CIBELES PROJECT: HOW TO REACH A HIGH SOLAR FRACTION IN AN INDEPENDENT BUILDING

Presentation of the Cibeles project

www.aiguasol.coop

AIGUASOL

BACKGROUND

THE HIGH-COMBI PROJECT

DESIGN PHASE

THE CIBELES PROJECT IN BARCELONA

CONCLUSIONS

AIGUASOL in few words

→ Independent engineering and consultancy company

→ Team of 20 highly qualified professionals*(PHDs, Physicists, Engineers and Architects)* dedicated to consultancy tasks, R&D and energy engineering

→ Organised under the legal framework of a cooperative, with a participative and horizontal work structure

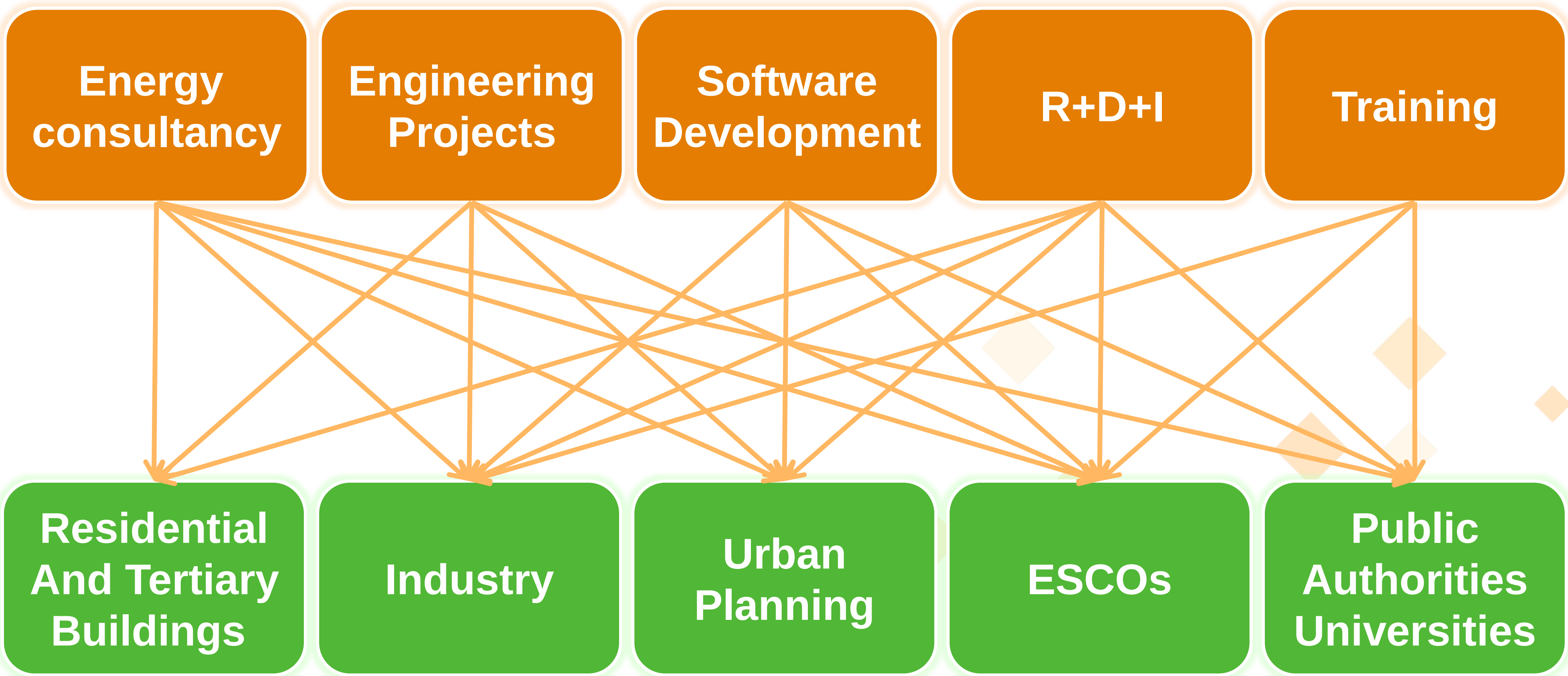
→ Founded in 1999 by two PhDs of the Universitat Politècnica de Catalunya, with a wide experience in R&D (tasks 25,33,44,45 of the International Energy Agency, more than 15 EC projects)

→ A step before the market in energy engineering (or at least trying!)

Mainly focused in:

- Energy optimisation of buildings and urban areas
- Renewable energies for buildings and industry
- Advanced simulation and calculation tools

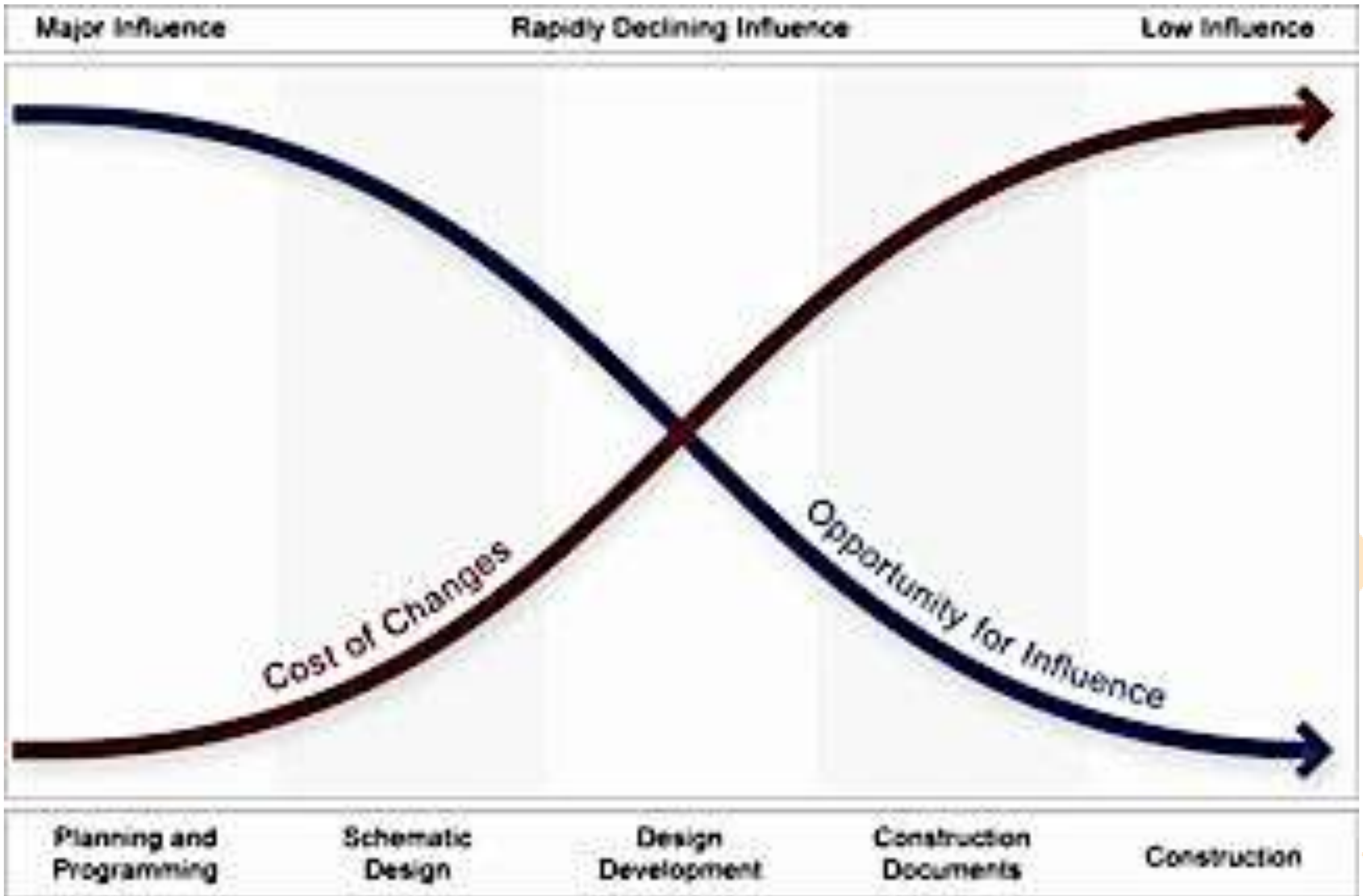
Services and markets



background

- The reduction of energy consumption in residential and diffuse sectors has become one of the key objectives of all countries when trying to avoid climate change (building and operation).
  - New energy Performance Building Directive EPBD 2010
  - Published in OJEU 18th June 2010
  - Looking to minimize **buildings life cycle cost**. Cost efficiency.
  - All new EU buildings must be near zero energy by December 2020 (public buildings December 2018). More renewables and centralization
- Current efforts from the national governments have to go this way. COST AND EFFICIENCY

