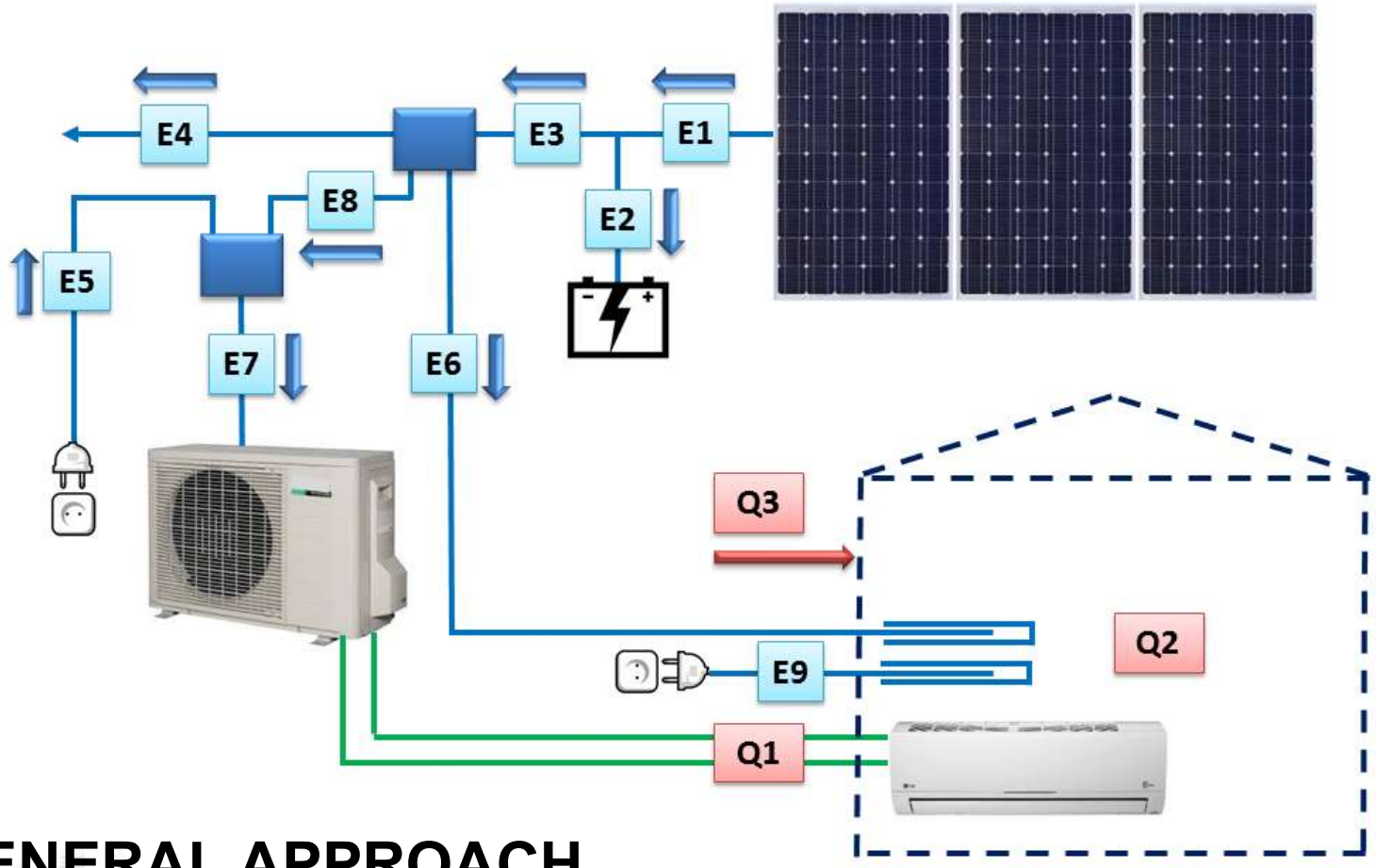
pedro.vicente@umh.es

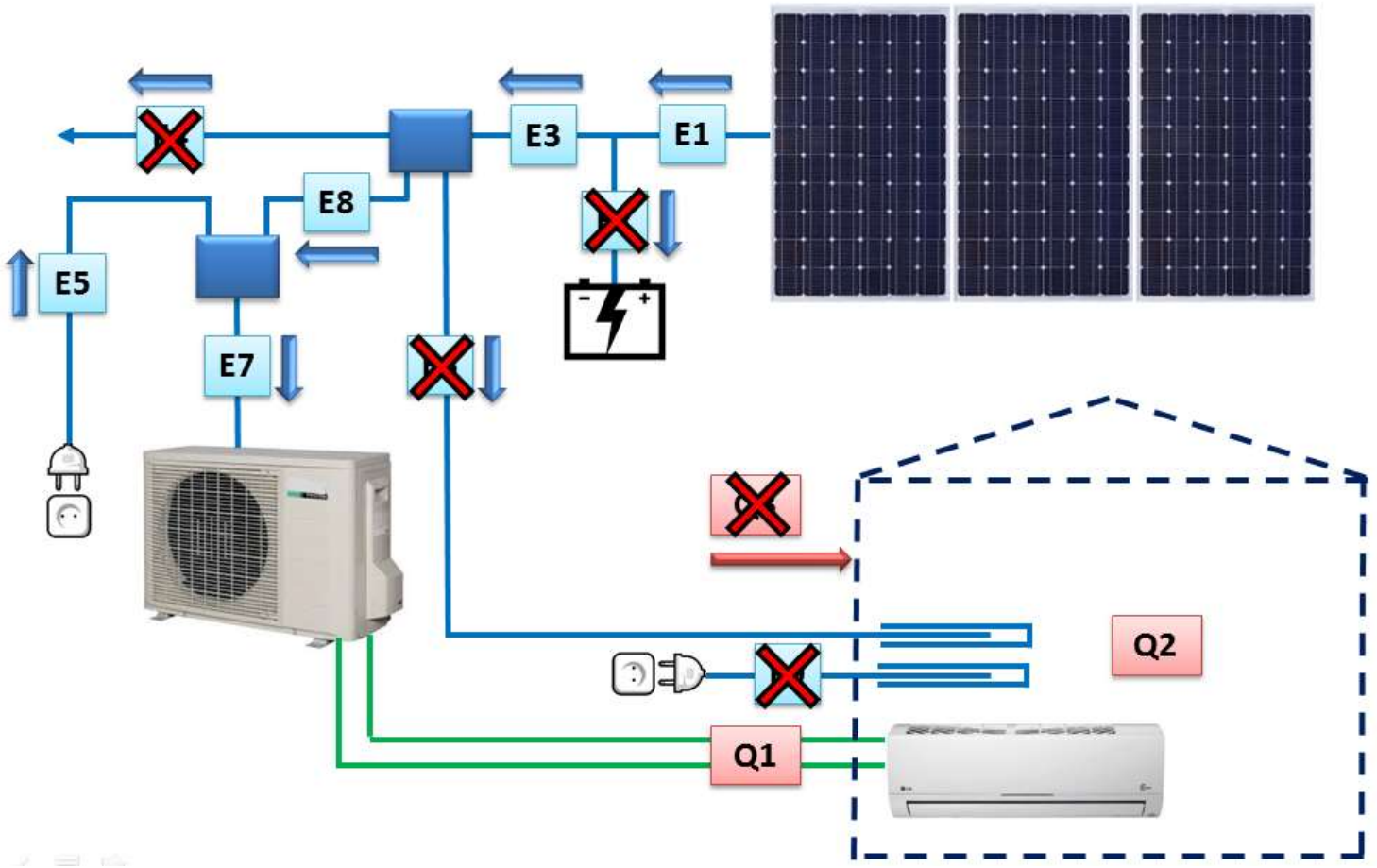
SOLAR AIRCONDITIONERS



GENERAL APPROACH

UMH. Pedro Vicente Quiles
