# EU PVSEC – Self-consumption business models – technical and economic challenges


# PV for Solar Cooling & Heating

TECSOL

Daniel MUGNIER – Amsterdam, 22/09/2014

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www.tecsol.fr

# **Context :** Status of **Solar cooling** in 2014

Solar thermal « traditionnal » cooling has **difficulty to emerge as a economically competitive solution**

Main reasons :

- **Technical** : Limit on adaptability due to hydraulics, complexity
- **Economical** : Investment cost, especially for small systems

⇒ Still need **intensive R&D** for quality improvment and best solution selection (ongoing IEA SHC Task 48)

However**, for large systems, solar thermal cooling has still interesting perspectives** (ex : UWC Singapore) because :

- Economy of scale
- Specialised engineering and control
- Energy sales

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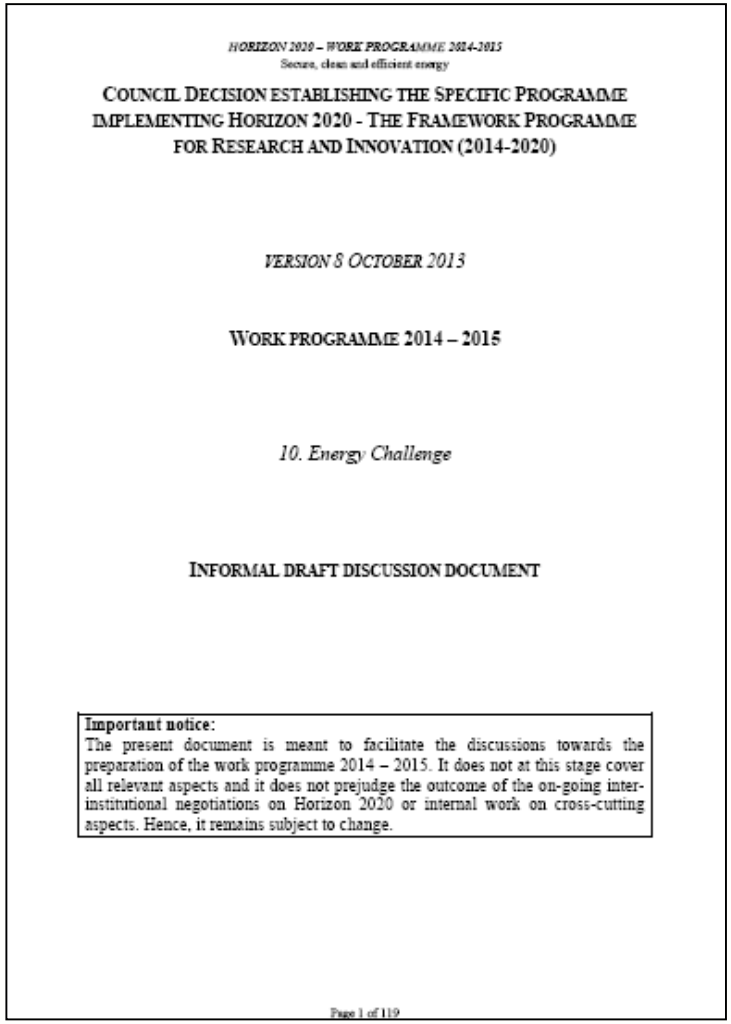
# In addition... a raising interest from EU

## on competitive Solar cooling

A specific topic on the ongoing call on Renewable Heating and Cooling....

... with deadline.. **Tomorrow !** (23/09/2014)



*HORIZON 2020 – WORK PROGRAMME 2014-2015*
Secure, clean and efficient energy

COUNCIL DECISION ESTABLISHING THE SPECIFIC PROGRAMME IMPLEMENTING HORIZON 2020 - THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION (2014-2020)

*VERSION 8 OCTOBER 2013*

WORK PROGRAMME 2014 – 2015

*10. Energy Challenge*

INFORMAL DRAFT DISCUSSION DOCUMENT

**Important notice:**
The present document is meant to facilitate the discussions towards the preparation of the work programme 2014 – 2015. It does not at this stage cover all relevant aspects and it does not prejudge the outcome of the on-going inter-institutional negotiations on Horizon 2020 or internal work on cross-cutting aspects. Hence, it remains subject to change.

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# How to find a solution for small / medium size ?

* A very **important priority** : solar for cooling,
especially for small to medium size

*Example : 10% of the entire Saudi Arabia oil production for national cooling*

* **New context on economics** for PV and trend towards selfconsumption

* A real **growing market**...

... but **strong need** of:

* standards
* thermal management optimum
* monitoring & best practice

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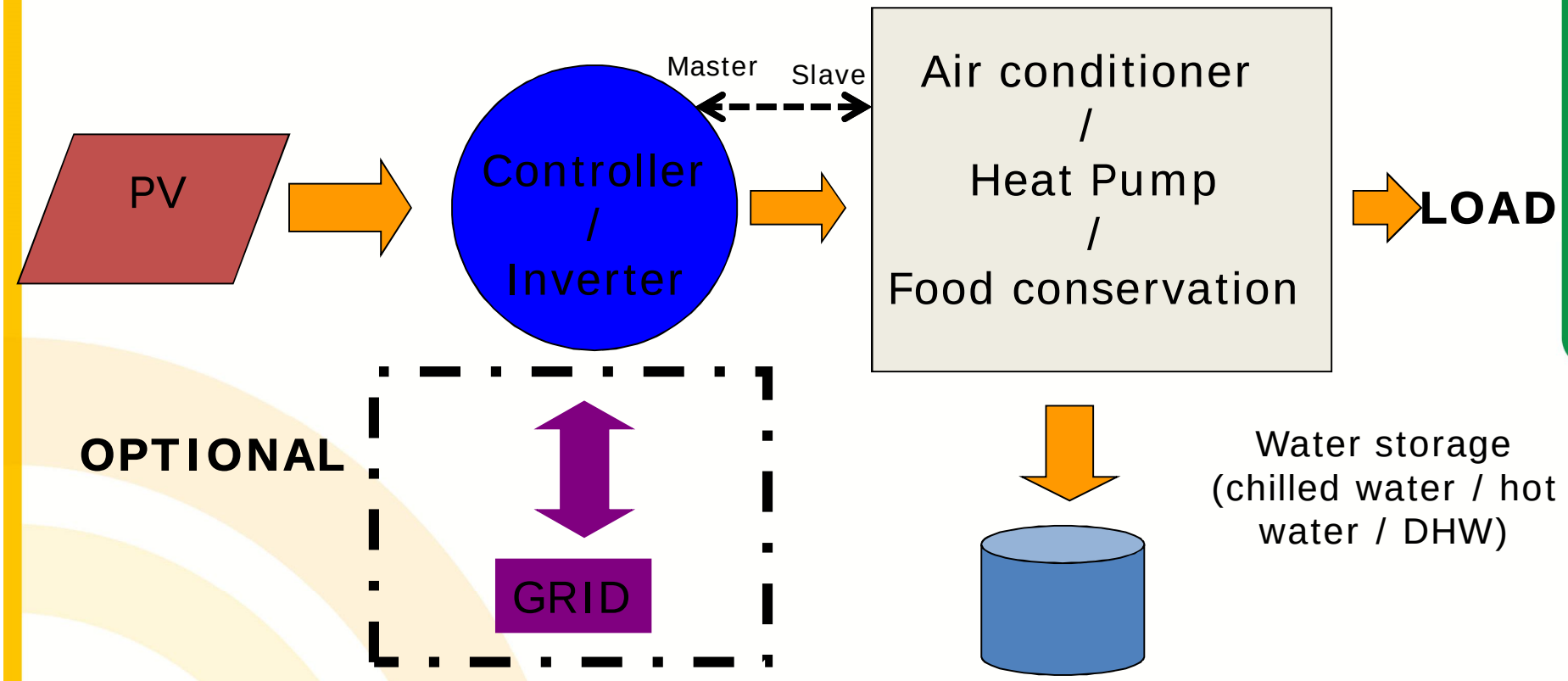
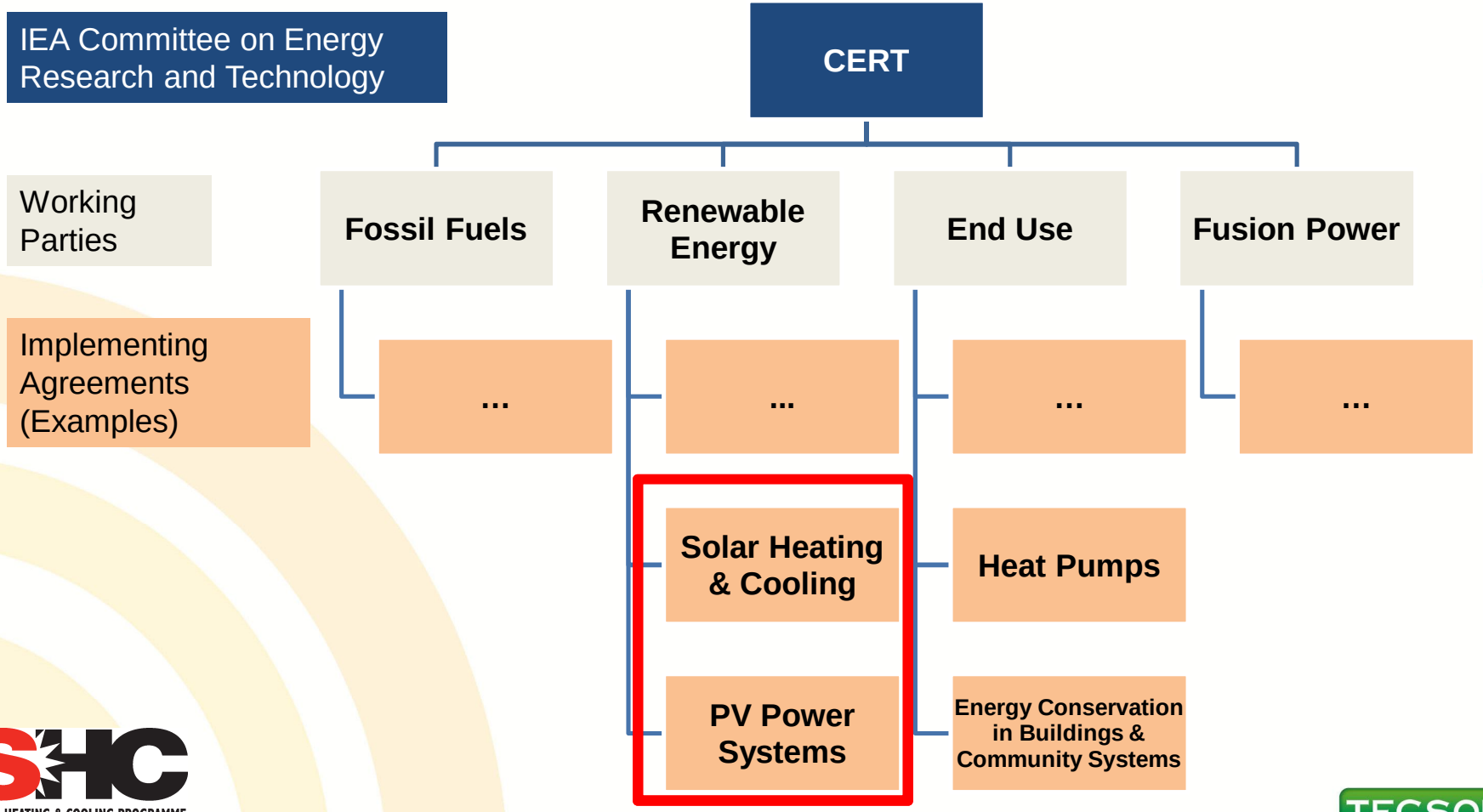
# Basic concept for the PV approach



# Why an IEA Solar and Heating and Cooling Task on PV cooling ?

IEA : International energy technology co-operation

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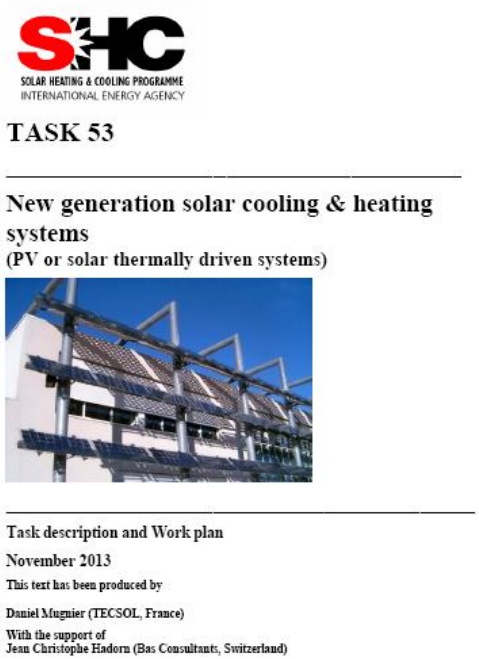
# IEA SHC Task 53 Goals