Cost efficiency vs. ZEB or NZEB building design

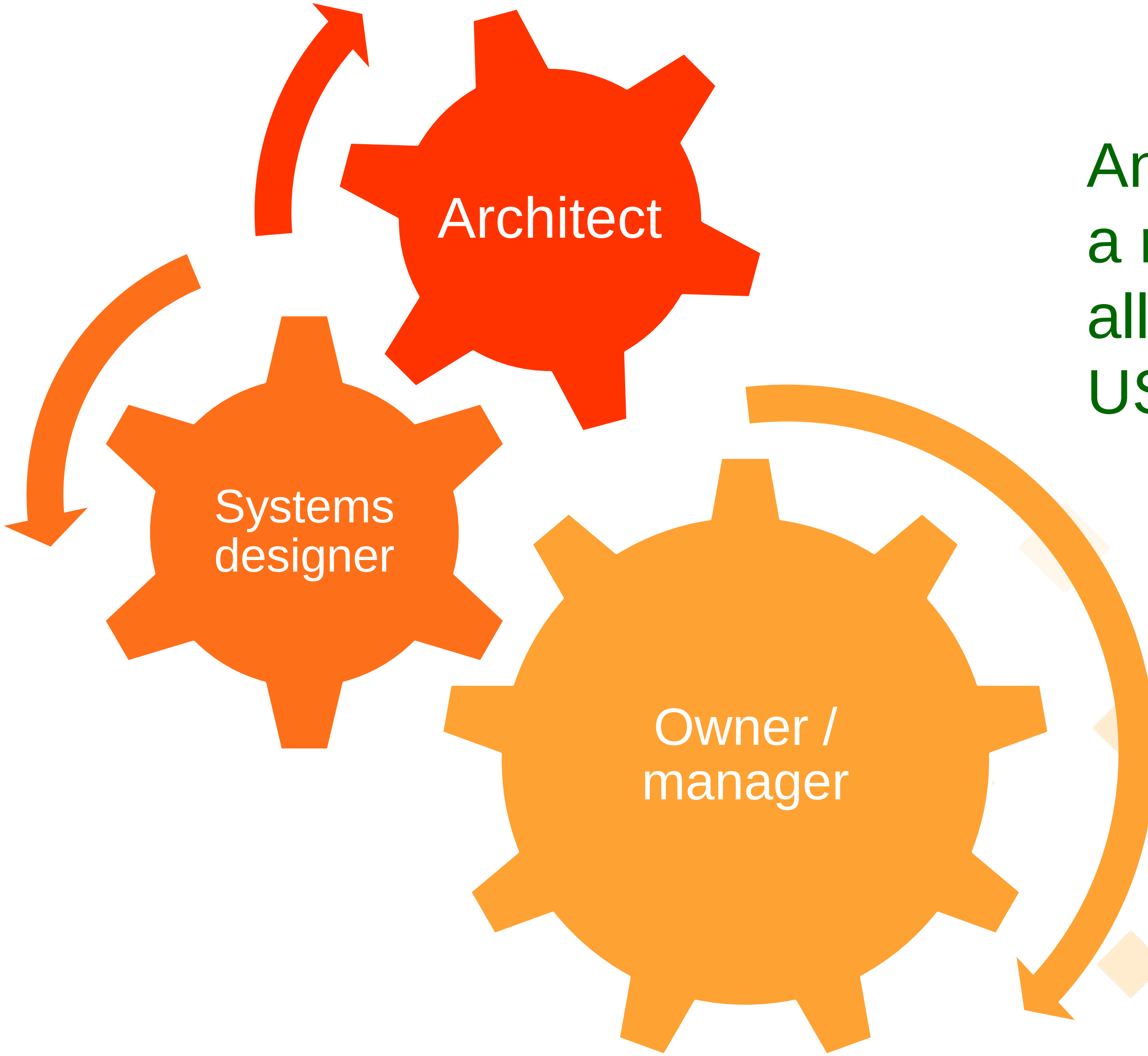


Early stages involvement
and throughout the process

background

- Important to focus on LOGIC and good simulation tools .Dynamic simulation is the best option:
  - Cost
  - speed
  - Results accuracy
- Important to help clean technologies break the market barriers and develop strongly, so as to be able to help fulfil new EPBD goals!
- Important to focus on on-site technologies!!

background



And, of course, and in a relevant position in all actions, the USER!!!

Three main actors in the process to make a NZEB building

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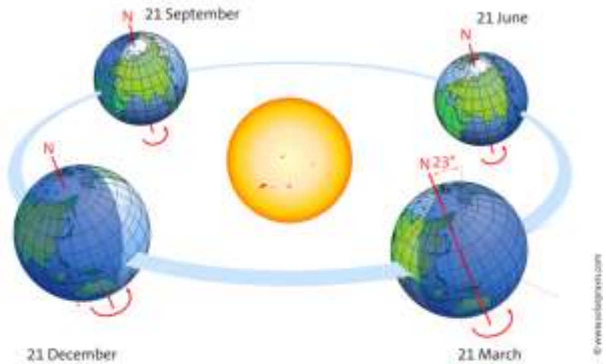
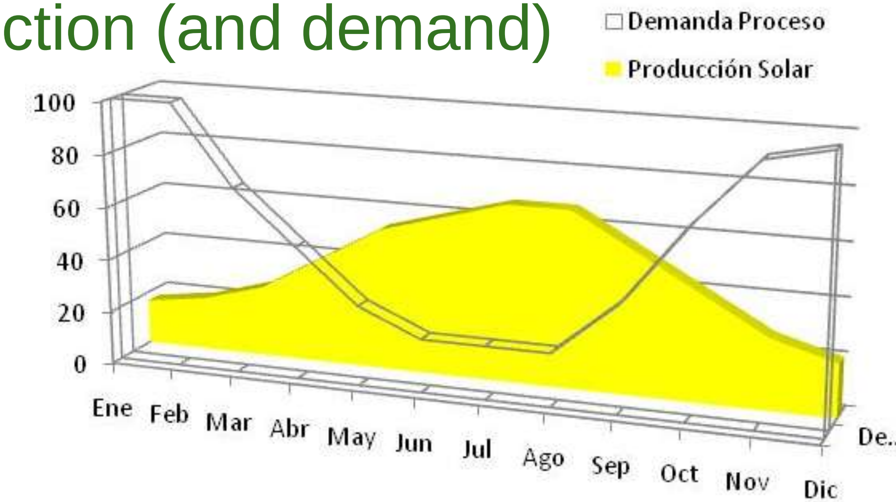
High-combi project

- The Cibeles project is born from the coincidence between these three actors, and an EC FP7 project that was ongoing, and where one of the partners (Habitatge Terrassa) had to quit the project
- The Patronat offered the Cibeles building
- The Cibeles building is not strictly a NZEB, but it is a very LEB, which has tried to reduce the demands and the consumption at a very low levels…with the goal to overcome the difficulties of one renewable energy technology to become an essential actor in a building
- SO… WHICH WAS THE IDEA BEHIND HIGH-COMBI?

Solar thermal technology

- Main limitations to high-solar (thermal) fractions:
  - Seasonality of production (and demand)

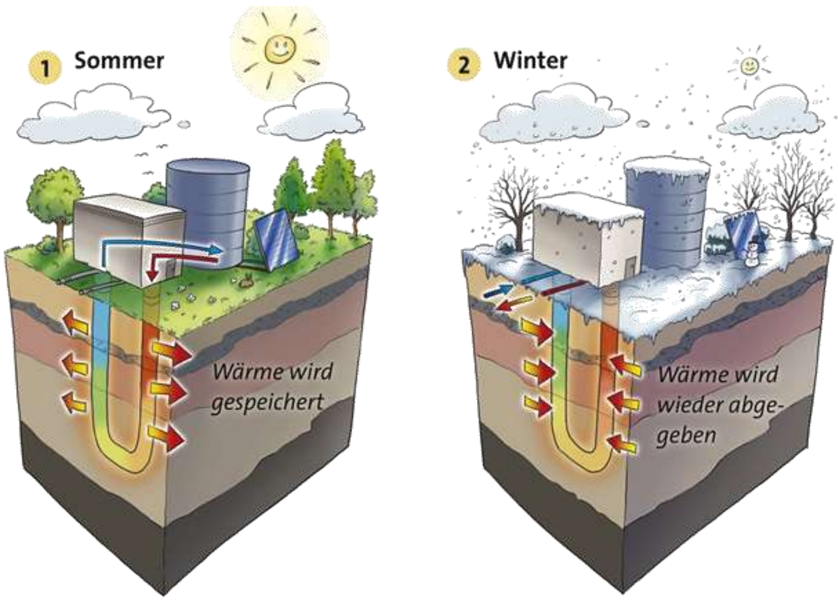


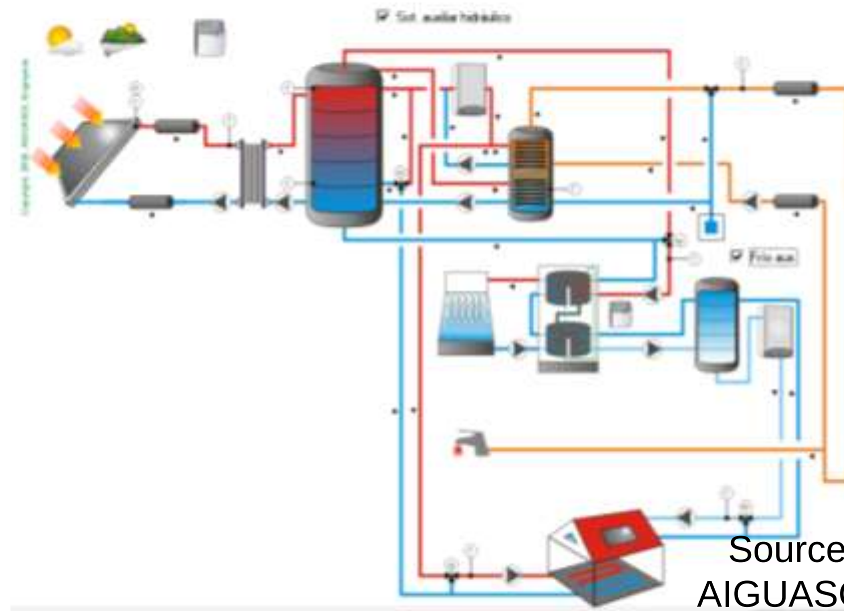


  - Production unstability

MAIN IDEA BEHIND HIGH-COMBI

- Combination of two state-of-the-art technologies
  - Solar cooling
  - Seasonal storage
- With the objective to reach a 60% of the total demand of heat, cold and domestic hot water





Source: AIGUASOL

[redacted]plement

- Greece [redacted])
- Austria [redacted]
  - 1 offi[redacted]
  - 1 offi[redacted]0 m2
- Italy : To[redacted]ctors, with buil[redacted]
- SPAIN: [redacted]. Changed to building in Barcelona, field of 200 m2.
  - ONLY BUILDING FROM THE INITIAL DESIGN PHASE