pedro.vicente@umh.es

SOLAR AIRCONDITIONERS



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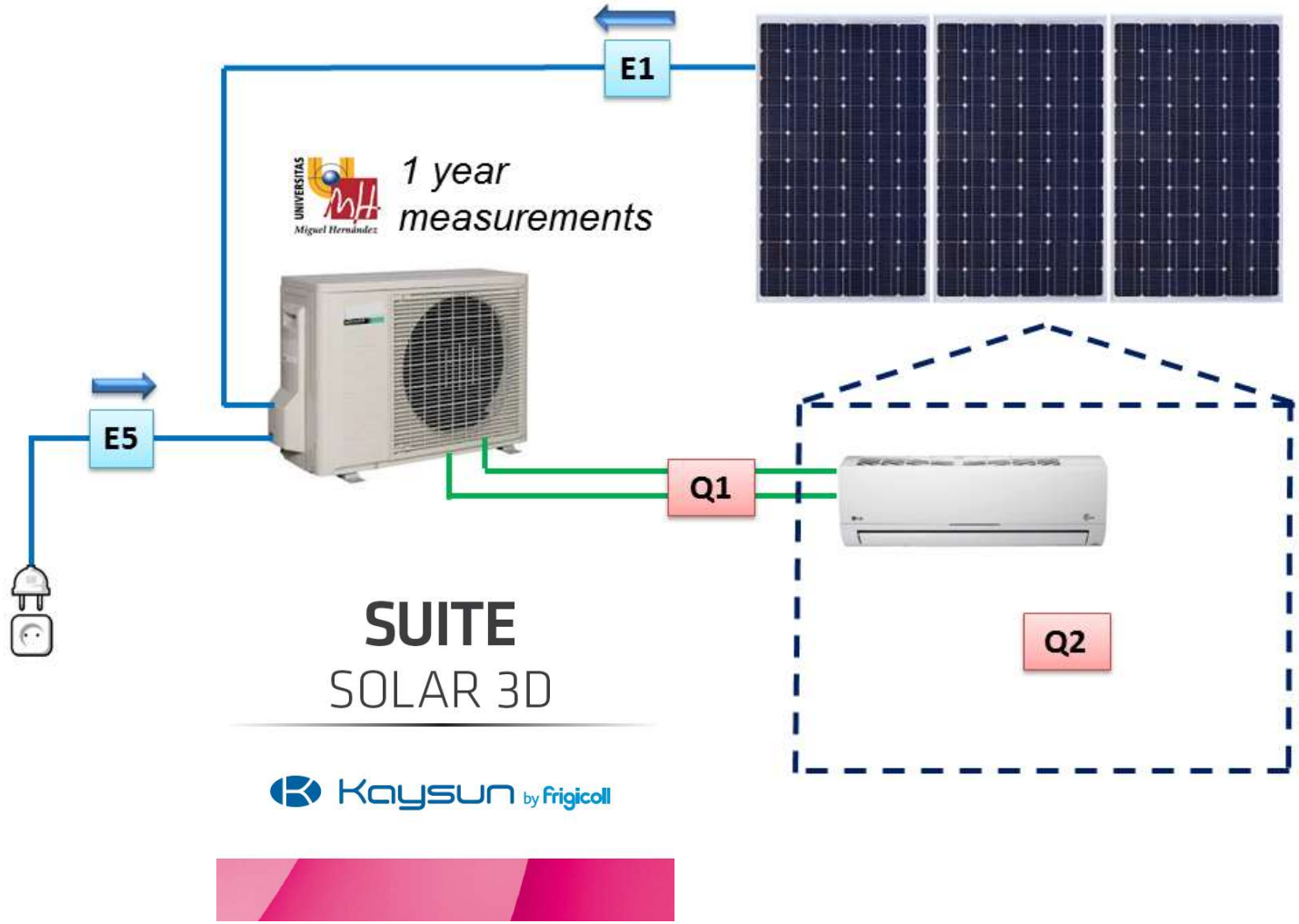
pedro.vicente@umh.es

