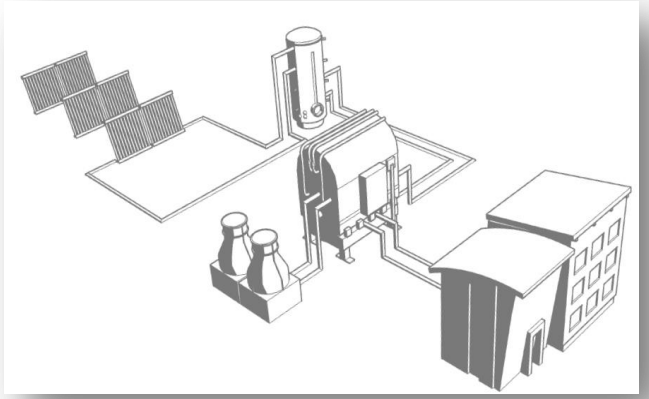
IEA SHC TASK 53

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

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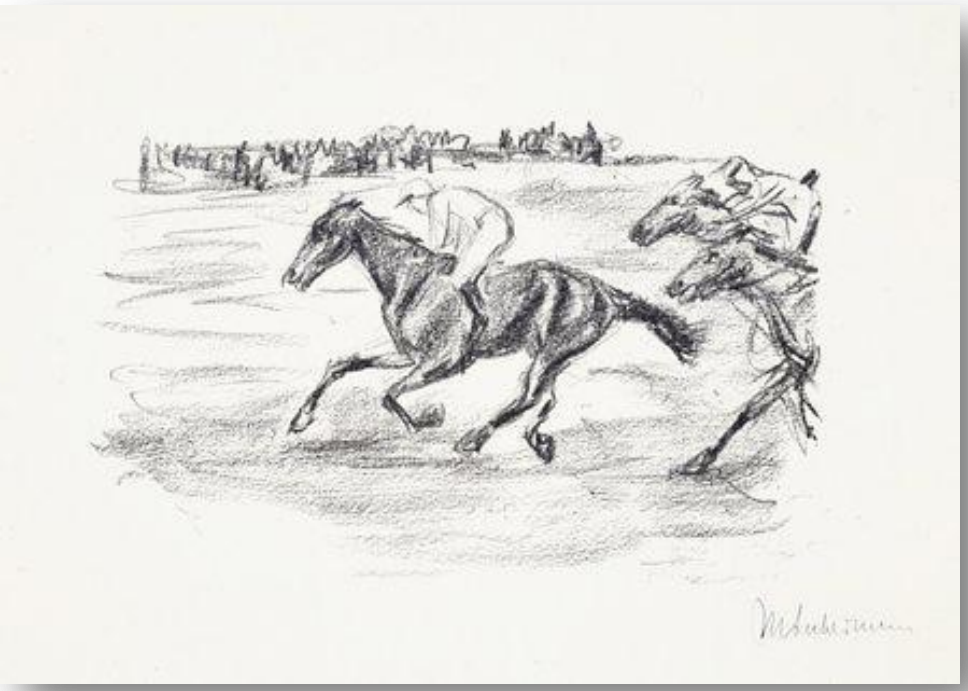
Framework and challenge



Max Liebermann
Berlin, 20. Juli 1847 - 1935, Berlin

- 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

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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

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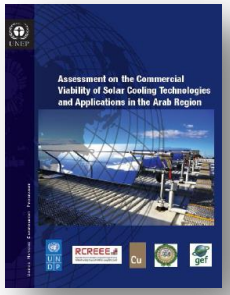
Lessons learnt