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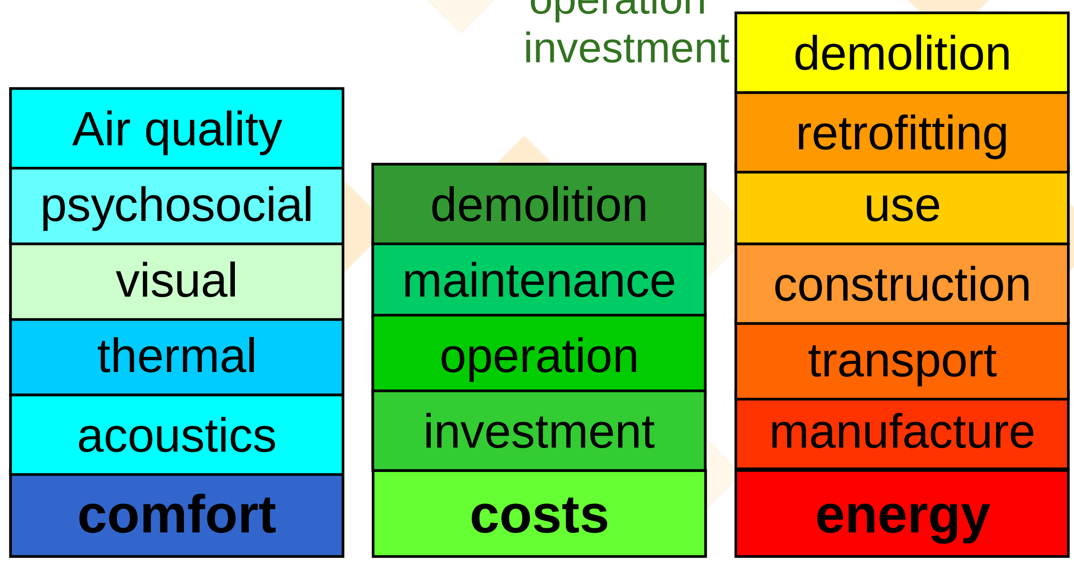
design phase

Design concept involves consideration (evaluation) of:

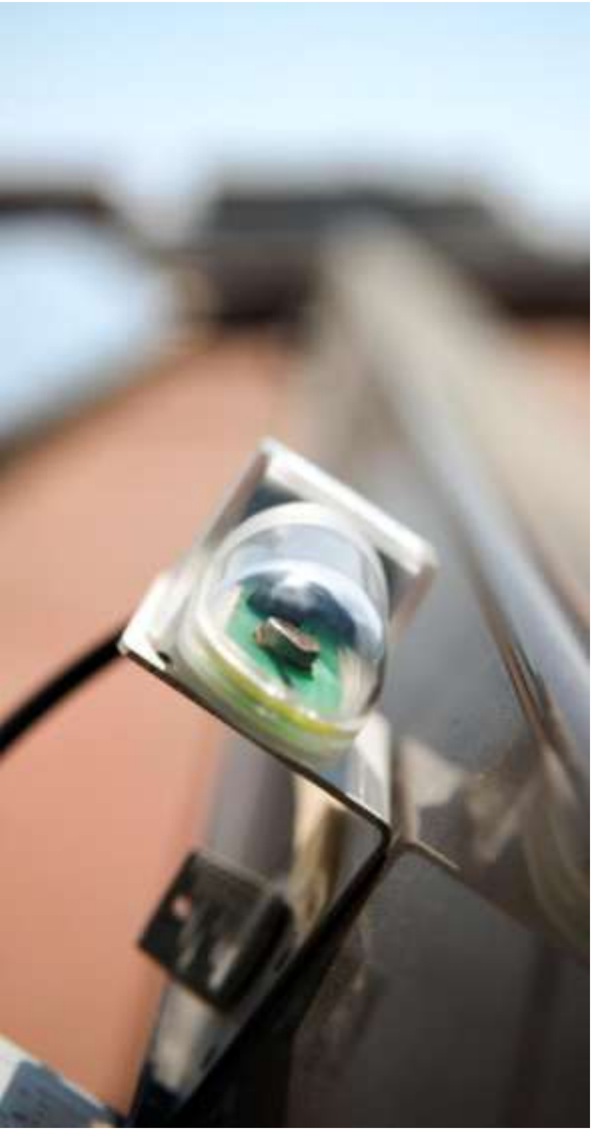
- Functionality
- Architectural design → Energy considerations
- Maximum comfort → Air quality, psychosocial, visual, thermal, acoustics
- Minimum energy impact → deconstruction, renovation, construction, transport, use, Manufaturing
- Economical optimum → deconstruct., maintenance, operation, investment

Considering

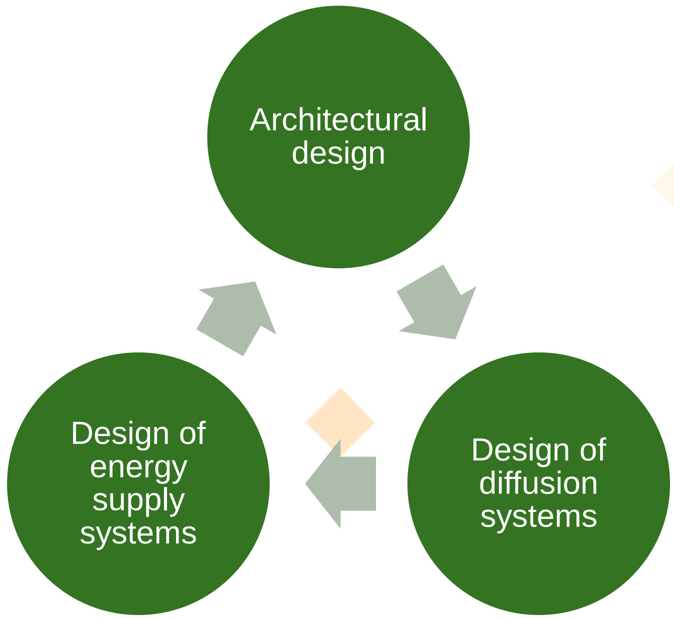
- Regulation (current and future)
  - Comfort
  - Energy demand in use and implementing RES
  - Waste management
  - Cost efficiency



Design phase



In the design phase, it is important to focus on the three main aspects of the building, which have feedback on each other



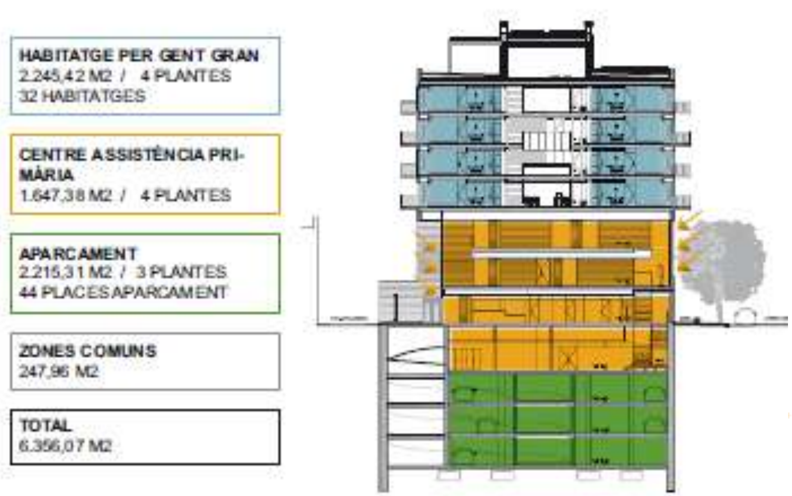
- **Climate**
- **Building use**

Design phase-architectural design

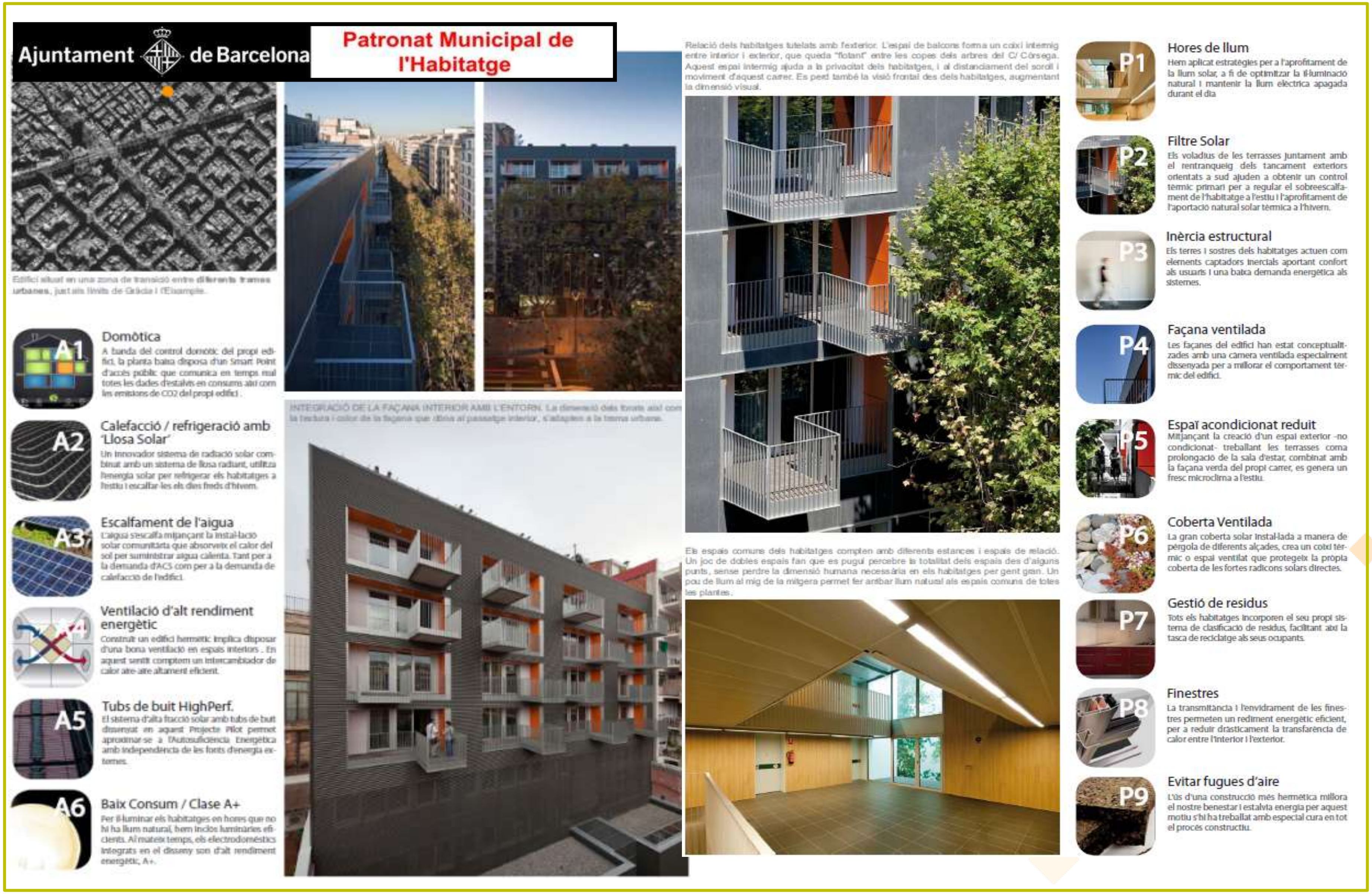
Architectural design / Bioclimatic design

The three uses of the building have to be integrated : small healtcare center, elderly social housing, parking.