SOLAR AIRCONDITIONERS



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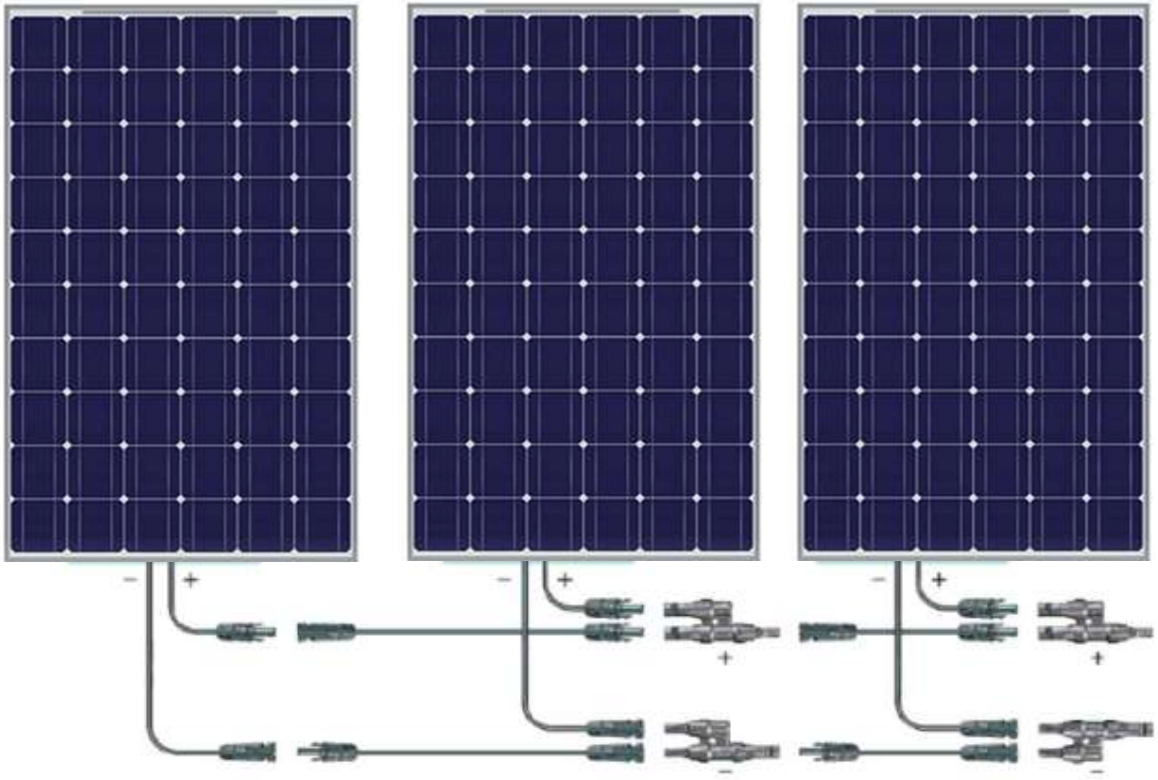
pedro.vicente@umh.es