- 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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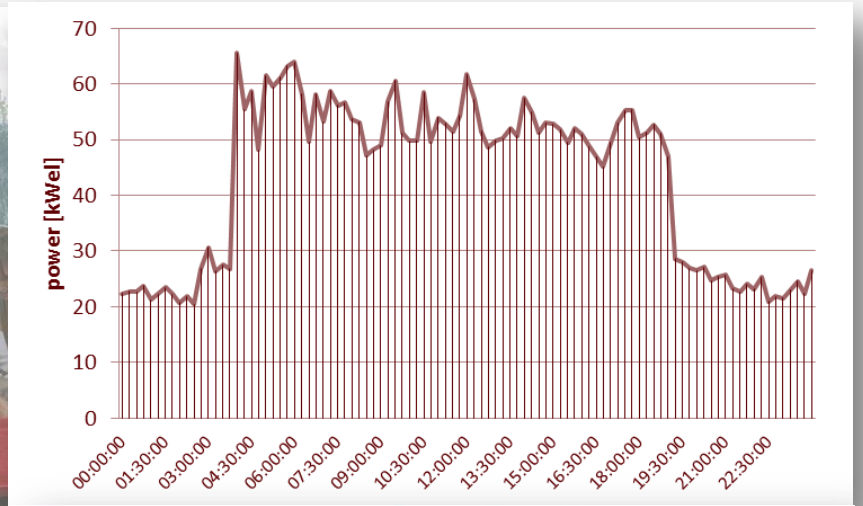
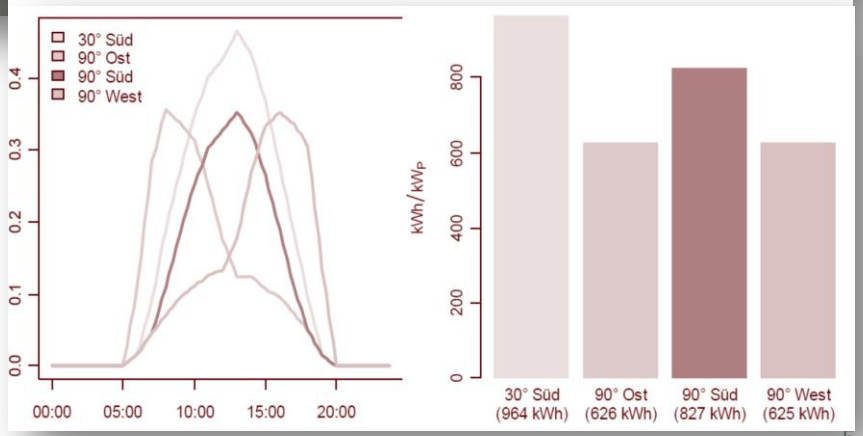
Best practice

- Supermarkets PV Cooling

Source: ÖGNI / Austria

Source: REWE group Austria





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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

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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)

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

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

Subtask D: Dissemination and Market Deployment
Leader : Daniel Mugnier (TECSOL, France, 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)*

- 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)*

- 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)

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What systems do we have?

NG systems market available

PV (Cooling/ Heating)

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

Solar thermal (Cooling/ Heating)

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

R&D Systems close to Market

PV (Cooling/ Heating)

- ATISYS / PV cooling (F)
- Helioherm

Solar thermal (Cooling/ Heating)

- FREESCOO (I)
- ClimateWELL (S)

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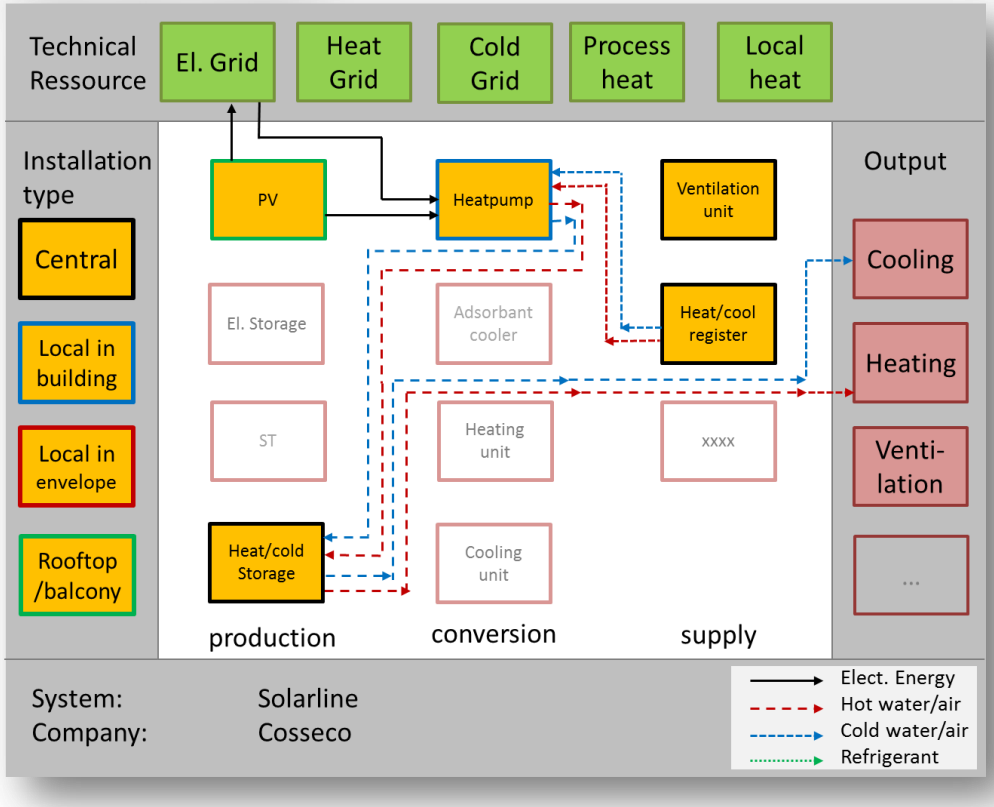
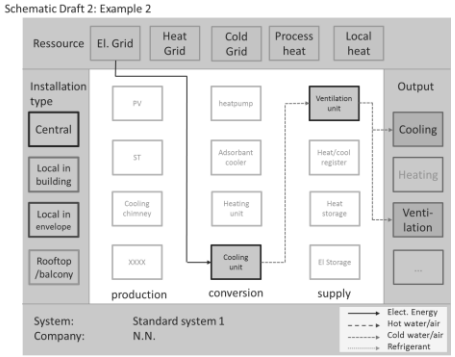
What do we have?

