

Task 53



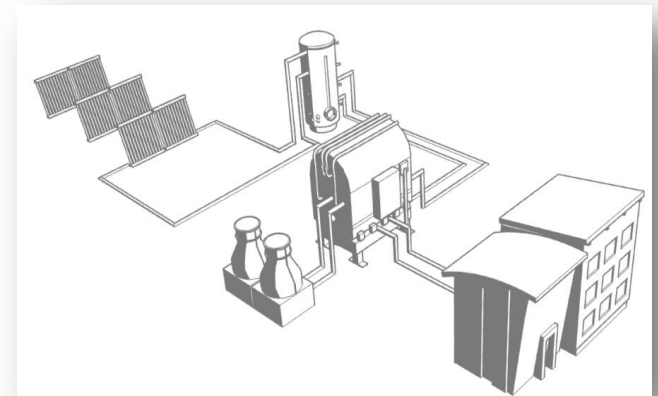
# IEA SHC TASK 53

Next Generation Solar Cooling Systems

Tim Selke

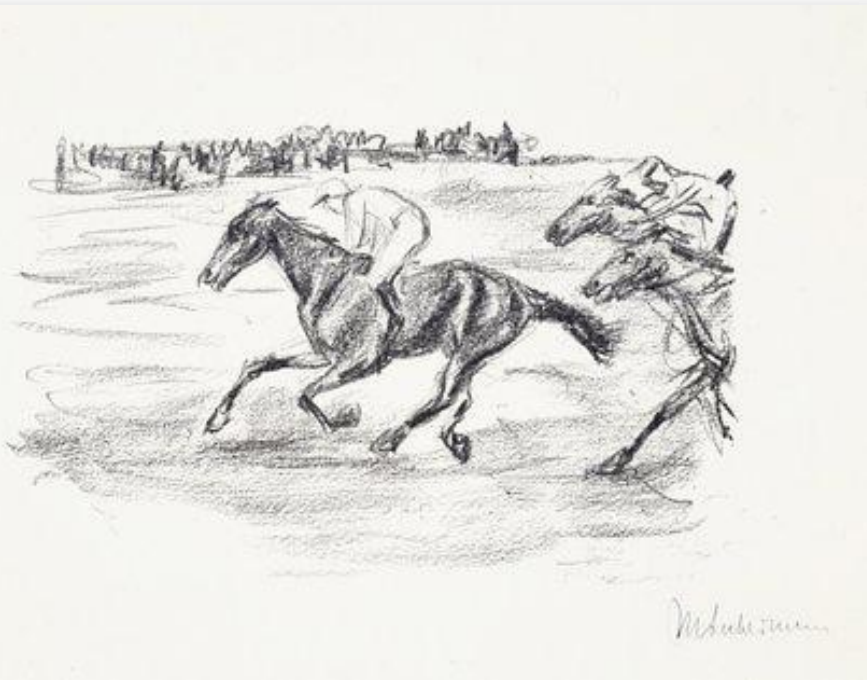
IEA Symposium on  
Demand Flexibility and RES Integration  
Thinking the Smart Grid from the Consumer End

SMART GRIDS Week 2016, LINZ AG, Linz, Austria  
Monday, 9th May 2016



# IEA SHC TASK 53

## Framework and challenge



- Transformation of the existing energy system into secure, affordable, reliable and robust renewable energy system
- Solar technologies (thermal and power) are key components of future solution for the world wide ,energy system transformation ‘Energiewende’
- Good coincidence between solar radiation and cooling demand of buildings

**Max Liebermann**

Berlin, 20. Juli 1847 - 1935, Berlin

# IEA SHC TASK 53

## Driving forces and framework



- National energy and climate targets
- Increasing comfort and cooling demand
- High electric peaks in the grids
- Coincidence between sunshine and demand
- Products are on the markets
- Affordable, secure, reliable and robust



Quelle [www.oew.org](http://www.oew.org)