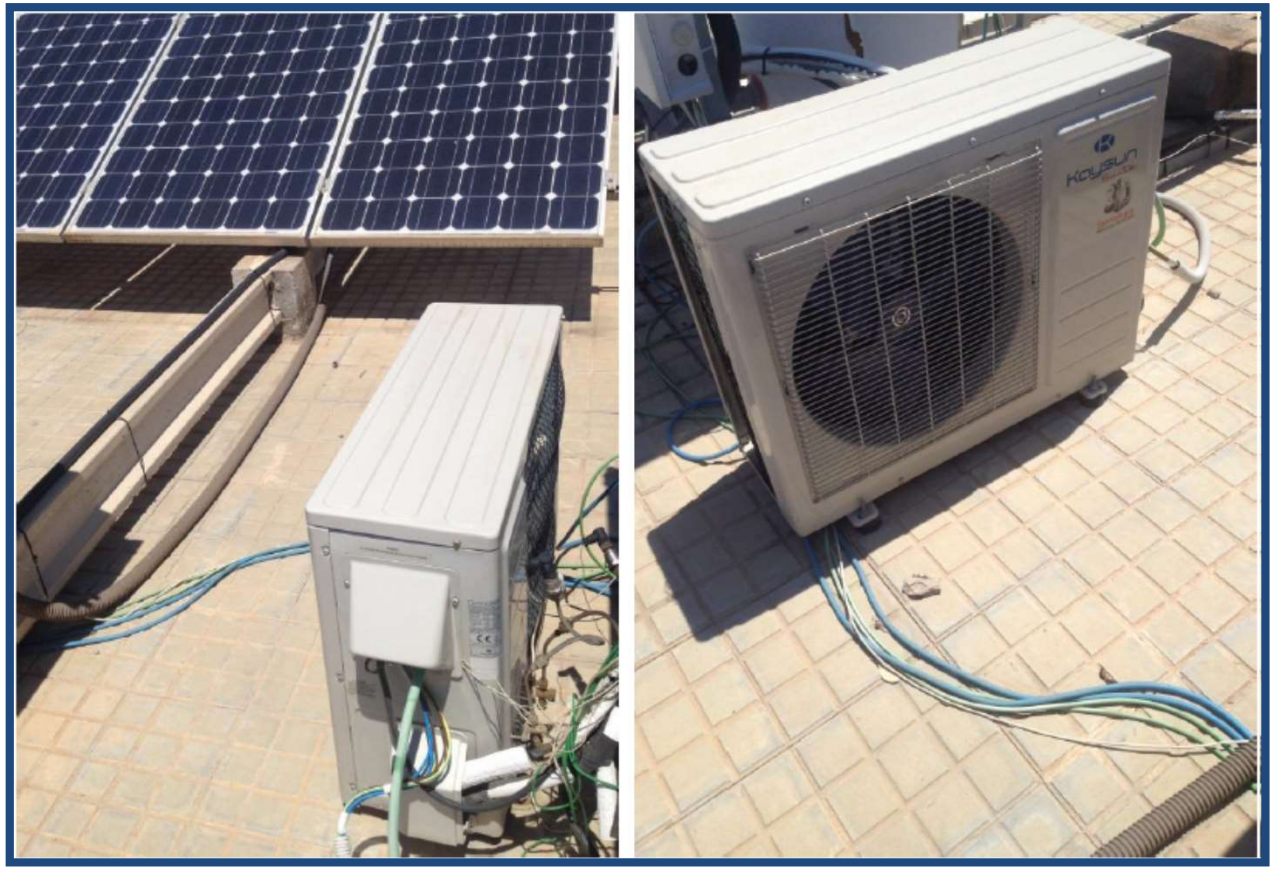
INSTALLATION
Cables connection



UMH. Pedro Vicente Quiles
pedro.vicente@umh.es

ELECTRONICS

UMH. Pedro Vicente Quiles
pedro.vicente@umh.es



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pedro.vicente@umh.es

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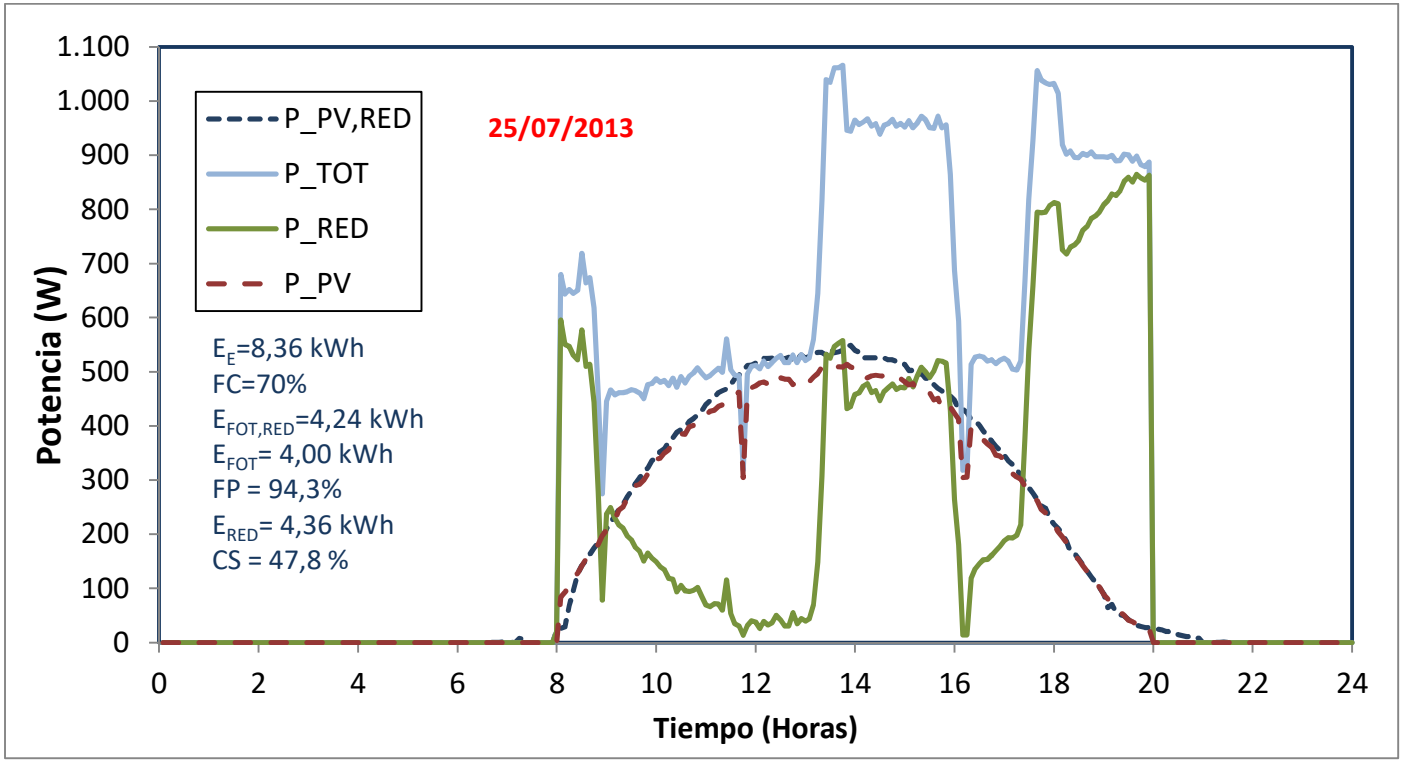
pedro.vicente@umh.es



P_{PV} → Electrical power from photovoltaic panels

P_{GRID} → Electrical power from the electrical grid

P_{TOT} → Total Electrical power

$P_{PV,GRID}$ → Electrical power from photovoltaic panels connected to the electrical grid

UMH. Pedro Vicente Quiles
pedro.vicente@umh.es

Horario de 8 a 20 h	E_PV (kWh)	E_RED (kWh)	E_TOT (kWh)	E_PV,RED (kWh)	E_U (kWh)	EER_Maq (-)	EER_Inst (-)	Cont. Sol CS (%)	F. Prod F (%)	T_ext (ºC)	T_int (ºC)
MAYO	66,0	25,8	91,8	116,8	519,5	6,50	23,12	82,5%	64,9%	24,0	23,3
JUNIO	67,1	18,7	85,7	125,1	514,1	6,00	27,54	78,2%	53,6%	26,8	23,1
JULIO	95,1	75,6	170,7	129,5	720,0	4,22	9,52	55,7%	73,4%	31,1	25,0
AGOSTO	84,8	57,0	141,8	114,7	655,2	4,62	11,49	59,8%	73,9%	30,6	25,0
SEPTIEMBRE	68,2	29,9	98,2	101,0	545,1	5,55	18,21	69,5%	67,5%	27,8	24,3
OCTUBRE	55,4	32,2	87,7	83,6	524,4	5,98	16,26	63,2%	66,3%	26,1	24,1
MODO FRÍO	436,5	239,3	675,8	670,7	3478,4	5,15	14,54	64,6%	65,1%	27,7	24,2

Horario de 8 a 20 h	E_PV (kWh)	E_RED (kWh)	E_TOT (kWh)	E_PV,RED (kWh)	E_U (kWh)	COP_Maq (-)	COP_Inst (-)	Cont. Sol CS (%)	F. Prod F (%)	T_ext (ºC)	T_int (ºC)
NOVIEMBRE	49,36	65,31	114,64	56,49	465,24	4,06	7,12	43,1%	87,4%	14,9	25,9
DICIEMBRE	51,73	89,47	141,18	56,44	551,67	3,91	6,17	36,6%	91,7%	15,2	24,1
ENERO	61,88	84,97	146,84	70,36	575,30	3,92	6,77	42,1%	87,9%	15,1	25,4
FEBRERO	63,98	83,02	147,00	75,74	532,98	3,63	6,42	43,5%	84,5%	13,6	25,2
MARZO	68,87	72,00	140,87	93,02	531,46	3,77	7,38	48,9%	74,0%	16,8	25,7
ABRIL	58,53	44,79	103,32	101,76	387,67	3,75	8,65	56,6%	57,5%	19,1	24,0
MODO CALOR	354,4	439,6	793,8	453,8	3044,3	3,83	6,93	44,6%	78,1%	15,8	25,0
TOTAL	790,9	678,9	1469,7	1124,5	6522,7	4,44	9,61	53,8%	70,3%	21,7	24,6

UMH. Pedro Vicente Quiles
pedro.vicente@umh.es

CONCLUSIONS

- SOLAR CONTRIBUTION (SC%)
  Definition: % of consumed energy which is solar: **54%**

- PRODUCTION FACTOR (PF%)
  Definition: % of employed PV energy compared to maximum: **70%**