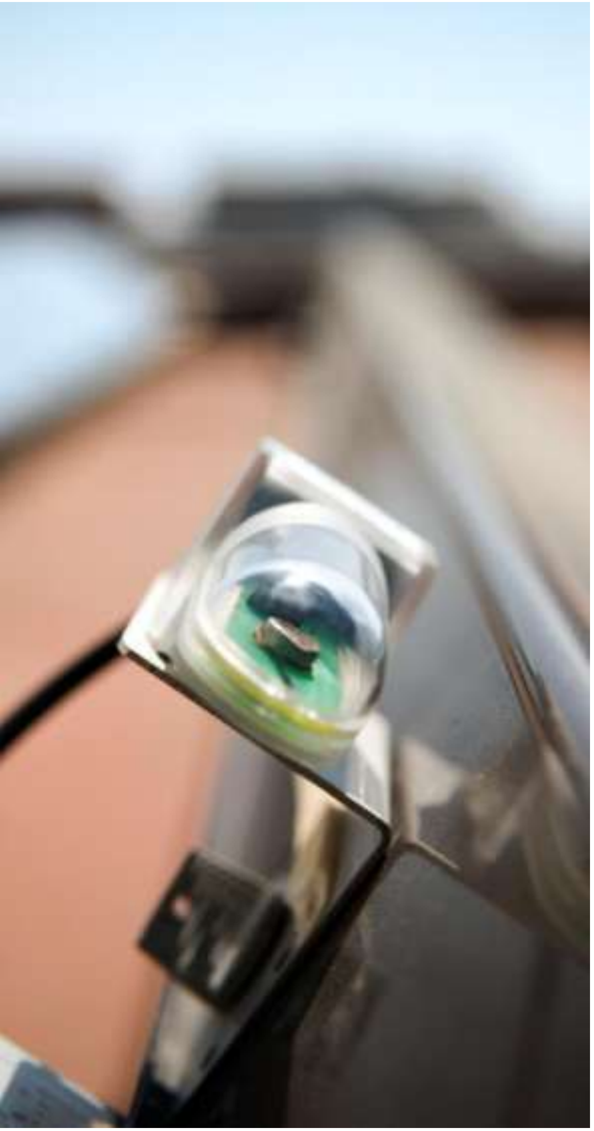
A strong effort has been put in natural daylighting to common spaces.



Design phase-architectural design



Design phase- diffusion systems design



Research phase

So, we analyse different diffusion technologies, which depend on the demand profile obtained from the building design phase and the use:

⇩

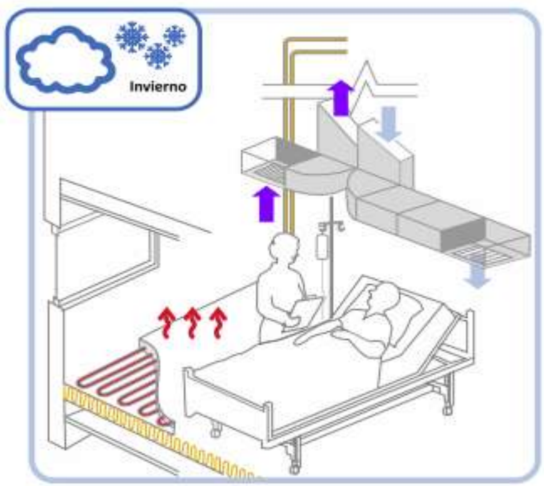
Hypotheses:

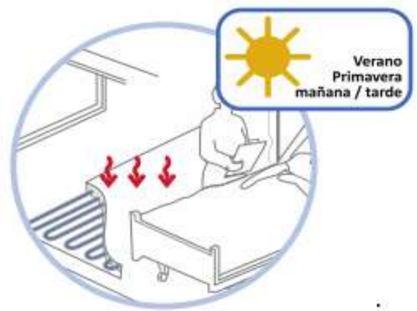
- Elderly people social housing : Building with continuous occupancy in the housing part, with low changes, and an equilibrate demand between heat and cold. Important DHW demand per m2. **Comfort is important.**
- Heatlhcare center : daily occupancy, high peaks, mainly cooling demand.

Design phase- diffusion systems design

Decision

For the elderly people, we opt for a very inertial system (radiant floor), for heat and cold, with hygienic air renovation (contiouous, because of constant loads). Operative temperature more important to comfort than air temperature.



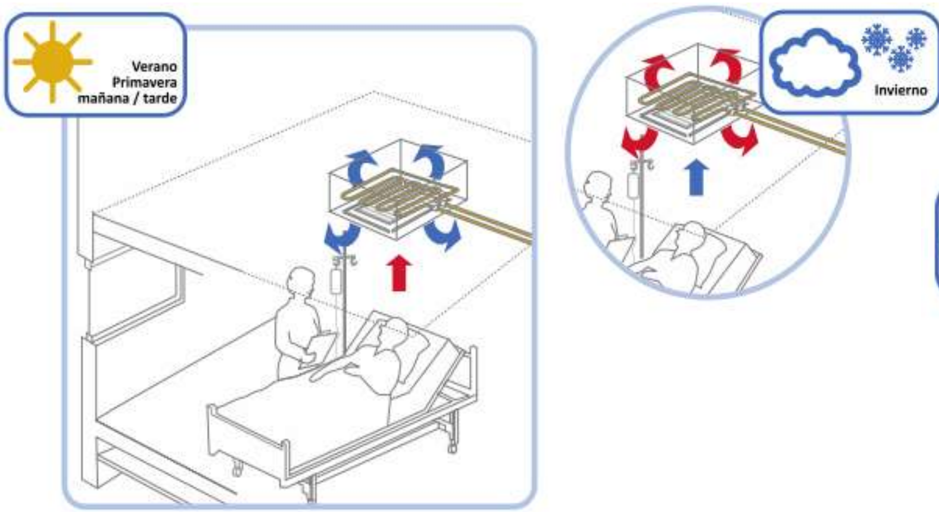


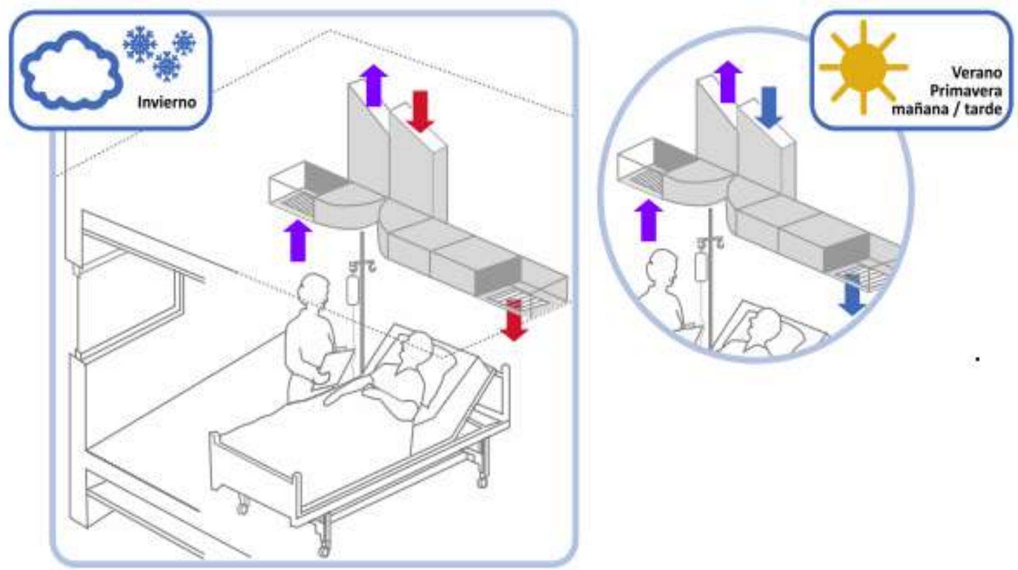
- In summer, to be able to avoid condensation and increase power, renovation air (1 ach) is dehumidified air. A humidity sensor is incorporated, to close the valve when high humidities are detected

Design phase- diffusion systems design

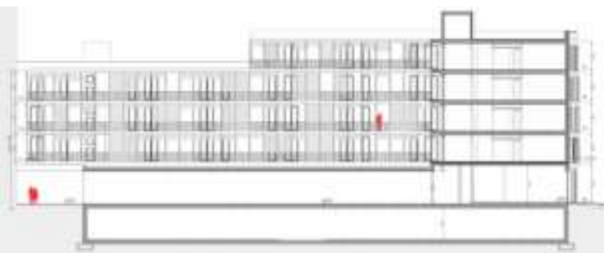
Decision

For the small healthcare center, because of the different behaviour and the different occupancies, two systems are foreseen : VAV for central spaces and fan-coils for the boxes