- System Integration

Schematic Draft 3: Example 2



Schematic Draft 2: Example 2



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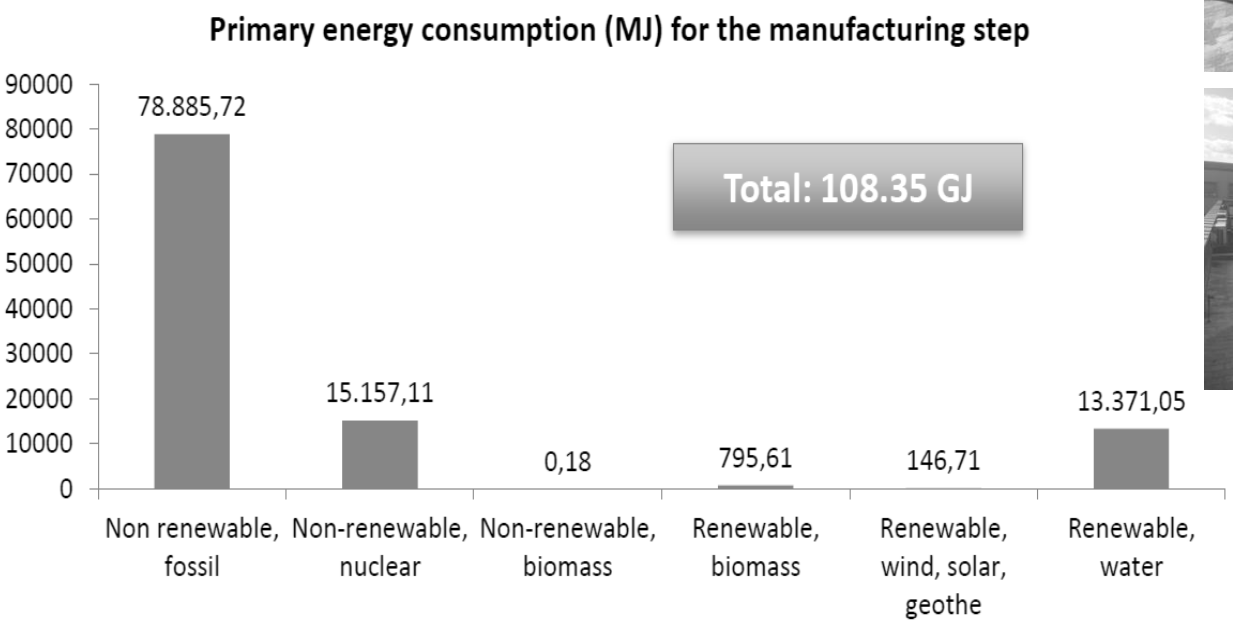
What do we have?