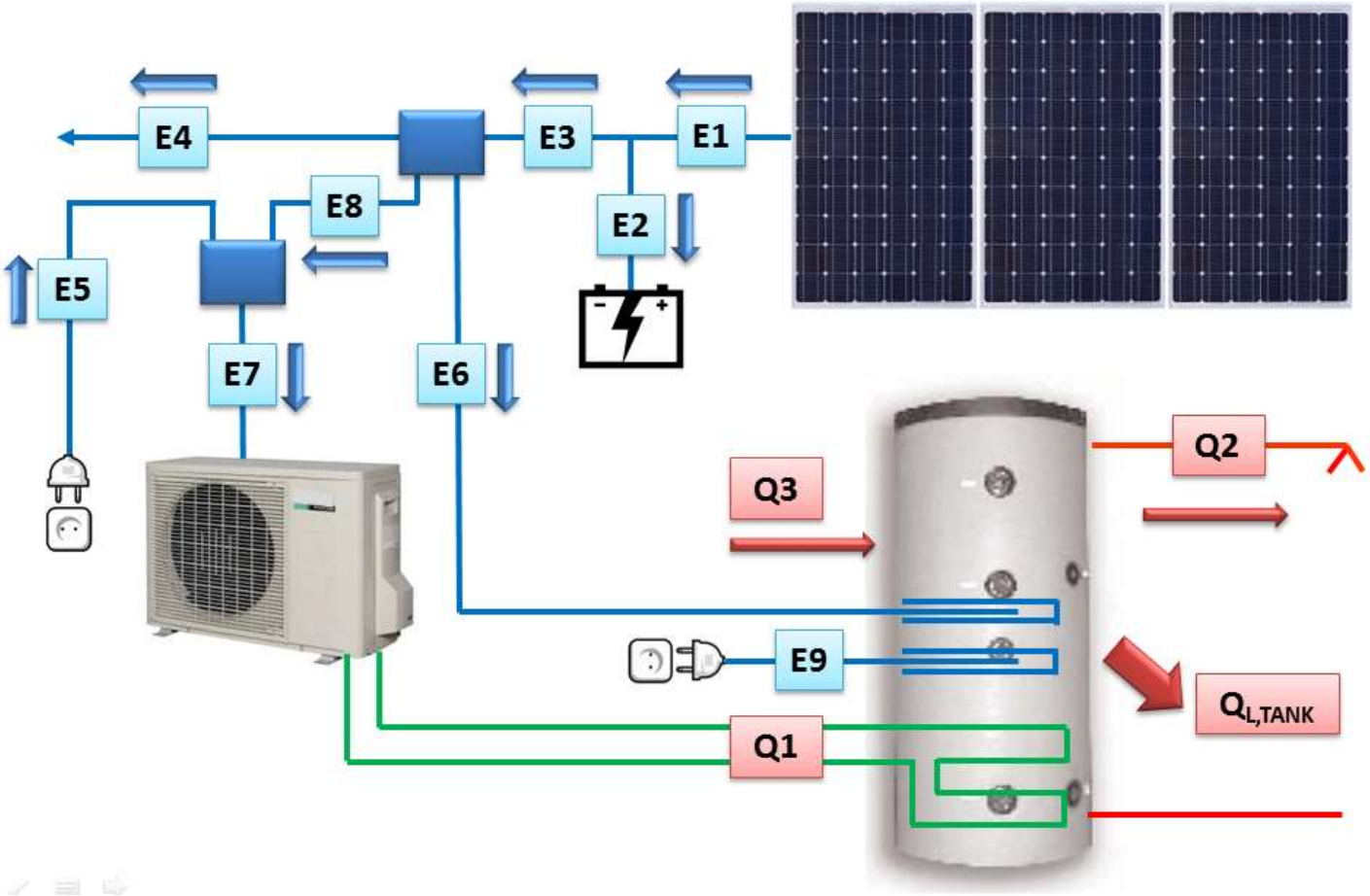
- EFFICIENCY (SPF)
  Definition: Heat + Cool compared to grid electricity: **9,6**

