



Solar cooling: climatizzazione con
l'energia solare

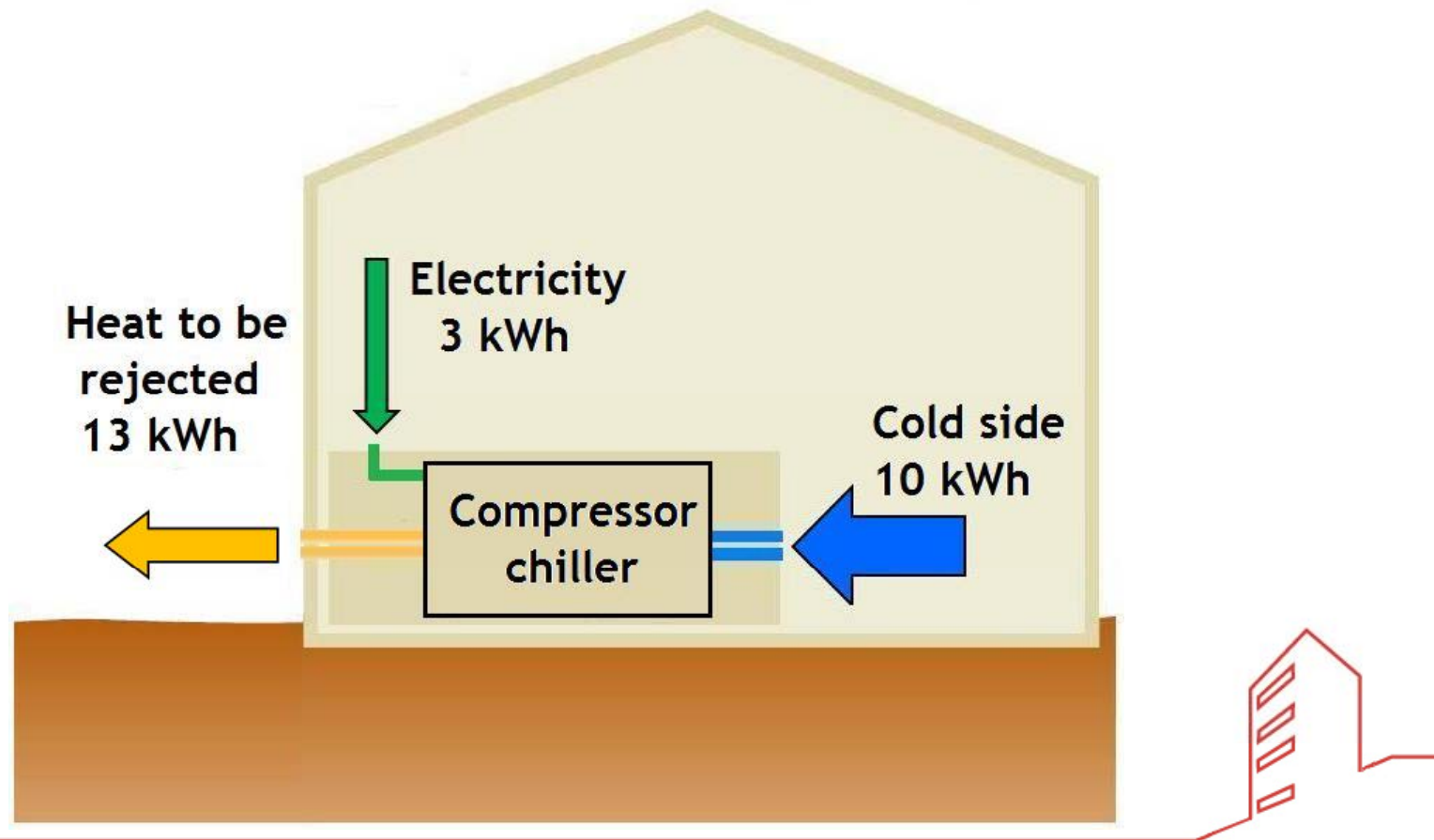


Summary

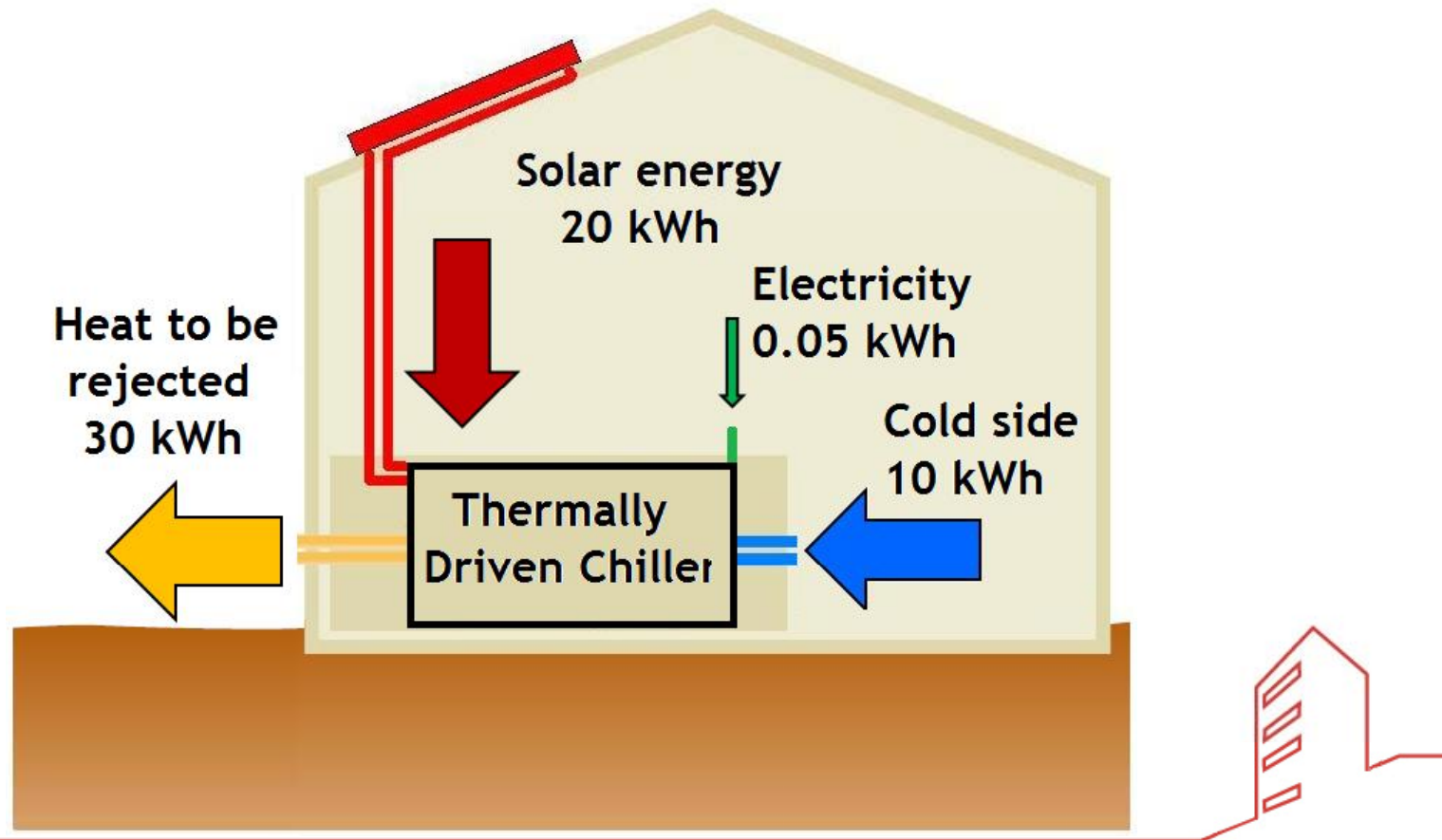
1. Sorption Chillers and Solar Cooling
2. Solar Combi+ Systems
3. Production
4. Costs
5. Feasibility studies
6. Conclusions