# IEA SHC TASK 53

## Lessons learnt

- Solar cooling highly needs innovations: cost reduction, 30 years reliability and performance..
- High stimulation from PV to solar thermal for small to medium cooling power range
-  High priority targets in term of markets :
  - » MENA region (roadmap available)
  - » China
  - » Sun Belt
- Very promising segments for large scale solar thermal cooling
- According to the IEA's Technology Roadmap on Solar Heating and Cooling, solar cooling should cover at least 17% of the total cooling needs by 2050

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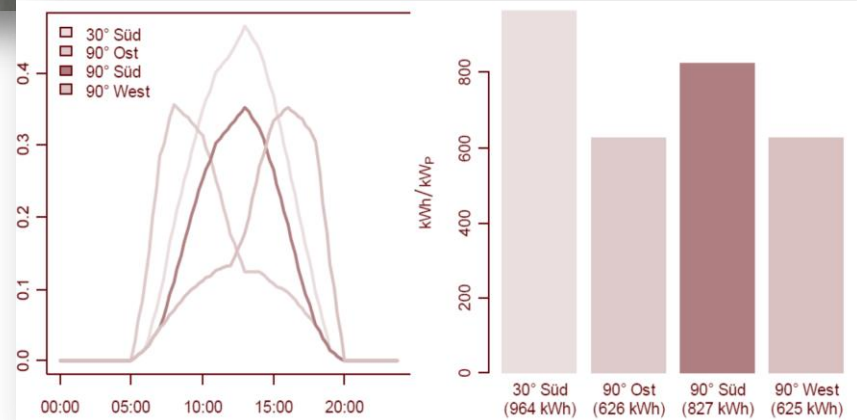
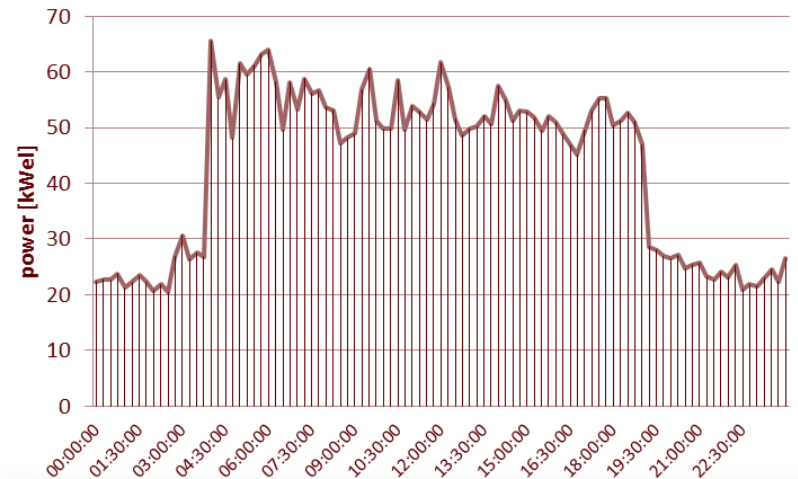
## Best practice

- Supermarkets PV Cooling



Source: ÖGNI / Austria

Source: REWE group Austria



# IEA SHC TASK 53

What is it about?



- What is the state-of-the-art market available products and upcoming R&D?  
Solar thermal and PV
- What system configuration do exist and fit for what application?  
NG technology, storage, control strategies, building type
- What are the benefits of NG Systems in comparison to conventional solution  
Economically, environmentally, maintenance ..



Quelle [www.oew.org](http://www.oew.org)

# IEA SHC TASK 53

## Scope of the Task SYSTEM

- Solar thermal driven innovative compact cooling and heating systems
- Photovoltaics + air conditioning system (Compression air conditioning / heat pump (if heating as well) ; food conservation included)

## APPLICATION

- Off grid & grid connected buildings (houses, small multi-family buildings, offices, shops, commercial center, hotels)

## POWER RANGE

- From 1 kW cooling to several tens kW cooling/heating power

## LIMIT

- Need to have a possible direct coupling between solar and cold production
- Partial or total