ELECTRICITY EXPORT: NO
BATTERIES: NO
THERMAL STORAGE: NO
COMPRESOR: INVERTER
IMPROVED CONTROL (SOLAR): NO

NUMBER OF PV PANELS: 3
COMPRESOR POWER: 1 kW

UMH. Pedro Vicente Quiles
pedro.vicente@umh.es

DOMESTIC HOT WATER SYSTEMS



UMH. Pedro Vicente Quiles
pedro.vicente@umh.es

PROTOTYPE UMH-DHW1

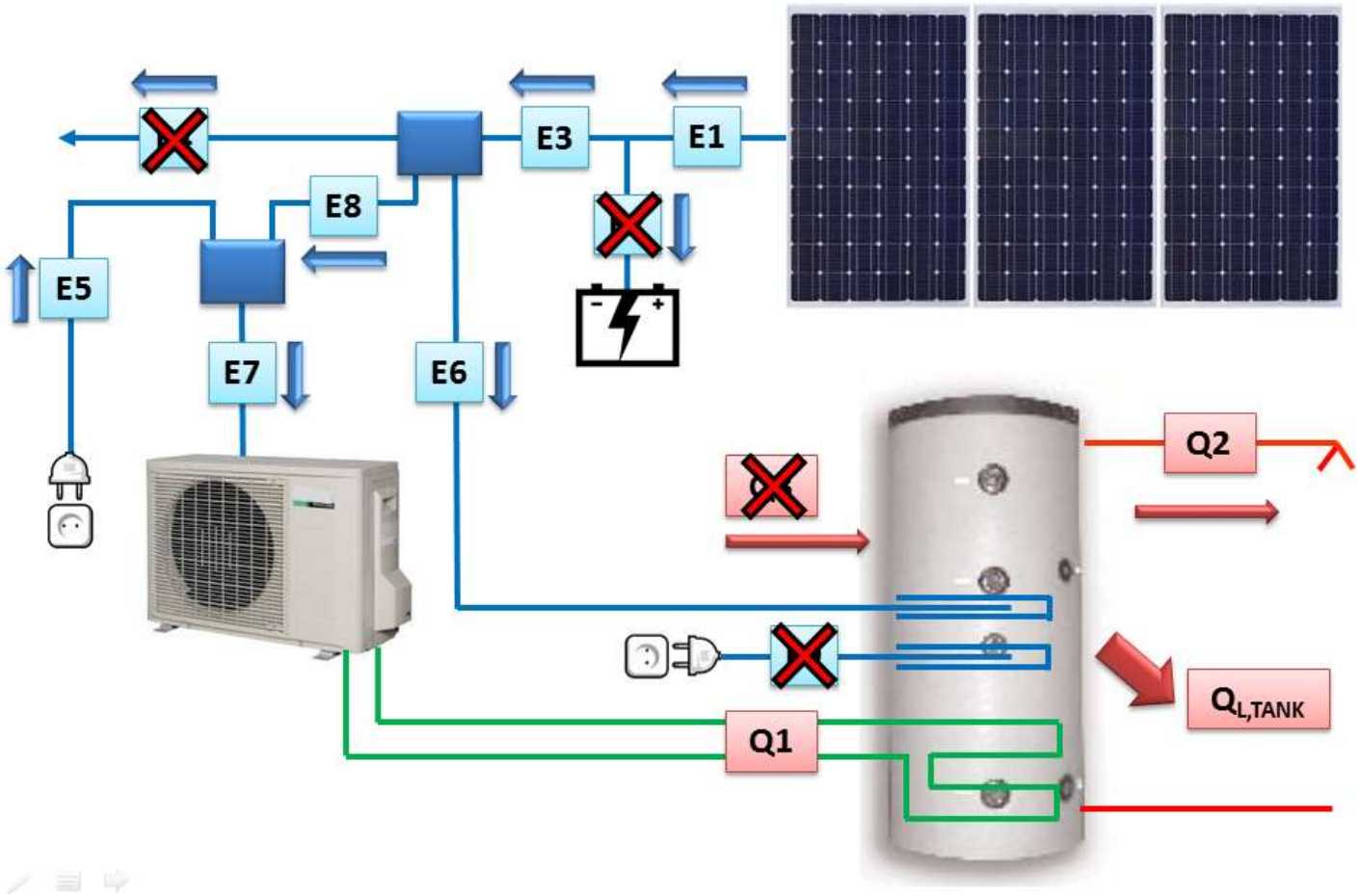
DHW consumption of a 4 member family

P_{PV}=470Wp

P_{HP}=1.5kW

UMH. Pedro Vicente Quiles
pedro.vicente@umh.es

PROTOTYPE UMH-DHW1



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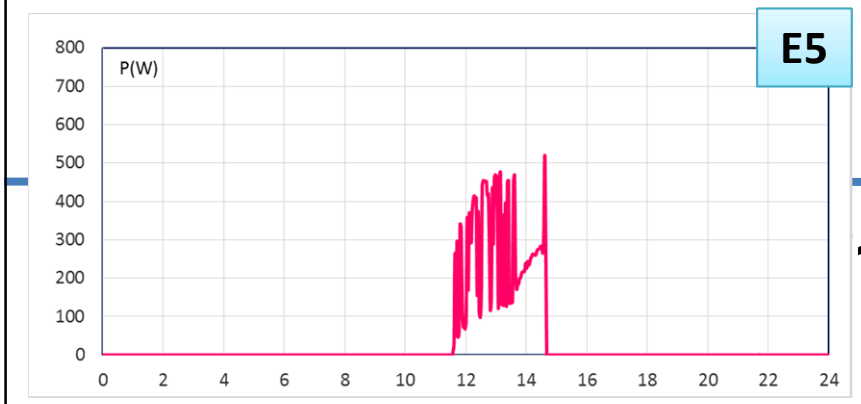

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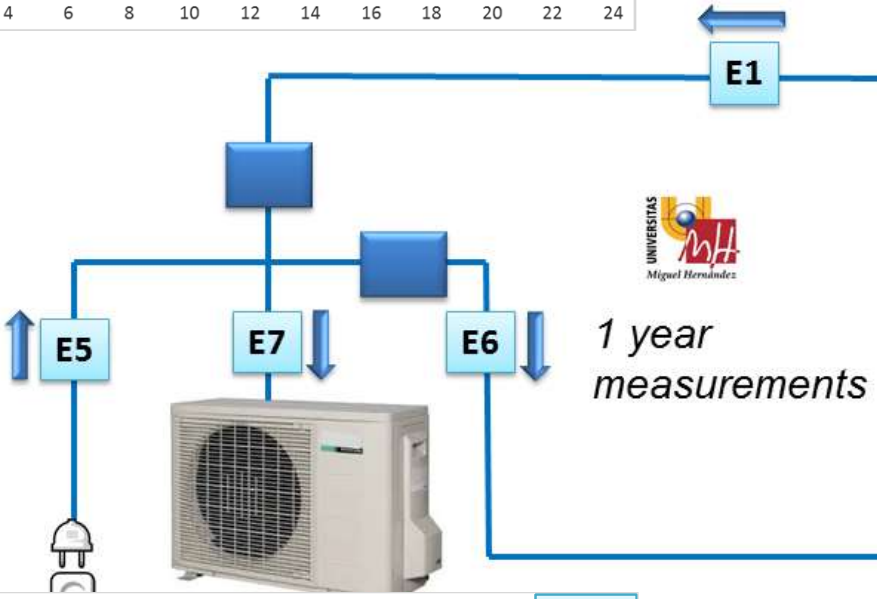
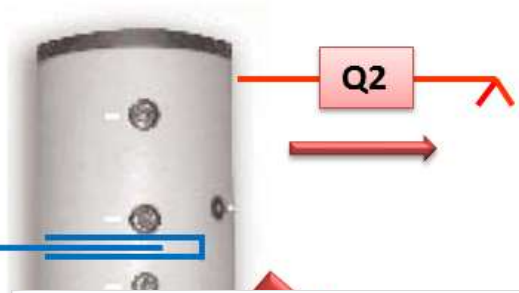
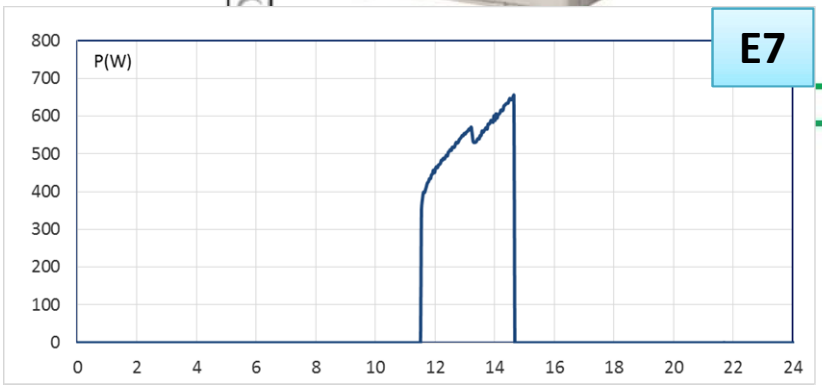
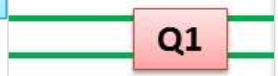