(1) **to analyze the interest of new generation solar cooling & heating concepts systems for bulidings in all climates and select best solutions** which lead to highly reliable, durable, efficient and robust solar cooling and heating (ambient + DHW) systems

(2) **to contribute to market entry of the technology** and identify most promising market areas in terms of cost competitiveness and value of electricity.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TASK 53

New generation solar cooling & heating systems
(PV or solar thermally driven systems)

Task description and Work plan

November 2013

This text has been produced by

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With the support of
Jean Christophe Hadorn (Bas Consultants, Switzerland)

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# Scope of the Task

System : solar driven systems for cooling and heating

* Solar thermal driven innovative compact cooling+heating systems

* **Photovoltaïc + air conditioning system** (Compression air conditioning / heat pump (if heating as well) ; **food conservation included**)

Applications : **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**

Limit : Need to have **a possible direct coupling between solar and cold production machine**

Partial or total coupling

# Outcome

- **Investigation on new small to medium size solar cooling systems** (thermal and PV) and develop best suited cooling & heating systems technology focusing on reliability, adaptability and quality
- **Proof of cost effectiveness** of new solar cooling & heating systems
- **Investigation on life cycle performances** on energy & environmental terms (LCA) of different options
- **Assistance for market deployment** of new solar cooling & heating systems for buildings worldwide
- **Increase of energy supply safety and influence the virtuous demand side management behaviors**

**Time Schedule**

- **40 months**
- **From March 2014 to June 2017**

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# Task 53 Structure

Subtask A

**Components, Systems & Quality**

Subtask B

**Control, Simulation & Design**

Subtask C

**Testing and demonstration projects**

Subtask D

**Dissemination & market deployment**



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# Activities brief description (1/2)

**Subtask A**: Components, Systems & Quality

A1: Reference systems

A2: New system configurations for cooling and heating

A3: **Storage concepts** and management

A4: Systems integration into buildings, microgrid and central Grid

A5: **LCA** & **techno-eco comparison** between reference & new systems

**Subtask B**: Control, Simulation & Design

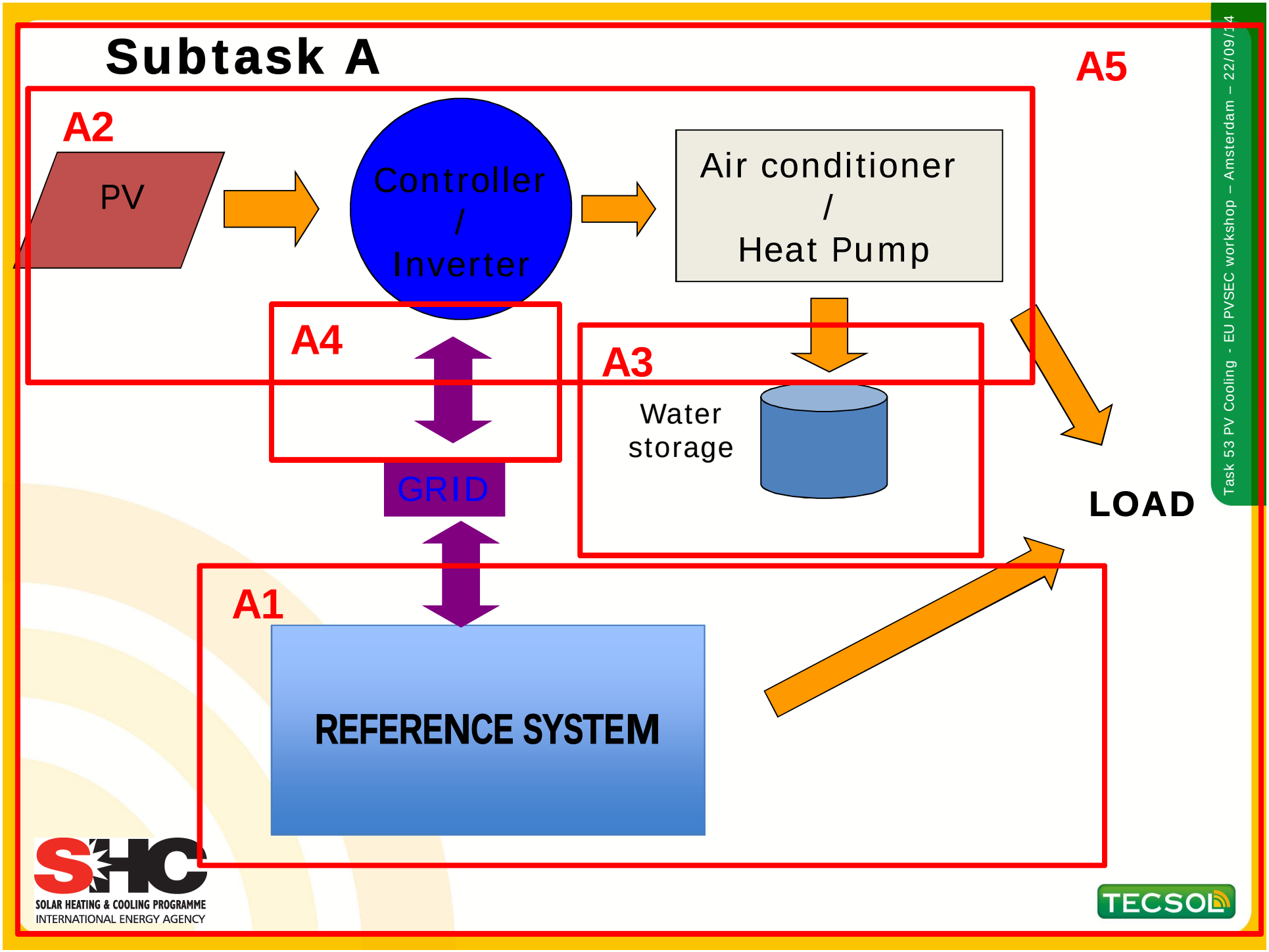
B1: Reference conditions

B2: **Grid access conditions** and building load management analysis

B3: Models of subcomponents and system simulation

B4: **Control strategy analysis** and optimization for ST and PV

B5: System inter-comparison


Subtask A
A5
A2
PV
Controller
/
Inverter
Air conditioner
/
Heat Pump
A4
A3
Water
storage
GRID
LOAD
A1
REFERENCE SYSTEM
Task 53 PV Cooling - EU PVSEC workshop – Amsterdam – 22/09/14
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# Participating countries