- 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



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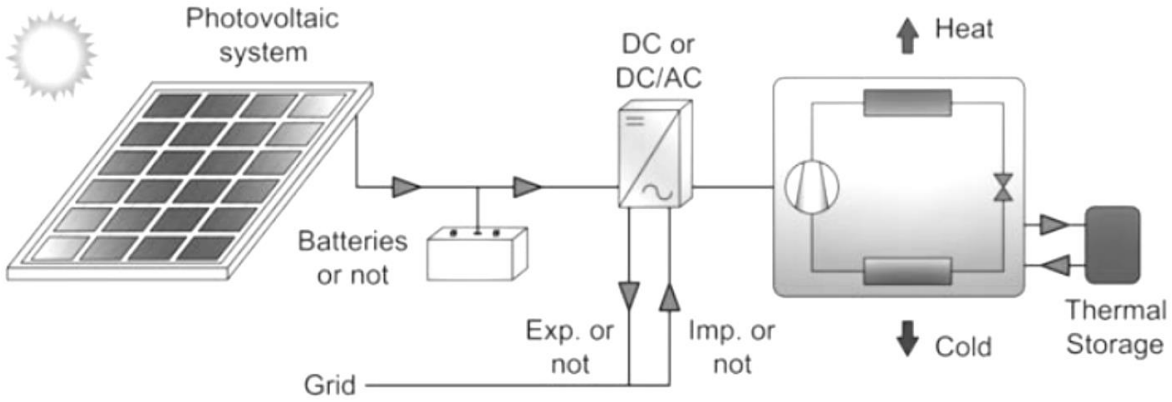
What do we have?

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)

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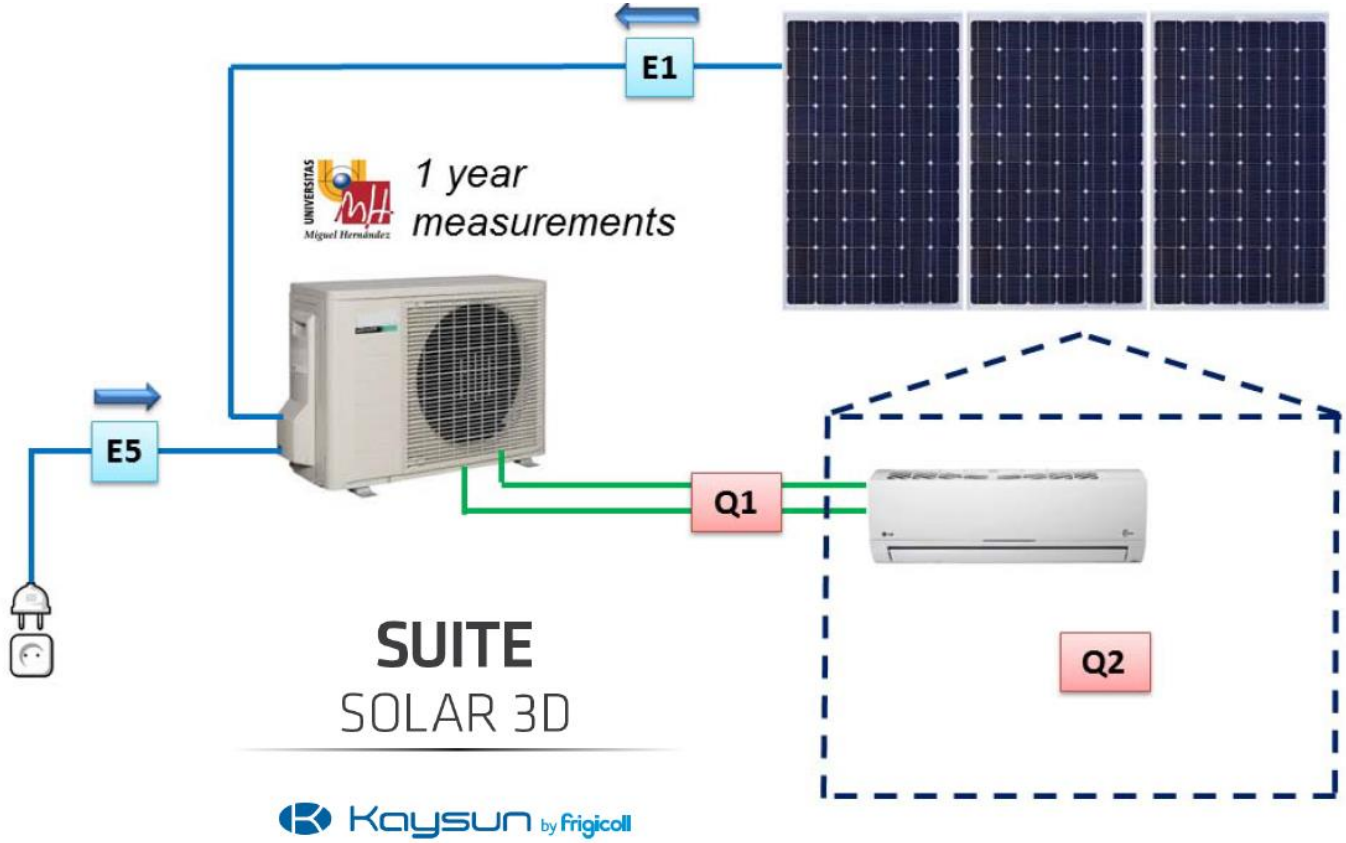
What do we have?