1 year measurements







UMH. Pedro Vicente Quiles
pedro.vicente@umh.es

Experimental Results

MONTLY RESULTS

Month	Vol. (L)	Q_2 (Kwh)	$E_{L,TANK}$ (Kwh)	E_Δ (Kwh)	Q_2 (Kwh)	E_7 (kWh)	E_1 (kWh)	E_5 (kWh)	E_6 (kWh)	E_1-E_6 (kWh)	Q_1 (kWh)	Q_1+Q_6 (kWh)	COP_{HP}	COP_{SIST}	$T_{M,24h}$ (ºC)	$T_{M,HP-ON}$ (ºC)	E_{SOLAR} (kWh/m2)	SC (%)
January	123,49	5,56	2,15	0,01	7,71	2,30	2,02	0,90	0,61	1,40	6,94	7,55	3,01	8,38	11,40	16,83	5,20	69,11
February	131,67	6,70	2,21	0,42	9,34	2,68	2,03	1,25	0,60	1,44	9,39	9,99	3,50	8,01	13,66	16,29	5,16	62,00
March	133,26	6,92	1,99	0,03	8,93	2,38	2,37	0,88	0,88	1,49	8,54	9,42	3,60	10,68	15,61	19,37	6,17	72,91
April	128,23	6,69	1,74	0,07	8,51	2,05	2,59	0,68	1,22	1,37	7,51	8,74	3,67	12,81	19,73	23,78	6,77	79,16
May	125,73	6,38	1,71	-0,01	8,08	1,96	2,19	0,87	1,10	1,09	7,17	8,27	3,67	9,54	19,53	24,16	5,88	71,61
June	130,83	6,53	1,36	-0,01	7,89	1,77	2,21	0,81	1,24	0,97	6,48	7,72	3,65	9,56	23,79	27,98	5,90	73,21
July	133,61	6,69	1,19	0,01	7,88	1,68	2,39	0,71	1,41	0,98	6,39	7,80	3,80	11,07	26,34	30,32	6,53	77,21
August	133,64	6,66	1,14	0,02	7,82	1,64	2,23	0,76	1,35	0,88	6,43	7,78	3,92	10,24	26,80	30,75	6,23	74,57
September	129,97	6,42	1,20	-0,01	7,62	1,67	2,14	0,80	1,27	0,87	6,34	7,61	3,81	9,56	25,76	29,85	5,86	72,89
October	129,28	6,31	1,44	0,02	7,77	1,80	2,19	0,76	1,15	1,04	6,41	7,56	3,55	9,92	22,12	26,92	5,92	74,20
November	129,06	5,74	1,77	0,02	7,53	2,03	1,62	1,13	0,72	0,89	6,54	7,26	3,23	6,41	16,09	20,29	4,14	58,83
December	125,90	5,67	2,03	0,01	7,70	2,23	1,92	1,04	0,72	1,20	6,78	7,50	3,04	7,23	12,02	16,82	4,88	64,91
TOTAL	**47281,70**	**2318,98**	**604,95**	**16,32**	**2940,25**	**734,27**	**787,88**	**320,73**	**373,80**	**414,08**	**2577,64**	**2951,44**	**3,51**	**9,17**	**19,41**	**23,61**	**2089,71**	**71,07**
AVERAGE	129,56	6,35	1,66	0,04	8,06	2,01	2,16	0,88	1,02	1,13	7,06	8,09	3,51	9,17	19,41	23,61	5,73	71,07

UMH. Pedro Vicente Quiles
pedro.vicente@umh.es

CONCLUSIONS

- SOLAR CONTRIBUTION (SC%)
  Definition: % of consumed energy which is solar: **71%**

- PRODUCTION FACTOR (PF%)
  Definition: % of employed PV energy compared to maximum: **100%**

- EFFICIENCY (SPF)
  Definition: Heat + Cool compared to grid electricity: **9,1**