## .. at least 8 countries

France

Austria

Spain

Italy

Sweden

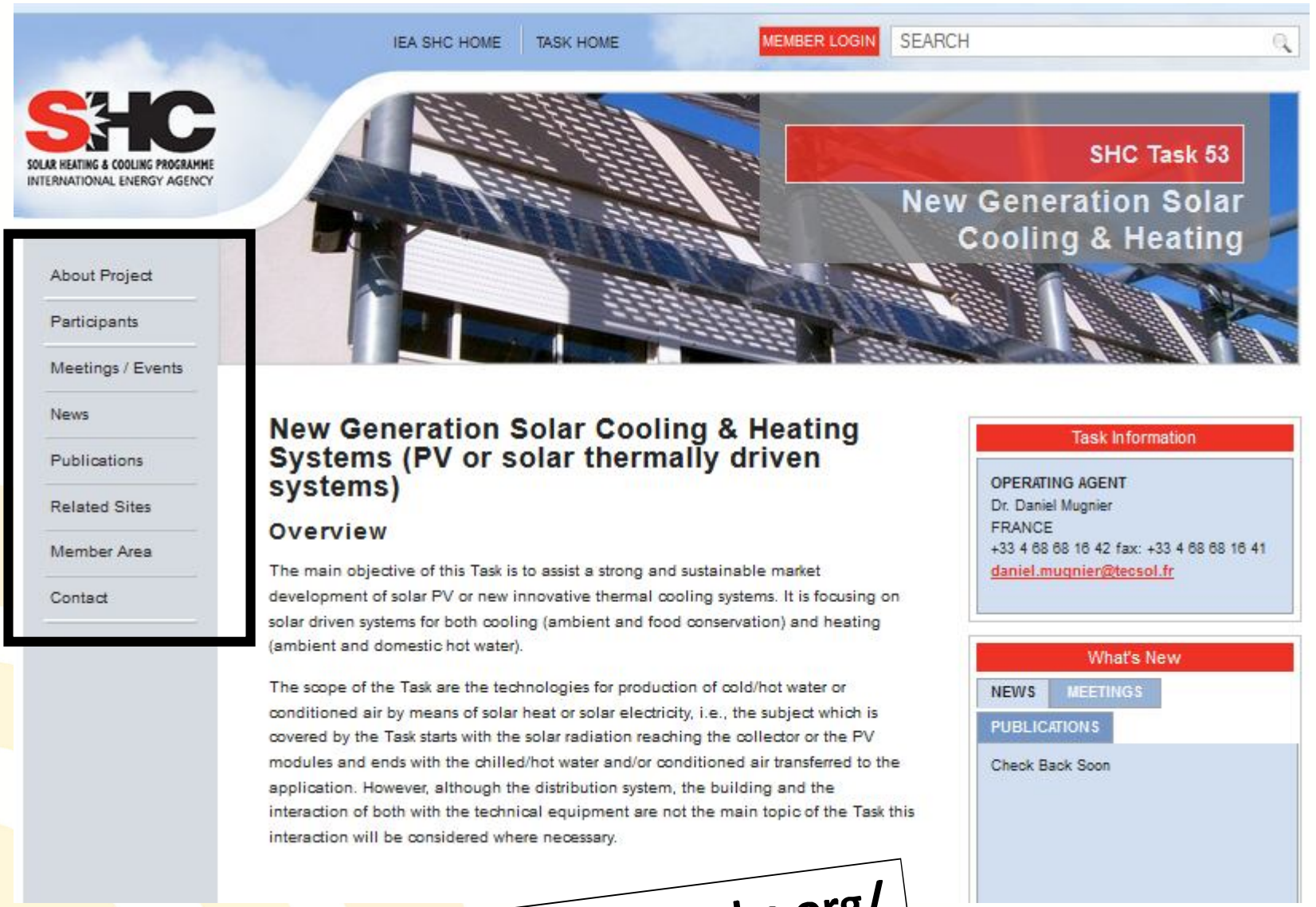
Australia

Switzerland

China

Probable newcomers :
Turkey, Germany

# IEA SHC Task 53 Website

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**http://task53.iea-shc.org/**

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# IEA SHC Task 53

Next experts meetings and workshops…

* Mälardalen University, Sweden : 7-8/10/2014

MÄLARDALEN UNIVERSITY SWEDEN

* Shanghai Jiao Tong University, China : March 2015

…for the **Solar Cooling Week !**

上海交通大學 SHANGHAI JIAO TONG UNIVERSITY

(workshop & expert meeting on solar thermal and solar PV cooling with Chinese and worldwide expert)

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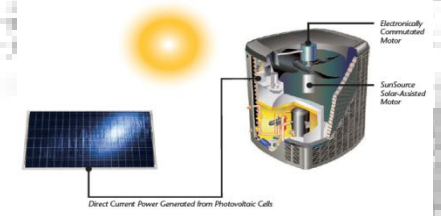
# State of the art of this new **Market**

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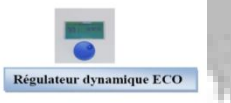



CLIMATISATION SPLIT SOLAIRE DIRECTE

COSSECO

VIESSMANN
climate of innovation



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(no claim for completeness)

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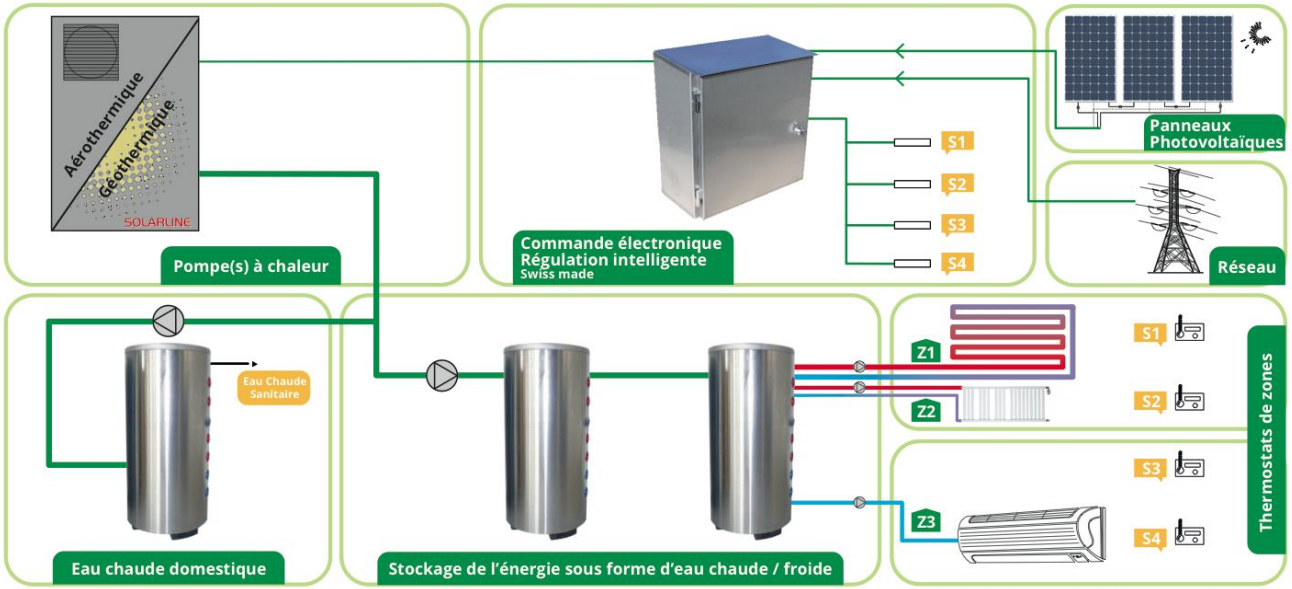
# Typical **ALREADY** EU market available solution