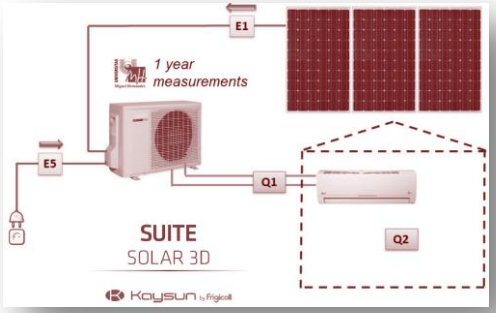
Monitored PV driven Air Conditioners



IEA SHC TASK 53

What do we have?

Monitored PV driven Air Conditioners



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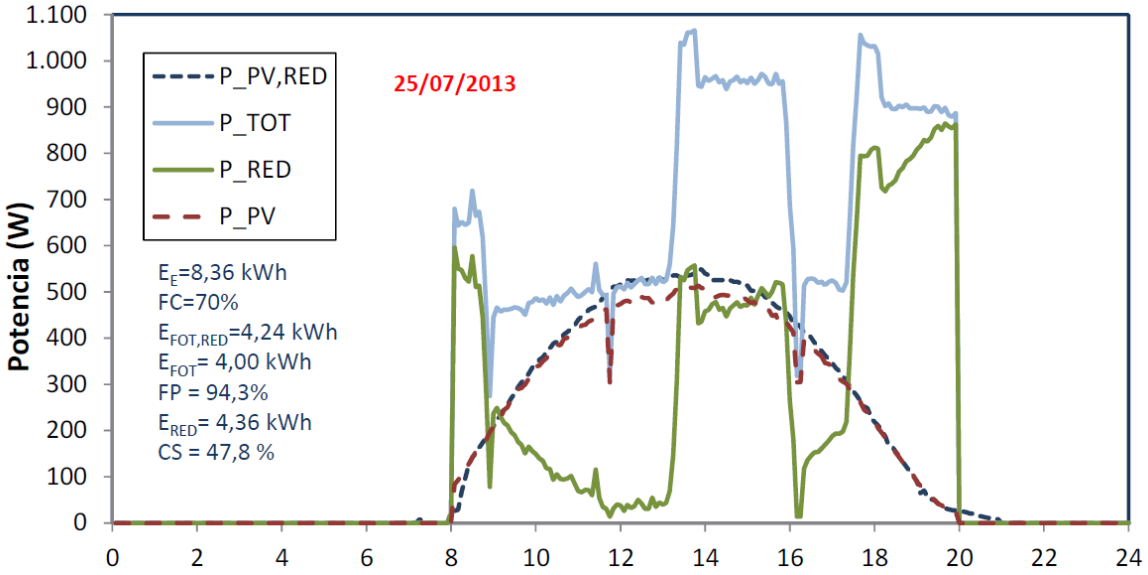

PPV → Electrical power from photovoltaic panels
PGRID → Electrical power from the electrical grid
PTOT → Total Electrical power
PPV,GRID → Electrical power from pv panels connected to the electrical grid

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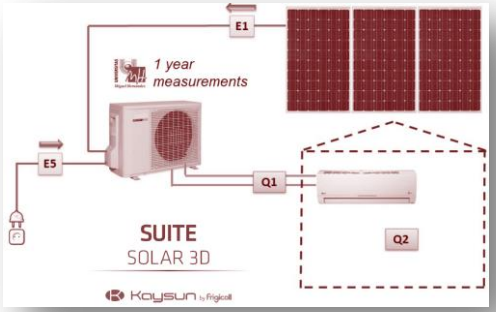
What do we have?

Monitored PV driven Air Conditioners



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

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

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

AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

AIT Austrian Institute of Technology

your ingenious partner

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