## DURATION

- 40 months
- From March 2014 to June 2017

# IEA SHC TASK 53

## Structure



**Subtask A: Components, Systems & Quality**  
Leader: Tim Selke (AIT, Austria, [tim.selke@ait.ac.at](mailto:tim.selke@ait.ac.at))

**Subtask B: Control, Simulation & Design**  
Leader : Roberto Fedrizzi (EURAC, Italy, [roberto.fedrizzi@eurac.edu](mailto:roberto.fedrizzi@eurac.edu))

**Subtask C: Testing and Demonstration Projects**  
Leader : Richard Thygesen (Mälardalen University, Sweden, [richard.thygesen@mdh.se](mailto:richard.thygesen@mdh.se))

**Subtask D: Dissemination and Market Deployment**  
Leader : Daniel Mugnier (TECSOL, France, [daniel.mugnier@tecsol.fr](mailto:daniel.mugnier@tecsol.fr))



# IEA SHC TASK 53

Area of work

Subtask A: Components, Systems & Quality

Leader: *Tim Selke (AIT, Austria, [tim.selke@ait.ac.at](mailto:tim.selke@ait.ac.at))*

- Focusing on the knowledge of the commercially available equipment on the AC side compatible with PV electricity supply as well as solar thermal cooling equipment
- Classify the ST/PV cooling products/application (schematic square view method) so as to prepare a certification process. It will estimate the value of electricity and LCA of the main components and systems

## Our Products

- Collection of market available NG SC products and system
- Simple classification of the identified NG SC systems
- Life cycle assessment/ inventory of selected NG SC systems

# IEA SHC TASK 53

Area of work

Subtask B: Control, Simulation & Design

Leader : *Roberto Fedrizzi (EURAC, Italy, roberto.fedrizzi@eurac.edu)*

- Investigating the different control strategies of new generation cooling & heating systems for buildings in order to select the best strategies for given climates and countries and developing modeling tools to predict performances and size/design systems and to manage smart interactions with the electric grid.

## Your Products

- Identified best NG system configuration (energy and costs performance with respect to application, control strategies and impact on the grid)
- Design advice for different NG system configuration (country- and climate-sensitive economical analysis)

# IEA SHC TASK 53

Area of work

Subtask C: Testing and Demonstration Projects

Leader: *Richard Thygesen*

*(Mälardalen University, Sweden, richard.thygesen@mdh.se)*

- Stimulating, monitoring and analyzing the performances of field test systems and demonstration projects for new generation solar cooling & heating systems.

## Our Products

- Monitoring procedure for field test & demo systems
- Documentation of performance data by field + laboratory tests
- Best practice examples
- Proposal for methods of quality standard

# IEA SHC TASK 53

## Area of work

### Subtask D: Dissemination and market deployment

Leader : *Daniel Mugnier (Tecsol, France, [daniel.mugnier@tecsol.fr](mailto:daniel.mugnier@tecsol.fr))*

- Implementation of targeted promotion activities
- Production of dissemination material for external communication; the implementation of knowledge

## Your Products

- Handbook
- Workshops (Industry, PVPS ..)
- Publication on SHC Task53 website

# IEA SHC TASK 53

What systems do we have?  
(no claim for completeness)



# IEA SHC TASK 53

What systems do we have?

NG systems market available

PV (Cooling/ Heating)

- COSSECO (CH)
- FREECOLD new PV split unit (F)
- Chinese System PV MIDEA

R&D Systems close to Market

PV (Cooling/ Heating)

- ATISYS / PV cooling (F)
- Helioherm

Solar thermal (Cooling/ Heating)

- YAZAKI (JP)
- PURIX A25 multi split chiller (DK)
- SolabCOOL (NL)

Solar thermal (Cooling/ Heating)