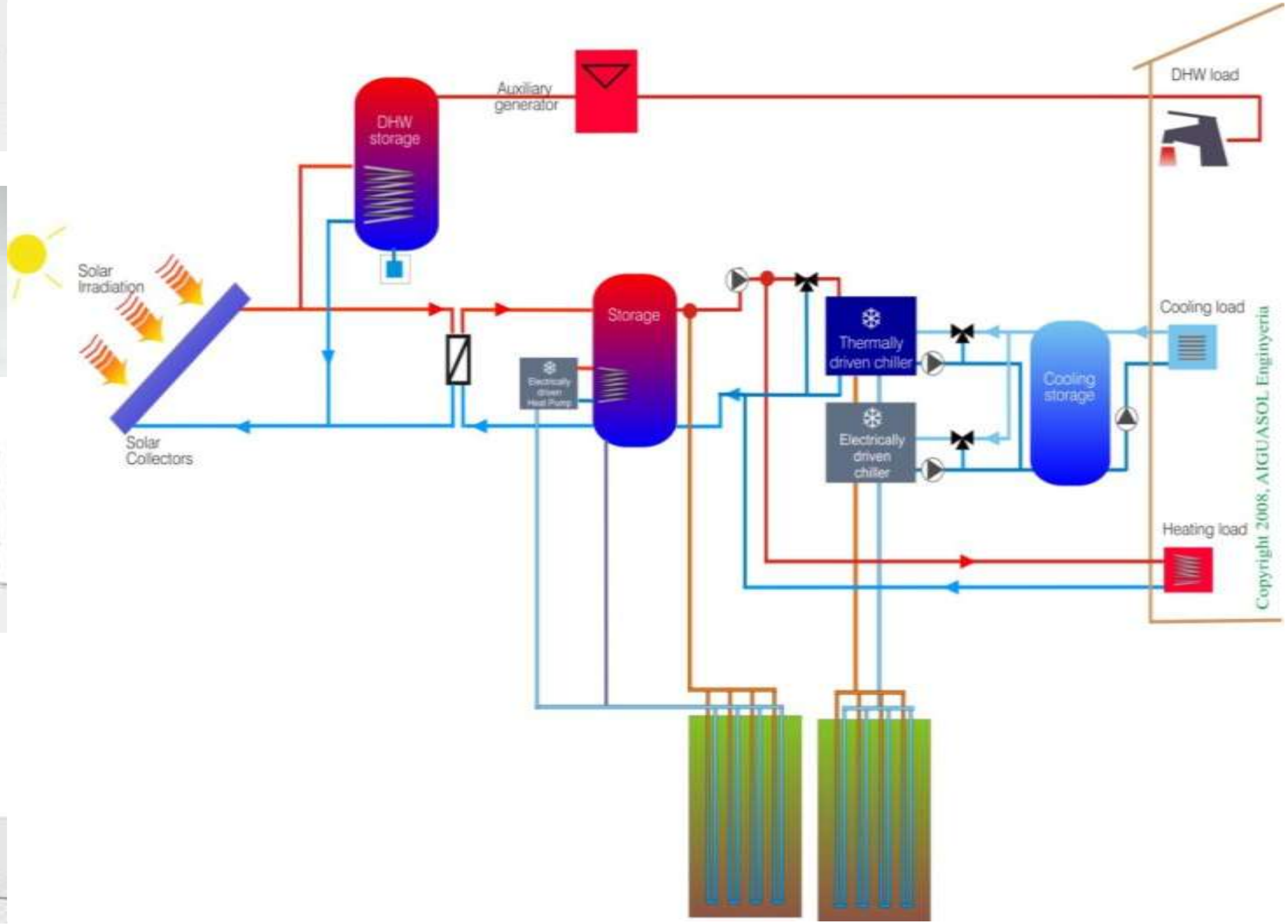




Design phase- generation systems design



SCH 1



Design phase- generation systems design

Administrative problems

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~~**Terrassa building not built**~~

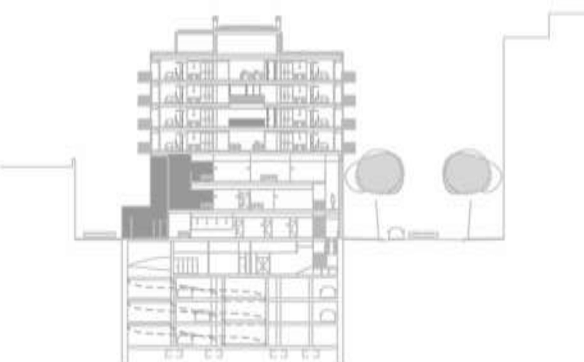
⇩

New building to find

⇩

Cibeles building, PMHB ✓

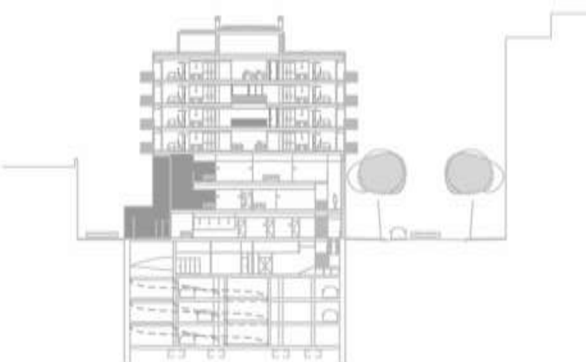
Design phase- generation systems design

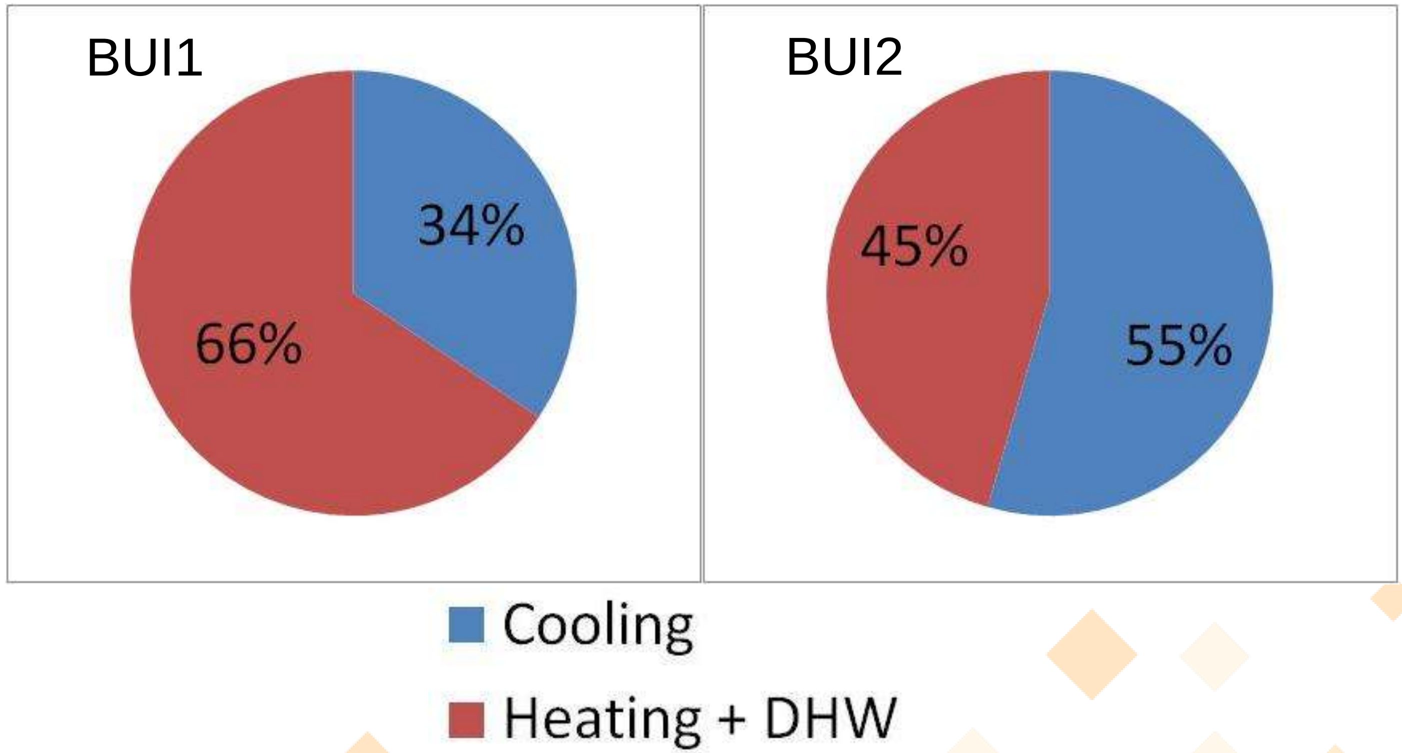


Terrassa is dryer and colder. Different usages

Demand kWh/m²	**Cold**	**Heat**	**DHW**
BUI 1	22	12	30
BUI 2	28,4	9,6	14,1
Difference	+ 29,1%	-20,0%	-53,0%