## Efficient Geothermal Heat Pump : COP of 5,3
## Field test since 2011 in Switzerland





PV booster => **overall yearly COP of 6,9**

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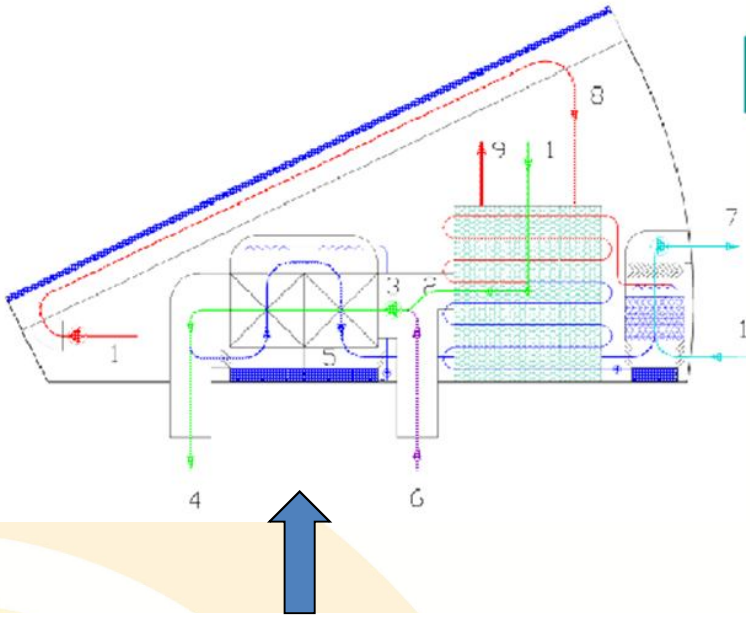
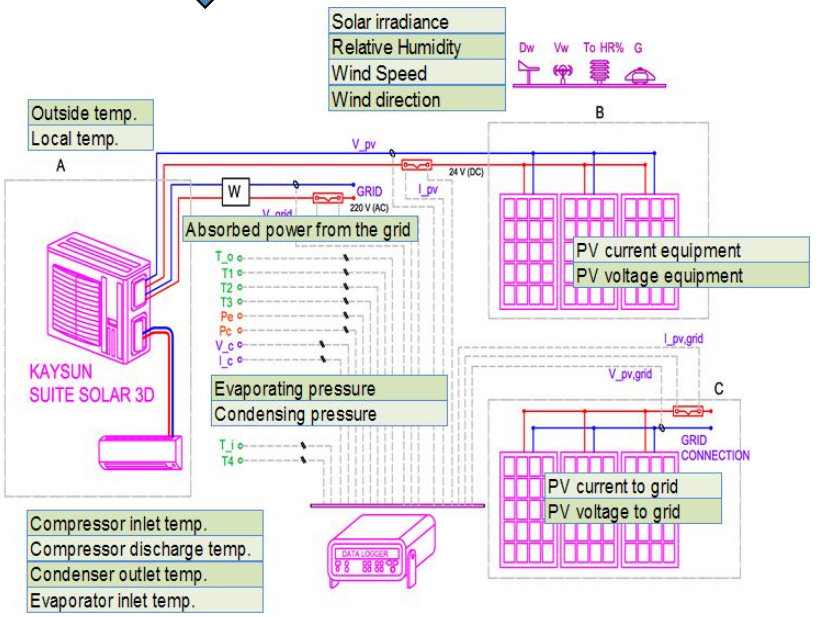
# State of the art of the future new **Market**

## Active R&D participants in Task 53




Concept for compact solar thermal air conditioner based on fixed & cooled adsorption beds (Source: Solarinvent)

**Testing principle for a Chinese PV split unit (Source: Universidad Miguel Hernández de Elche)**

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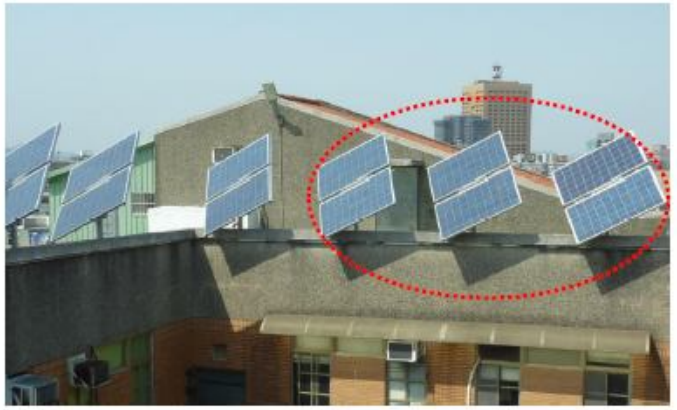
# State of the art of the future new **Market**

# Ongoing R&D in Taïwan

## Design of a stand-alone solar PV air conditioner

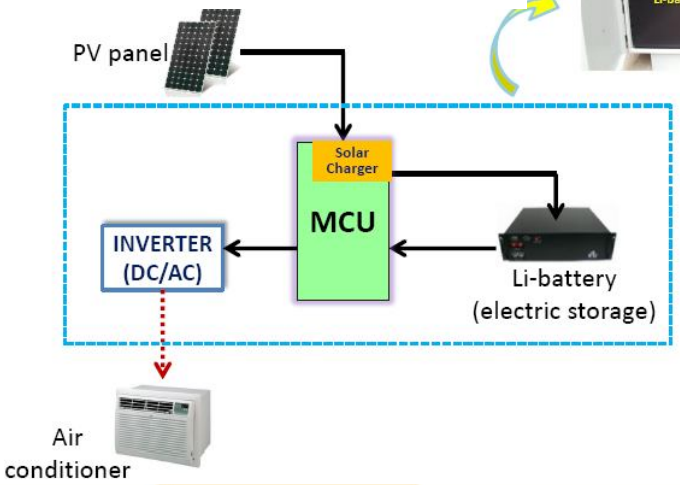
- Solar PV panel installed: 1.38 kWp
- Li-battery capacity: 720 Wh (DOD 80%)
- Power consumption of air conditioner: 200~800W (average 500W)
- Cooling capacity of air conditioner: 2.2 kW