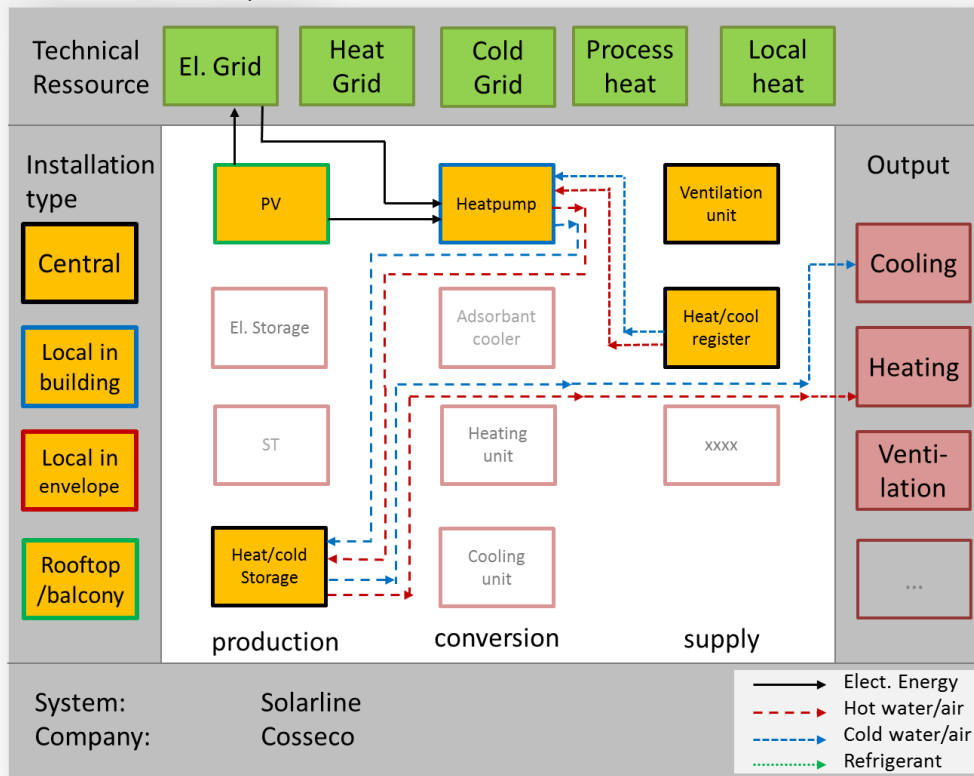
- FREESCOO (I)
- ClimateWELL (S)

# IEA SHC TASK 53

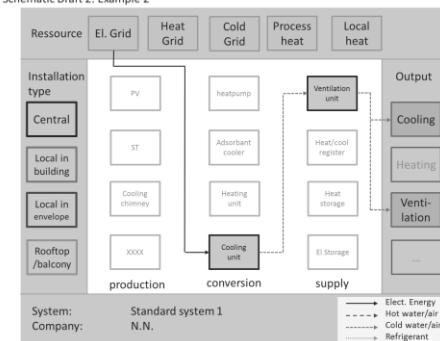
What do we have?