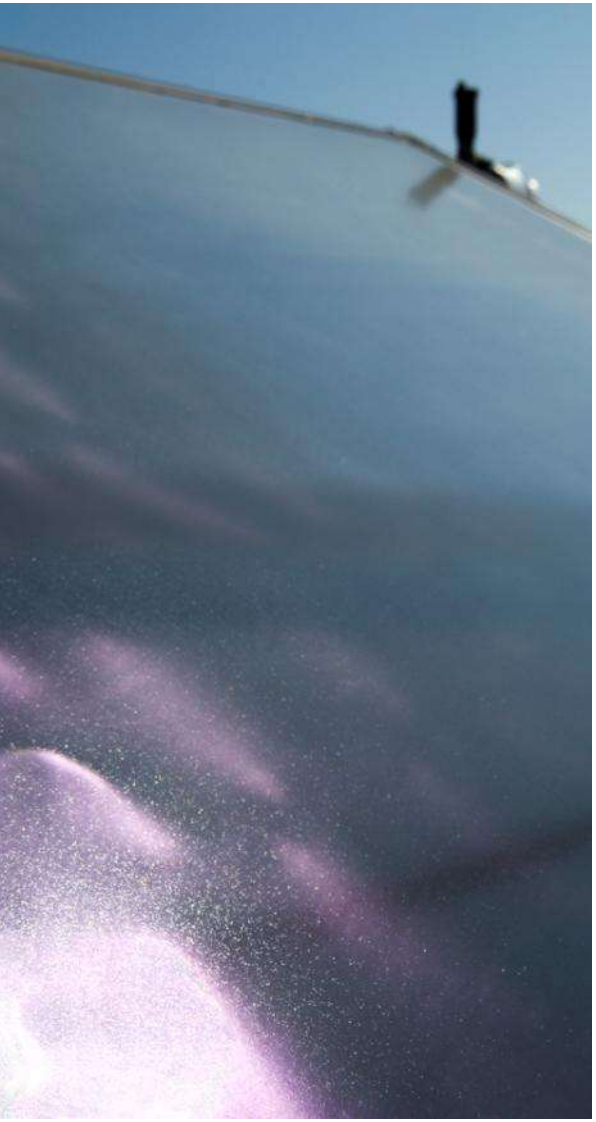
Design phase- generation systems design



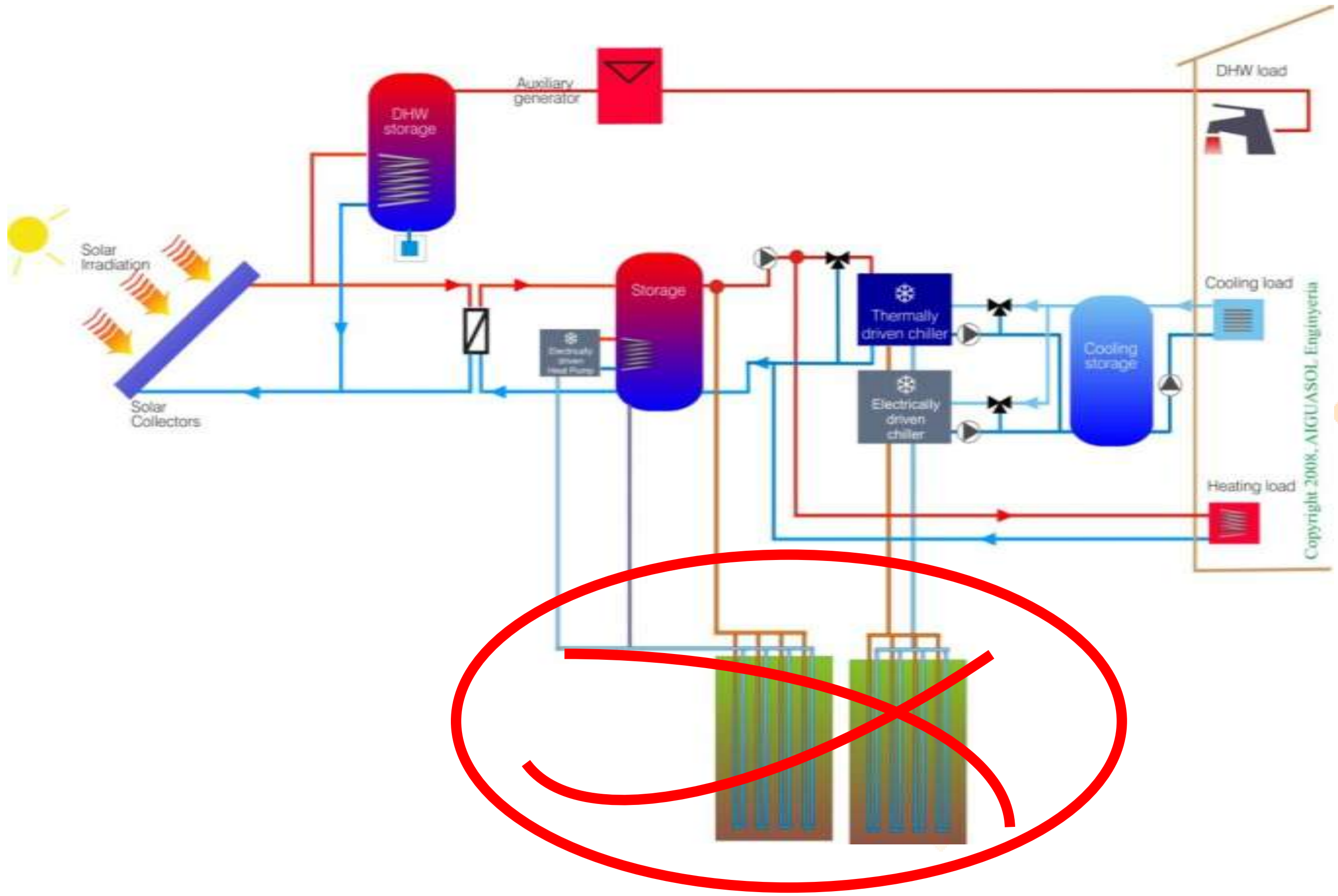


	Ratio (Heat+DHW)/Cold	
BUI 1	1,9	Heat+DHW>> Cold
BUI 2	0,8	Heat+DHW< Cold

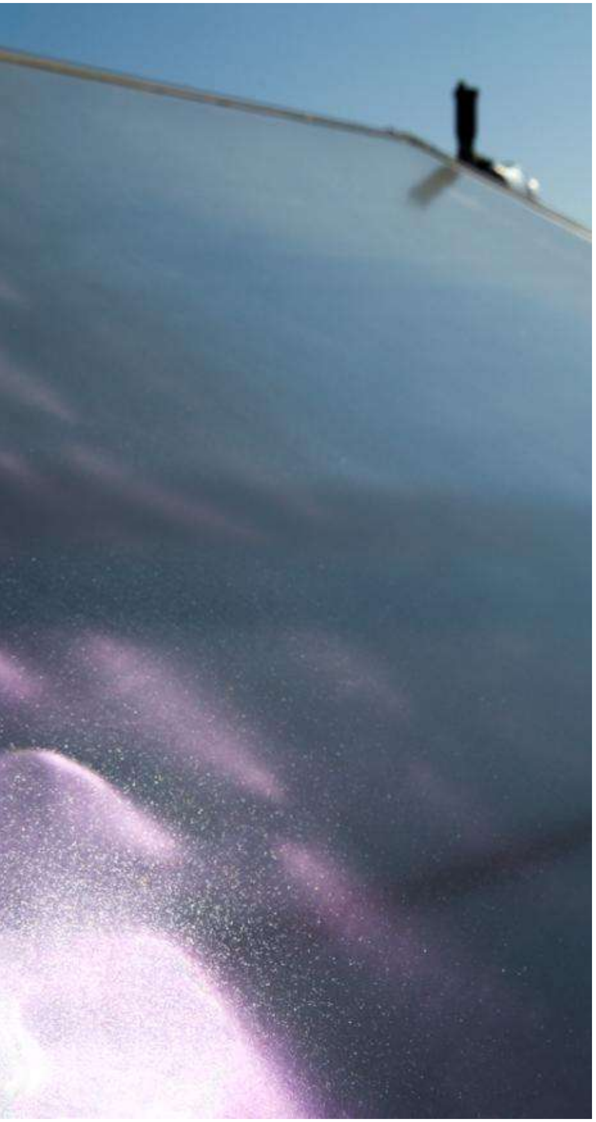
Design phase- generation systems design

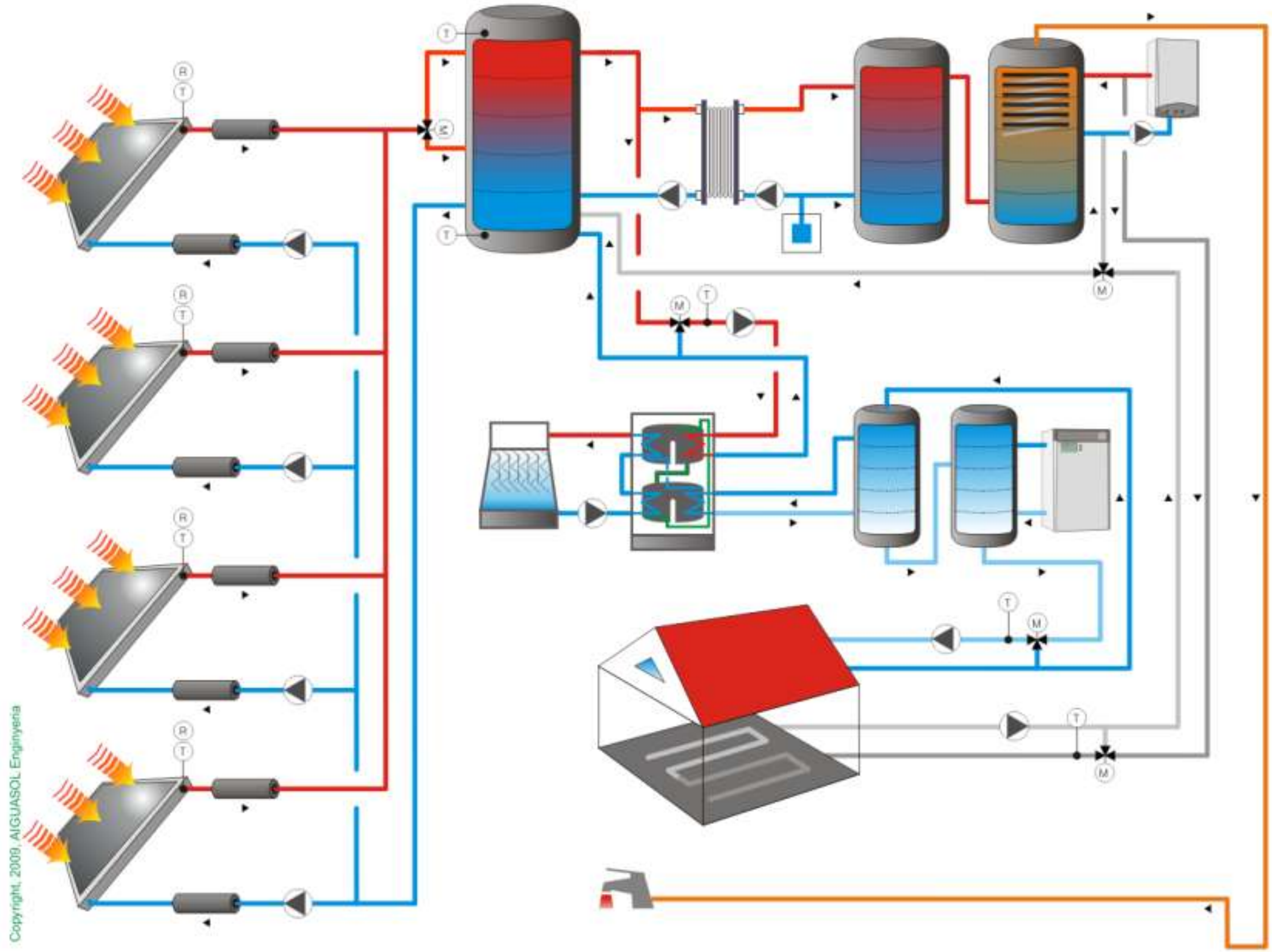


New building, new scheme

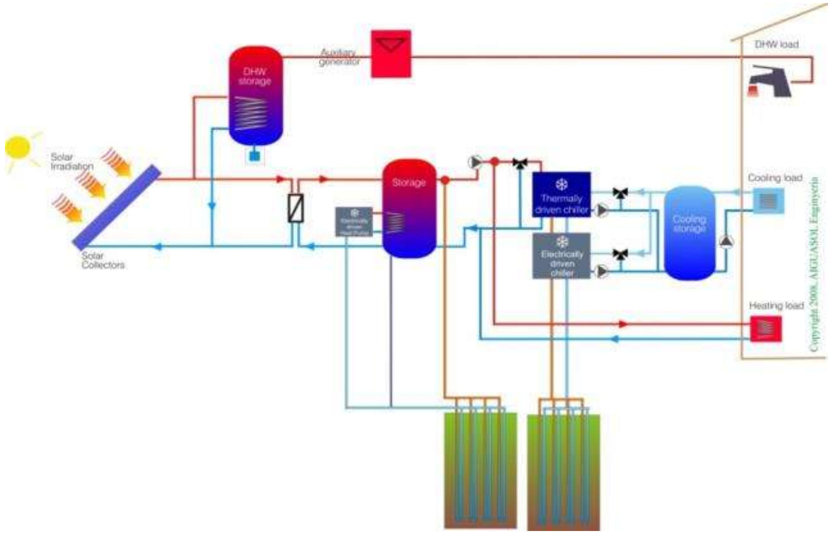


Design phase- generation systems design

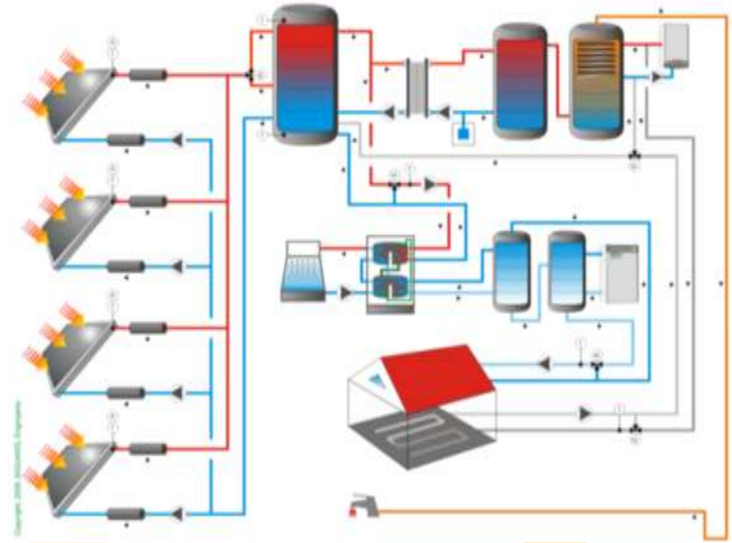




Design phase- generation systems design

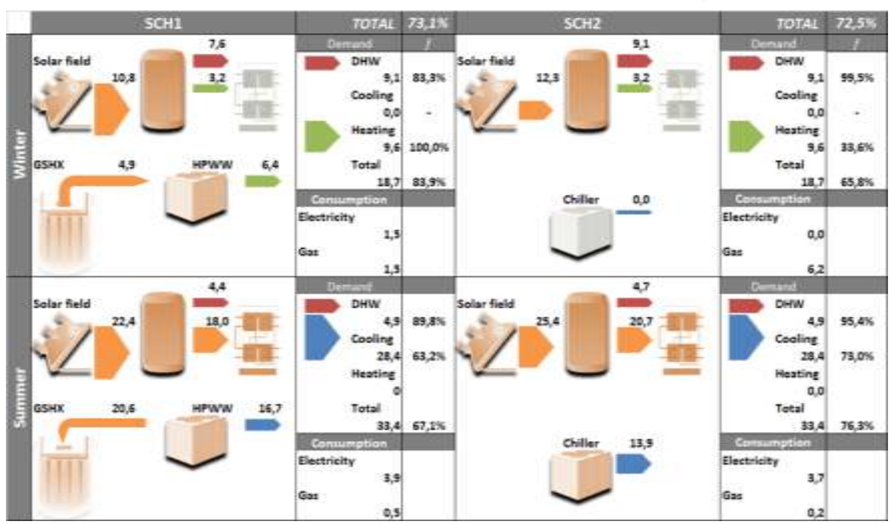


LOADS BUI2



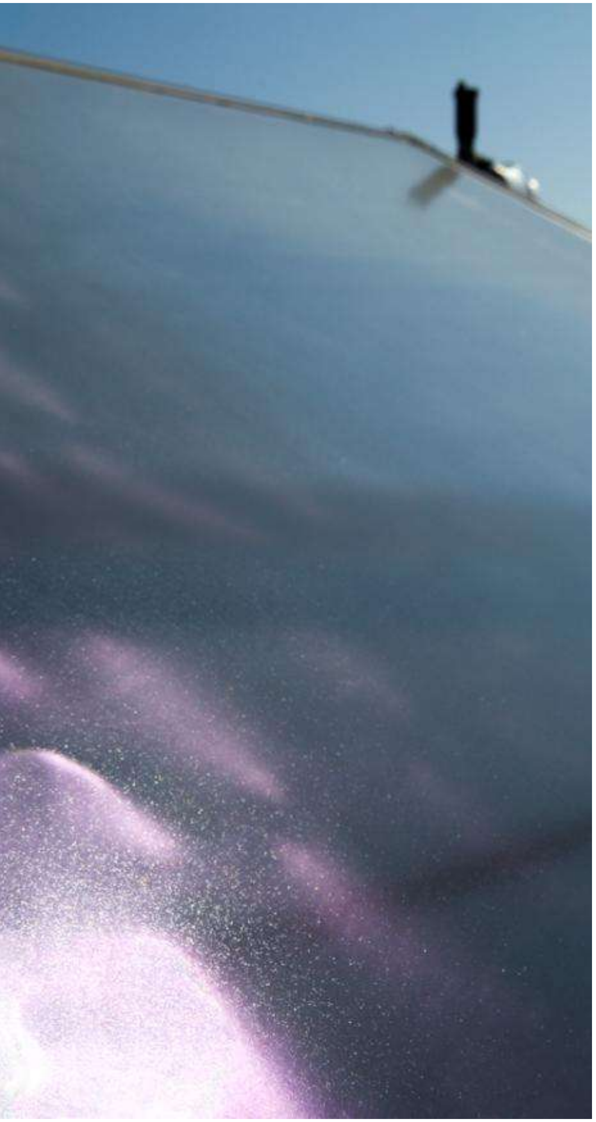
VS

SCH 1



SCH 2