*Source: EUROSUN conference, Prof Huang, National Taiwan University, Taipei, Taiwan*

# State of the art of the future new **Market**

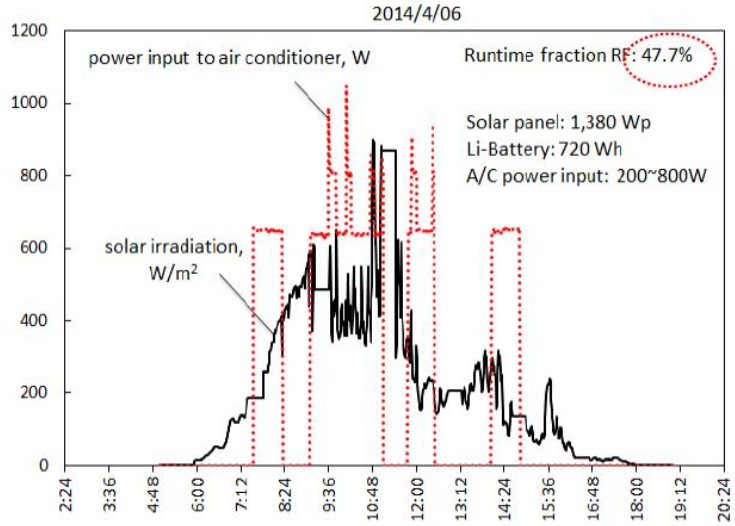
## Ongoing R&D in Taïwan


**Operation probability (*OPB*)**

- 100% at solar irradiation >550W/m2 (full solar cooling)
- around 80% at solar irradiation 400W/m2 (partly solar cooling) at cloudy condition

Battery use to run a AC on/off air conditioner




*Source: EUROSUN conference, Prof Huang, National Taiwan University, Taipei, Taiwan*

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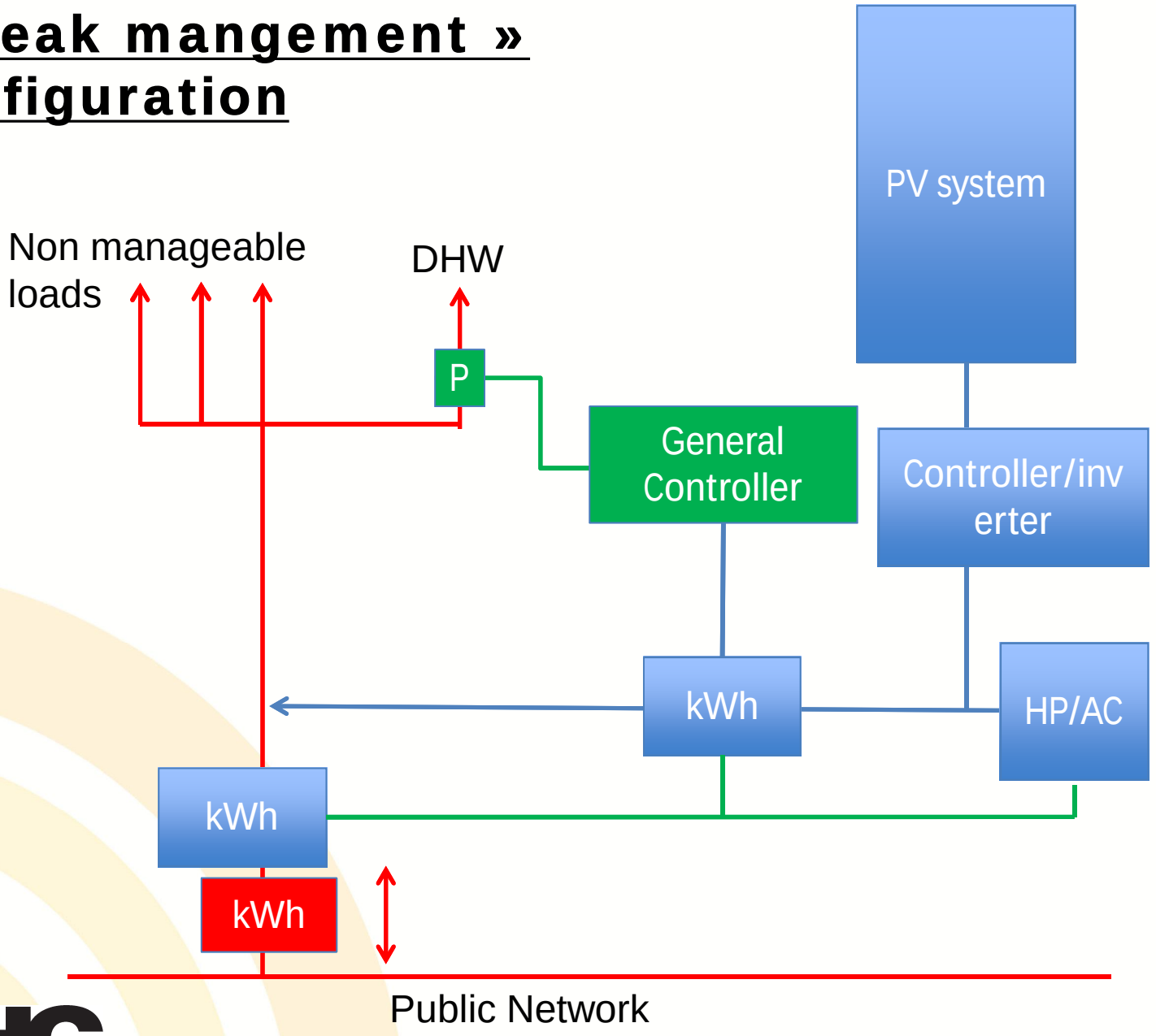
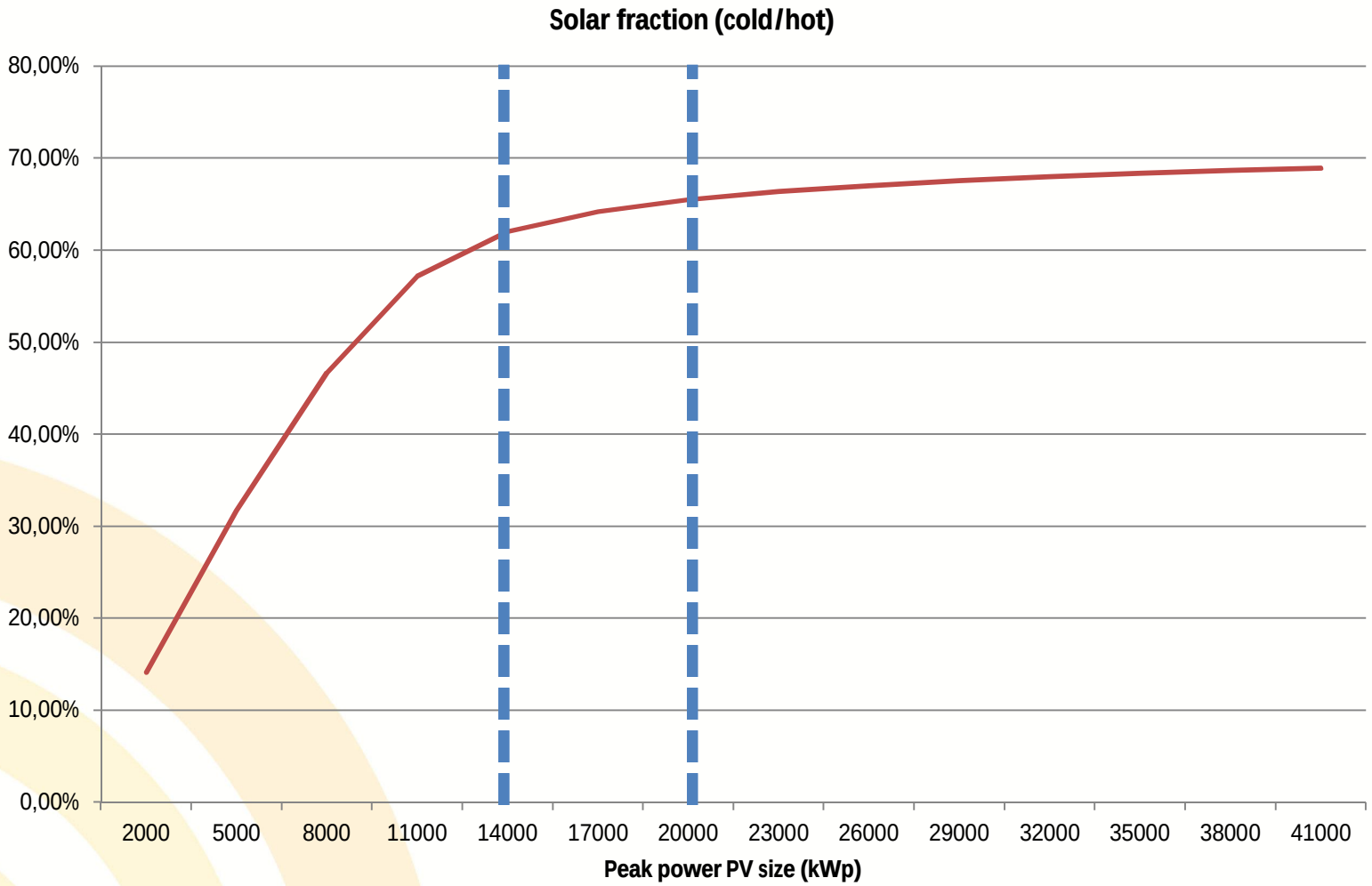
# Case study on the interest PV cooling