- System Integration

Schematic Draft 3: Example 2



Schematic Draft 2: Example 2



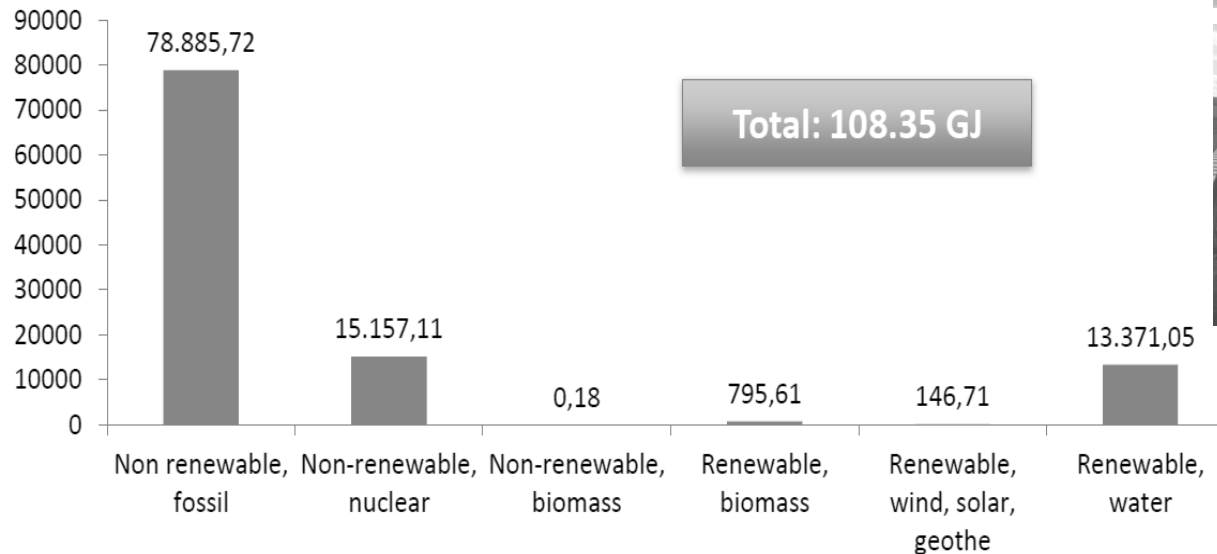
# IEA SHC TASK 53

What do we have?

- LCA and Techno-ECO Analysis
  - Already 2 Italian NG cooling systems R&D analyzed
  - Literature review on existing LCA

Air handling unit desiccant cooling (AHU-DEC): first results

Primary energy consumption (MJ) for the manufacturing step





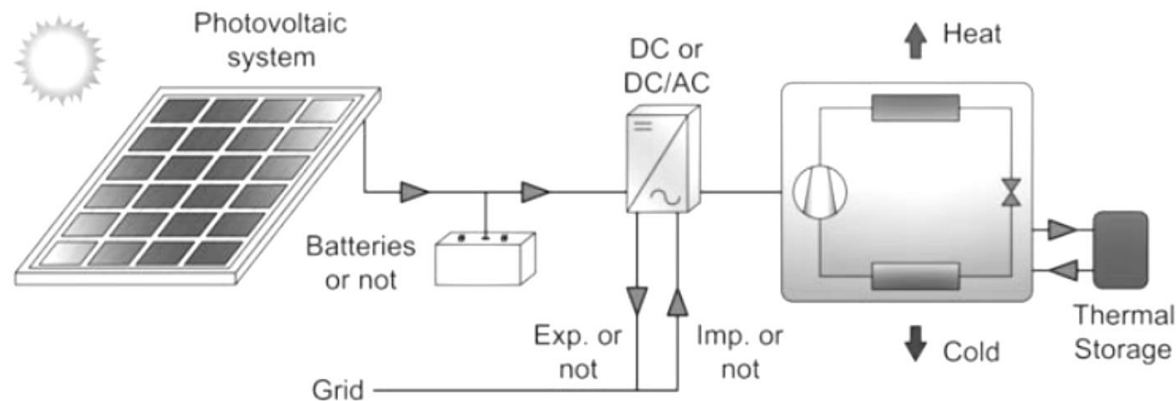
# IEA SHC TASK 53

What do we have?

## Monitoring Procedure for Field Test & Demo Systems

### Compression Heat Pumps Driven by Photovoltaic Solar Energy

- Generic schemes of PV driven heat pumps
- Electrical and thermal flows to be measured
- Definition of Performance Ratio Indicators (KPI)
- Measurement methods for air-to-air heat pumps
- Uncertainty analysis