Design phase- generation systems design



BUI2		SCH 1	SCH 2	Dif.
Electricity	kWh/m²	5,4	3,7	- 32 %
Gas	kWh/m²	2,0	6,4	218 %
Primary energy	kWh/m²	15,7	15,9	2 %
Solar fraction	%	73,1	72,5	- 1%
Investment cost	€/m²	210	162	- 23 %

Costs

Solar fraction

Energy consumption

+ LIFE CYCLE ANALYSIS

Design phase- generation systems design

<u>Innovations</u>

Overheating problems

- Huge expansion vessels!
- Primary fluid water
- Antifreezing detailed control

Design phase- generation systems design

<u>Final design</u>

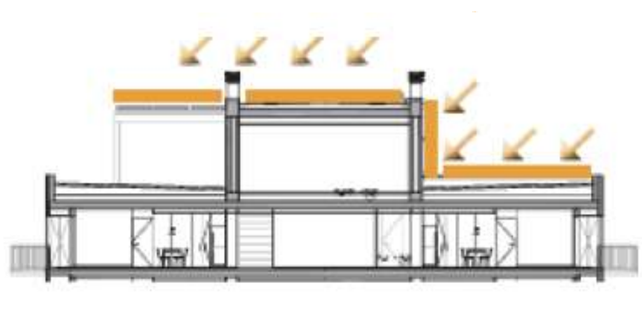
200 m2 evacuated tube solar collectors (4 fields), heat pipe, min inclination.