- Solar heating/cooling/DHW in Madrid
- Residential building (multifamily)
- Thermal cooling load : 25 $kW_{peak}$

# « Peak mangement » configuration



# System sizing



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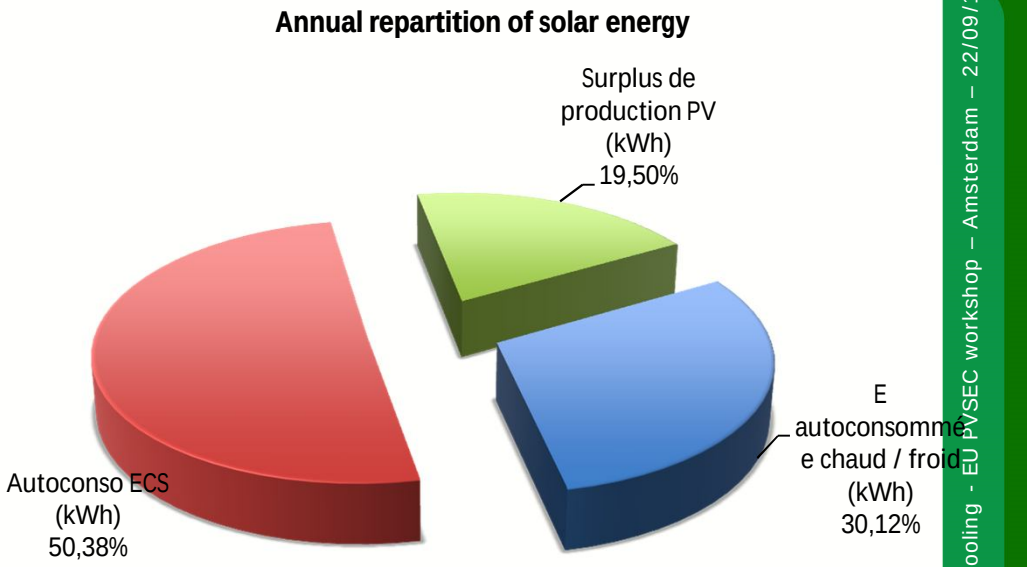
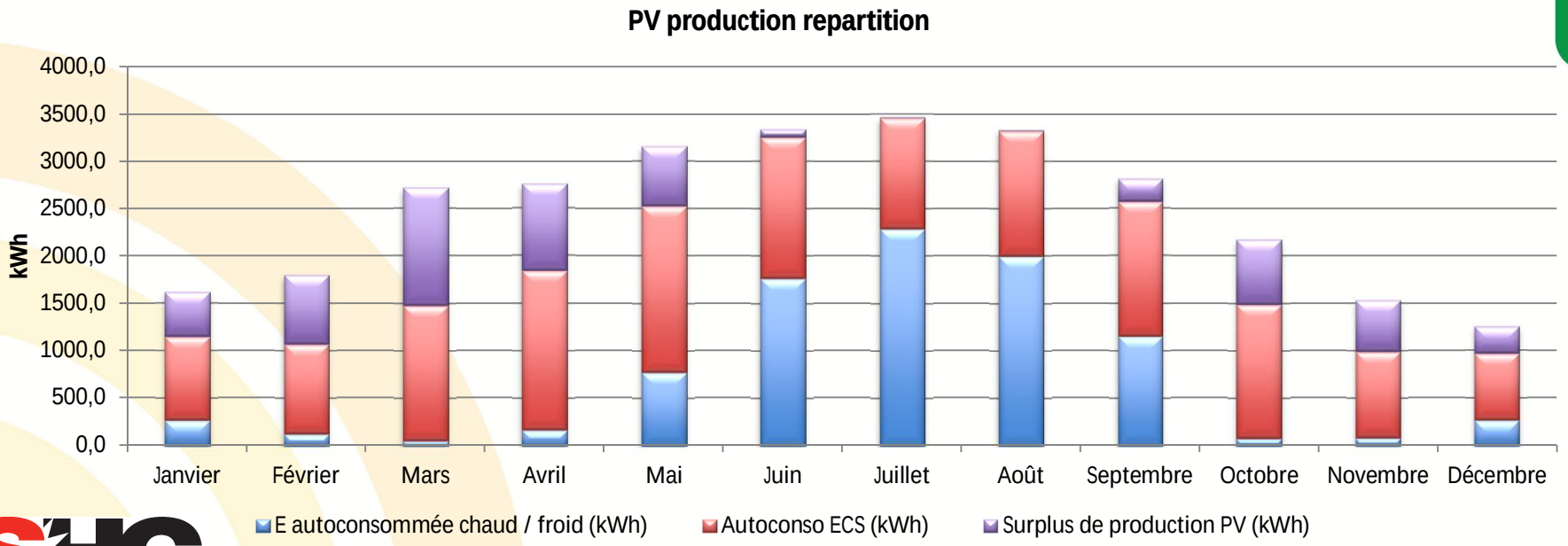
| | |
|---|---|
| Install | 20kWp |
| COP | 7,25 |
| besoins électriques annuel | 13 765kWh |
| besoins thermiques annuel | 34 414kWh |
| Energie réseau pou chaud/froid | 4 749kWh |