ELECTRICITY EXPORT: NO
BATTERIES: NO
THERMAL STORAGE: YES
COMPRESOR: W=CONSTANT
IMPROVED CONTROL (SOLAR): YES

NUMBER OF PV PANELS; 2
COMPRESOR POWER: 500 W
STORAGE CAPACITY: 200 LITERS

UMH. Pedro Vicente Quiles
pedro.vicente@umh.es

PROTOTYPE UMH-DHW2

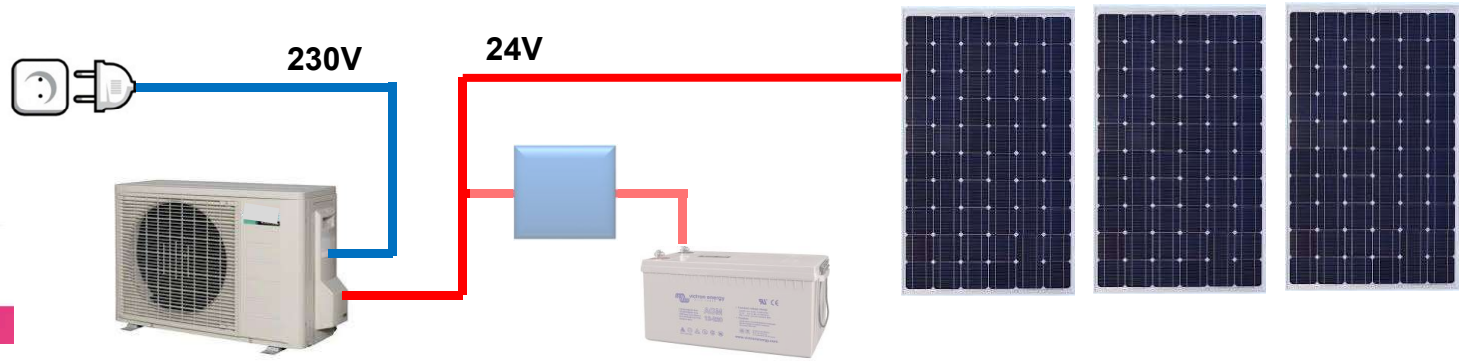
DHW consumption of a 4 member family

P_{PV}=470Wp

P_{HP}=1.5kW

UMH. Pedro Vicente Quiles
pedro.vicente@umh.es

SUITE
SOLAR 3D
Kaysun by frigicoll



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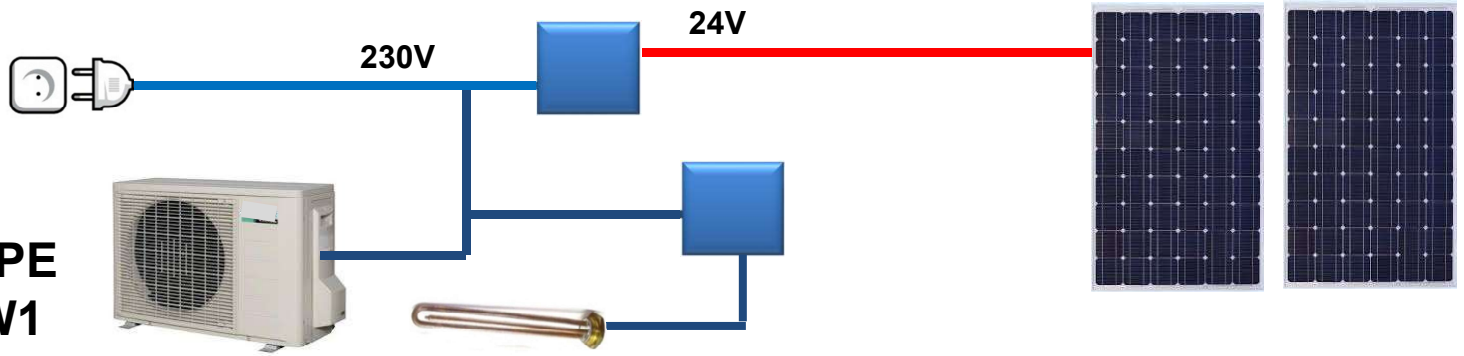
PROTOTYPE UMH-DHW1



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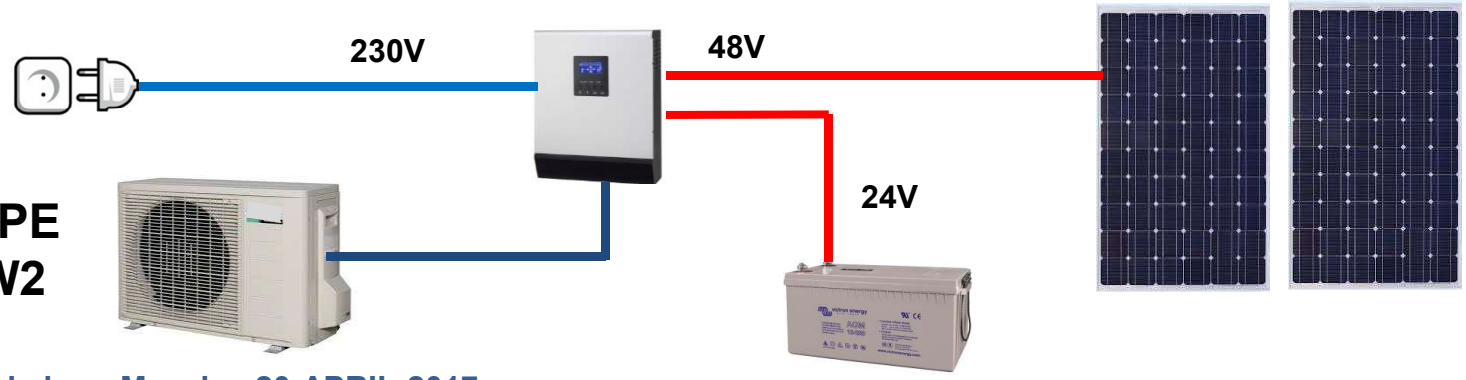
PROTOTYPE UMH-DHW2



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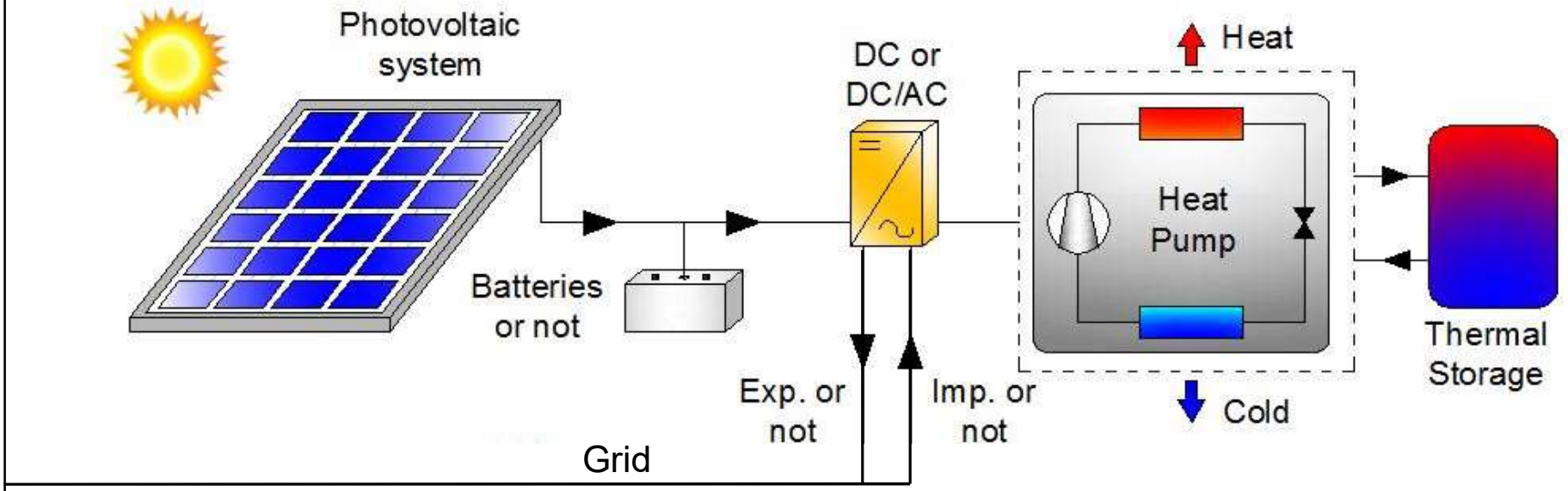

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- **BATTERIES: YES/NO**
- **THERMAL STORAGE: YES/NO**
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- **IMPROVED CONTROL (SOLAR)**

DIMENSIONS:

- **NUMBER OF PV PANELS**
- **COMPRESOR POWER**
- **BATTERIES: Ah**
- **STORAGE CAPACITY**

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