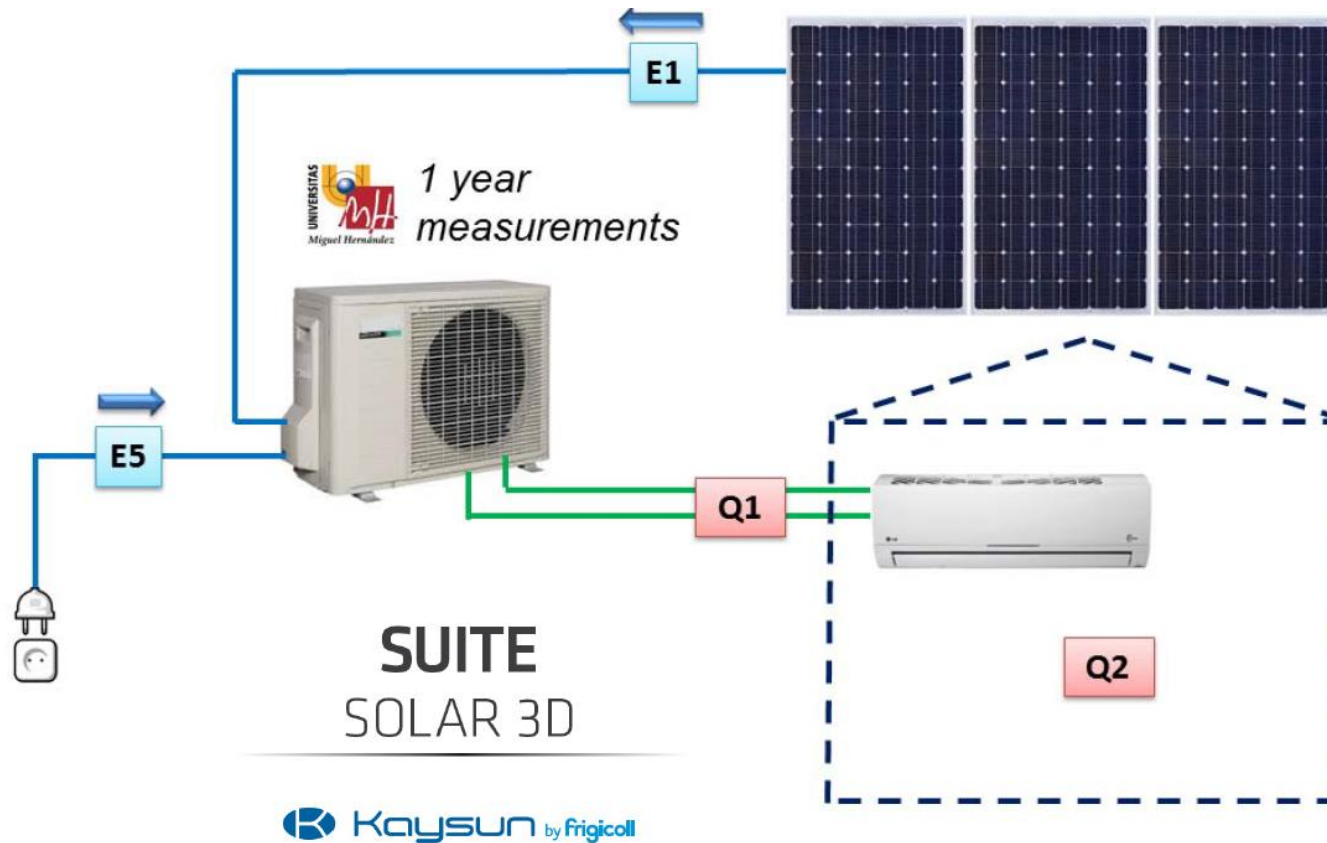


**Compression heat pump driven by PV panels (UMH)**

# IEA SHC TASK 53

What do we have?