ratio de 2,5

# Summer SEER (june-september) : 10,24

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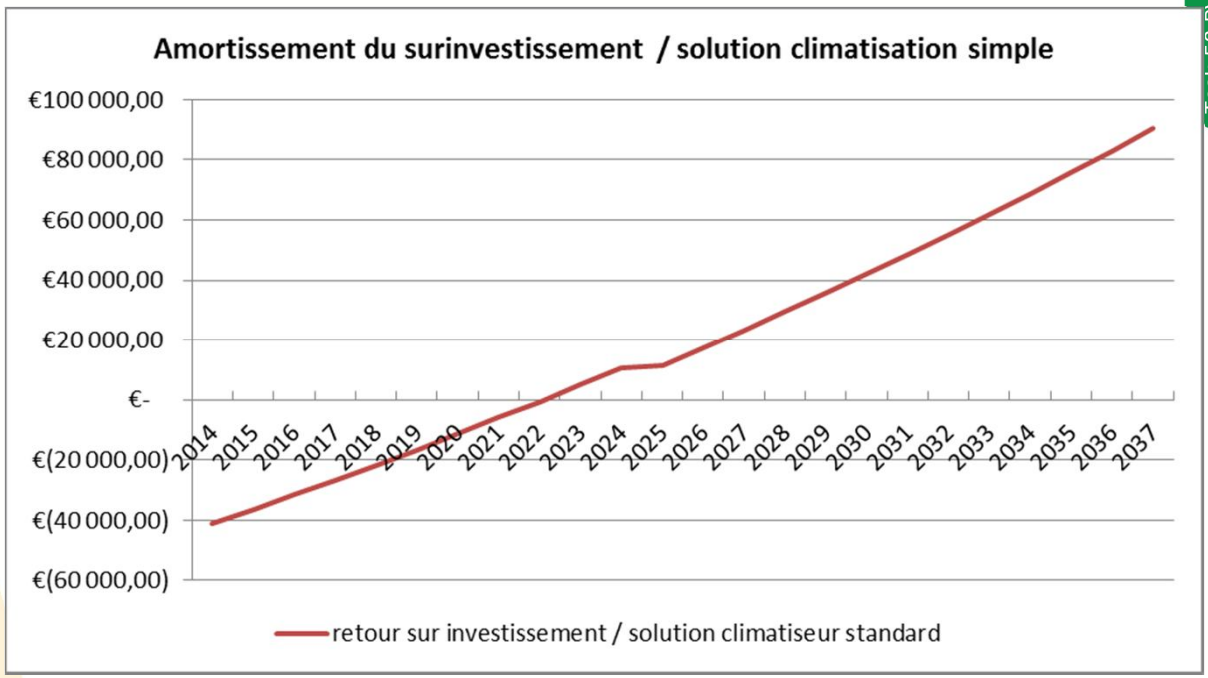
# Economical results

| Part | Price €HT |
|---|---|
| PV+structure - 20 kWp | 24 000,00 € |
| Controller/inverters | 10 000,00 € |
| DHW storage tank 400 liters | 1 800,00€ |
| HP (modules intérieur et extérieur) - Power 20 kWc | 1 5 000,00 € |
| Installation + wiring | 10 000,00 € |
| Total | **60 800,00 €** |




## Payback < 10 years

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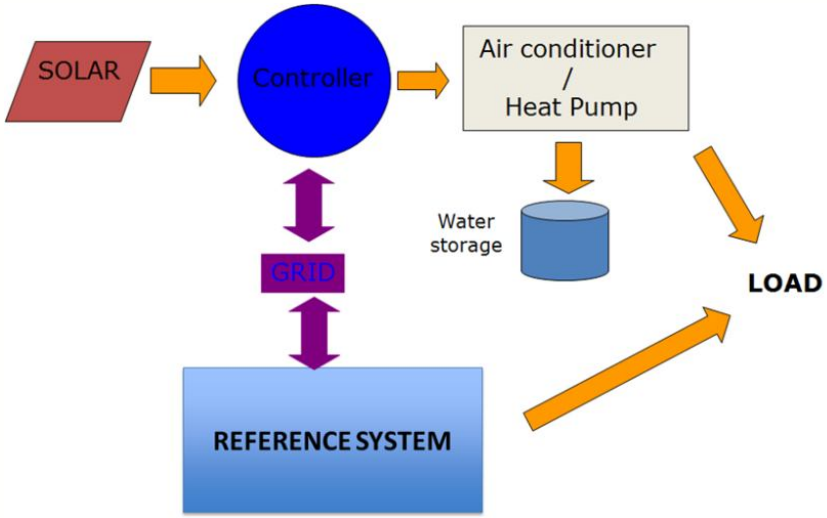


Task 53

# Thanks for your attention !

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