9 m3 accumulation

70 kW absorption machine

300 kW boilers

250 kW compression chiller



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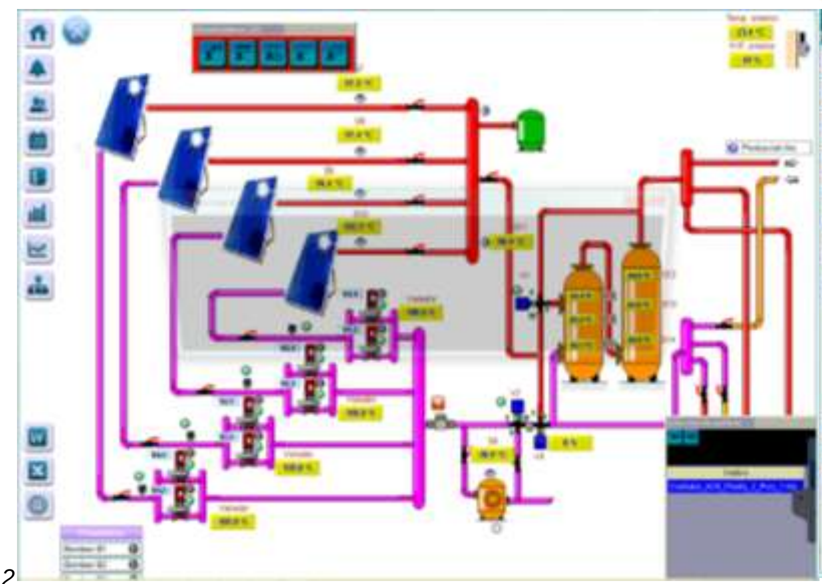
Ajuntament de Barcelona

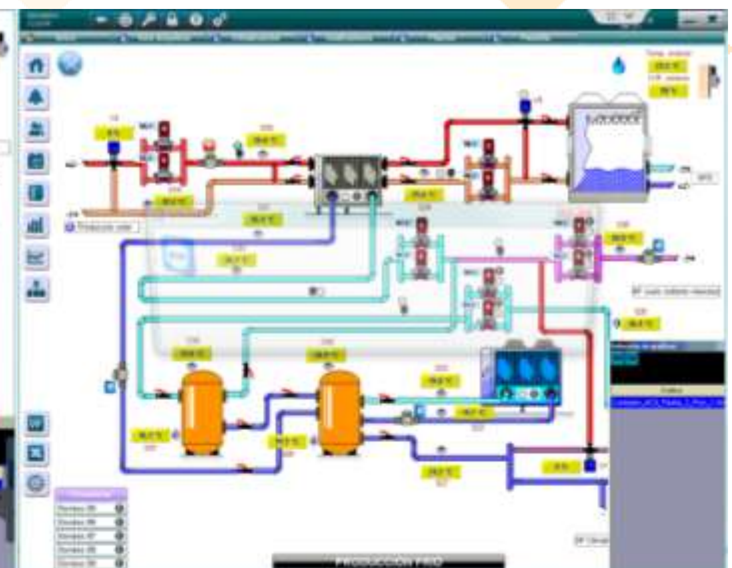
Patronat Municipal de l'Habitatge


IN
Sala
d'Informàtica

Project monitoring

- A detailed monitoring of the system was installed, according to Task 38 from the IEA, to account well for the primary energy saved by the project
- We know the detailed operation of the project via SCADA, which is governed by an external energy service company

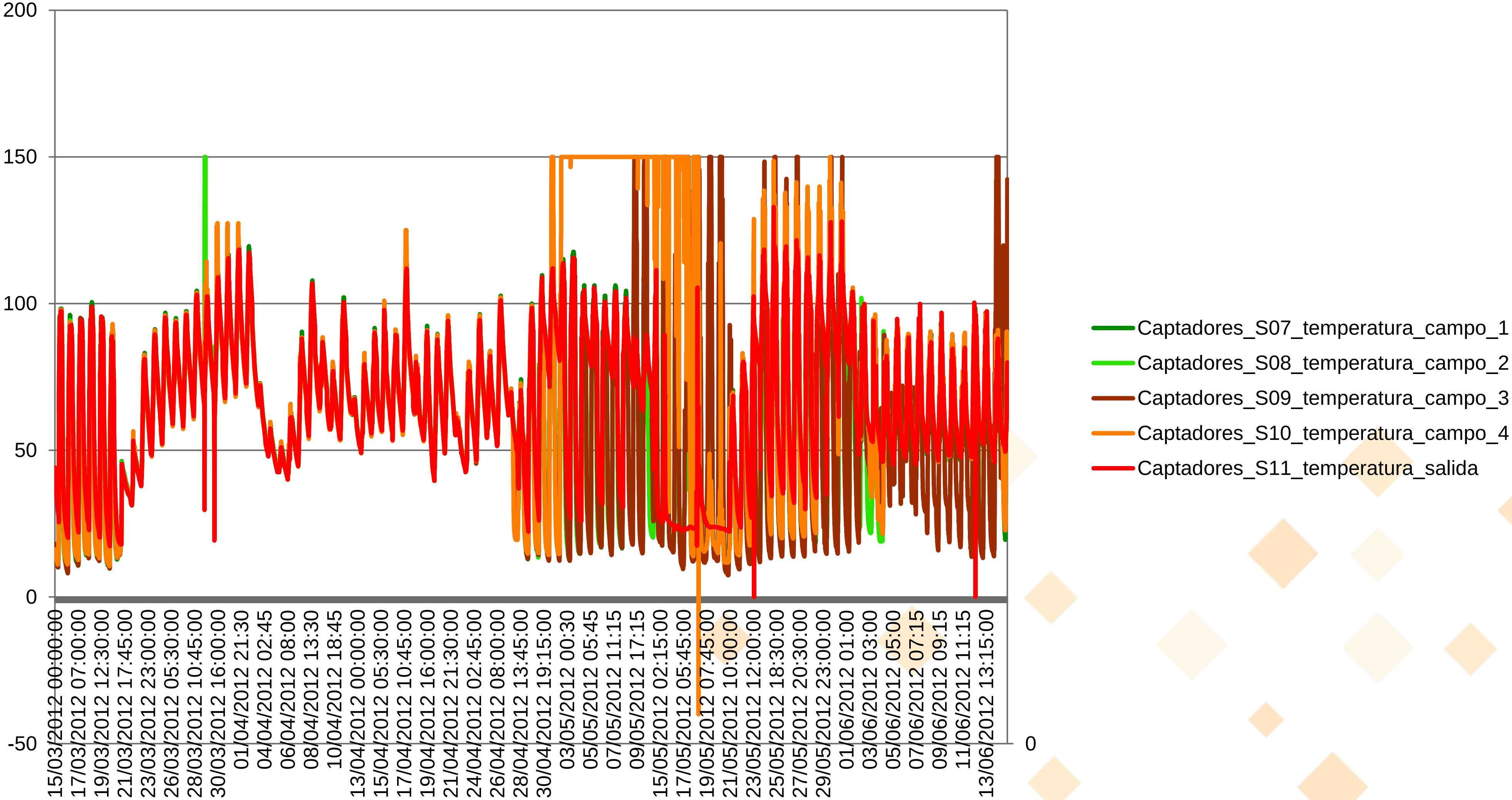




monitoring

- The EC project included a monitoring period
- However, due to the changes in the project, the building finished late (one month to the end of the project)
- Current R&D funds, either from the Catalan or Spanish project dedicate little effort in monitoring and evaluation
- Monitoring has been partially done, own funds from Aiguasol

reality (first six months)



reality (first six months)

expected

DHW Dem.	HEAT Dem.	COO Dem.
18,068	15,778	35,886
DHW solar contribution	Heating solar contribution	Solar cooling production
17,165	6,826	19,090
95%	43%	53%

reality

DHW Dem.	HEAT Dem.	COO Dem.
⇧ 22,440	⇧⇧ 26,030	⇧⇧⇧ 76,544
DHW solar contribution	Heating solar contribution	Solar cooling production
12,500	20,824	18,320
56%	80%	24%

reality

- Although the project has followed all correct steps, two lessons learnt:
  - Commissioning of this type of systems takes a looooong time, if we want to tune perfectly the systems
  - Reality is stubborn…..
- According to real figures (we have to take into account that they are first months of partial operation of the building)
  - BUILDING
  - Higher heating consumption than expected (late entry of users and some problem with the control of the AHU)
  - High cooling demand (small change in initial project because of cost matters – solar protection façades-), freedom in regulation temperature between 22 and 25ºC.

reality

- BUILDING
- Some training has lately been done to users
- Problems with people switching on and off mains, thermostat is going crazy!
- DIFFUSION SYSTEMS
- Initial difficulties with radiant floor (not perceived as real cooling as there was no air involved), explanation was given and people is feeling each time more comfortable
- Hardly any condensation problem (2 appartments, before the temperature was correctly adjusted)

reality

- GENERAL HVAC SYSTEM
- Good field production (higher than expected)
- Good behaviour of absorption machine, although late
- Control problems (strong difficulties with the control contractor, solving them now)
- Good solar fraction, although low in cooling and dhw
  - The absorption machine was turned on later than the rest of the system, commissioning problems
  - The control of the hystheresis temperature of boilers for DHW loop is being controlled
- **IMPORTANT TO WAIT FOR A FULL YEAR MONITORING, TO EVALUATE CORRECTLY**

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Conclusions low energy building

- A lot of costs can be saved working together with the property and the architect (exe and the Patronat very collaborative from minute zero!!!!)
- Different heat and cold profiles imply different system solutions!!!
  - → Avoid preconceived schemes
  - → A very good initial choice of the scheme, design and basic project will reduce time of maintenance and operation.
- COST IS A BASIC ELEMENT IN DECISION CHOICE.

Conclusions low energy building

- The cost of a building like these (including parking) is lower than 900 €/m2. The healthcare center has to be finished…
- For a low energy building, it is a very small cost, considering that we have a R&D demonstration project in it.
- With respect to the BAU scenario, we save around 3100 €/year in energy!!!
- So, it implies that if we decide to make a good building starting from scratch we can have a good behaviour for a cost that is not excessive

Conclusions low energy building

- However, it is important to point out that low energy buildings are not EASY buildings.
- People have to get used to them, they have to be trained (no immediate satisfaction of comfort in this case)
- Architects have to work thoroughly together with energy engineers and the owner.
- A good BEMS/BEPS system is necessary to be able to deal with all the details involved, as much as it is important to keep is as simple as possible.
- There are always problems in the beginning, it is our job to overcome them!!

Conclusions low energy building

- It is essential to have funds to monitor these buildings, otherwise a lot of experiences will be lost!!!
- Although inaugurating “monitoring data” is not as appealing as inaugurating “new premises”, it is basic and not so costly!!!!!
- It is also important to disseminate the knowledge : congratulations to the AIDA project, it looks at things from the right point of view!!

GRÀCIES PER LA SEVA ATENCIÓ

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