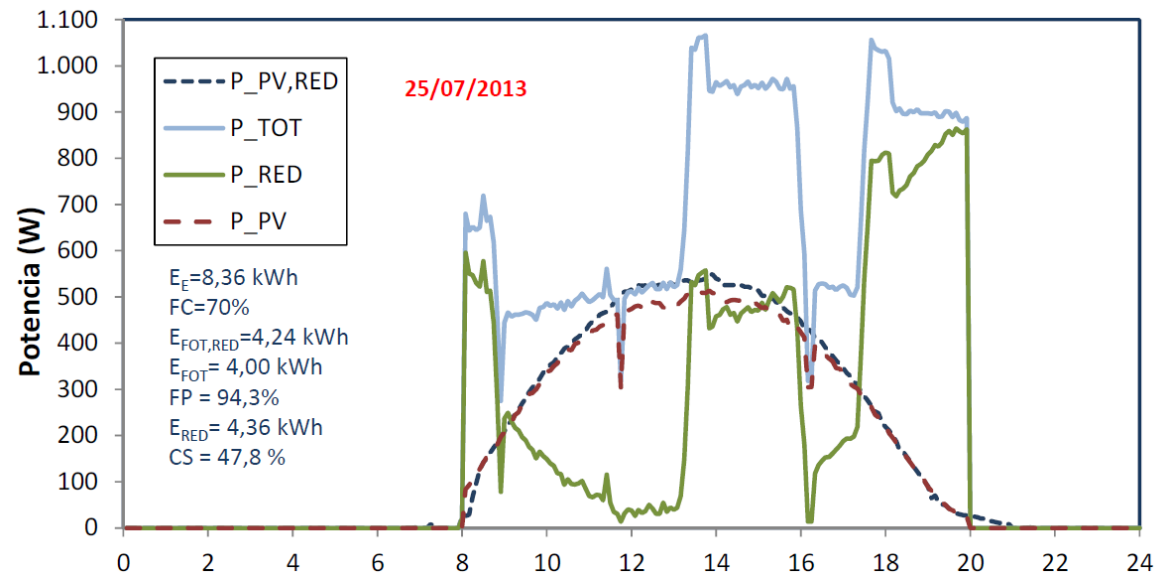
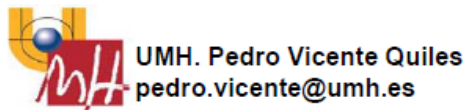
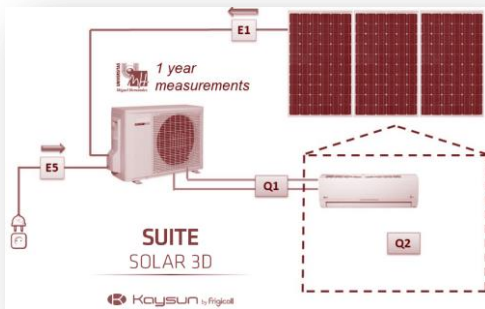
Monitored PV driven Air Conditioners



# IEA SHC TASK 53

What do we have?

## Monitored PV driven Air Conditioners



**PPV** → Electrical power from photovoltaic panels

**PGRID** → Electrical power from the electrical grid

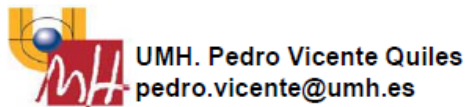
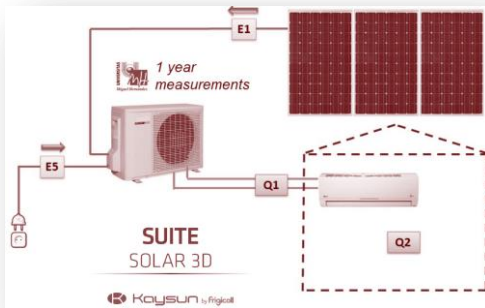
**PTOT** → Total Electrical power

**PPV,GRID** → Electrical power from pv panels connected to the electrical grid

# IEA SHC TASK 53

What do we have?

## Monitored PV driven Air Conditioners



**ELECTRICITY EXPORT: NO**  
**BATTERIES: NO**  
**THERMAL STORAGE: NO**  
**COMPRESOR: INVERTER**  
**IMPROVED CONTROL (SOLAR): NO**  
**NUMBER OF PV PANELS: 3**  
**COMPRESSOR POWER: 1 KW**

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 (°C)	T_int (°C)
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 (°C)	T_int (°C)
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

### 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

# IEA SHC TASK 53 - Workshop in Rom

What is the key outcome in 2018

- State of the art of new generation commercially available products
- Technical report on optimized control strategies for solar cooling & heating systems
- Design tool including a country- and climate-sensitive economic analysis
- Handbook on new generation solar cooling and heating systems
- International workshops



# AIT Austrian Institute of Technology

your ingenious partner

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