1.1 Compression chiller - Conventional Technology

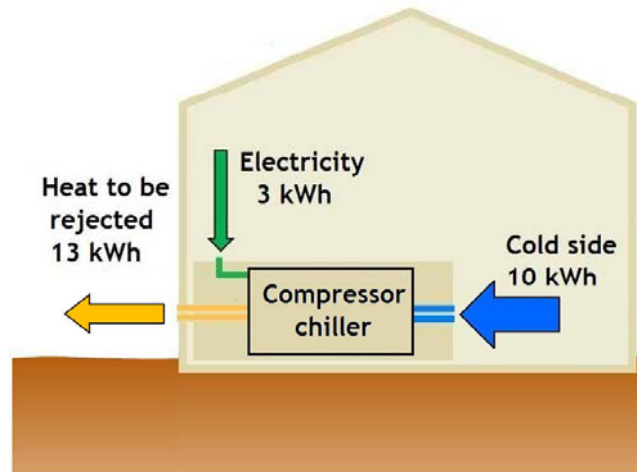


1.2 Sorption Chiller - New Technology

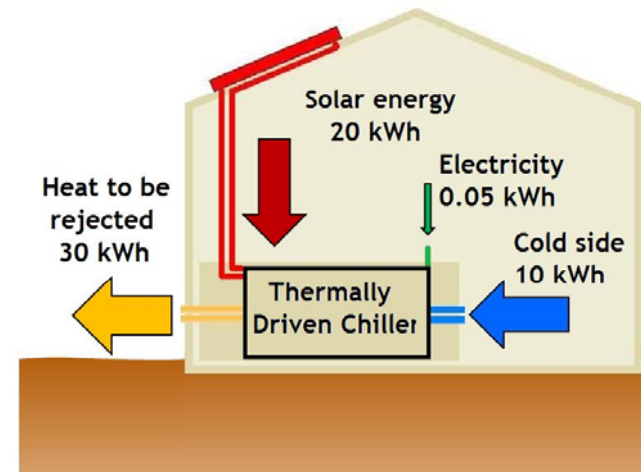


1.3 Comparison

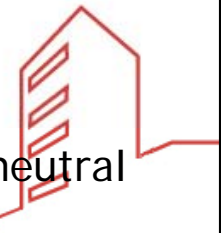
Compression chiller



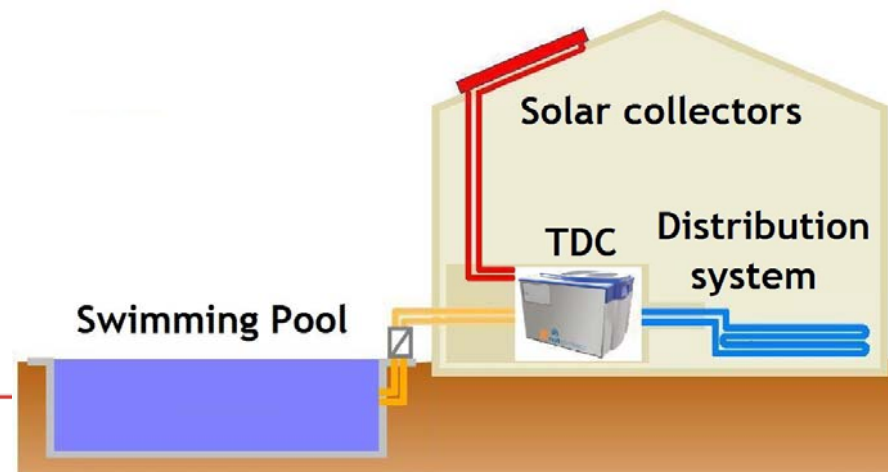
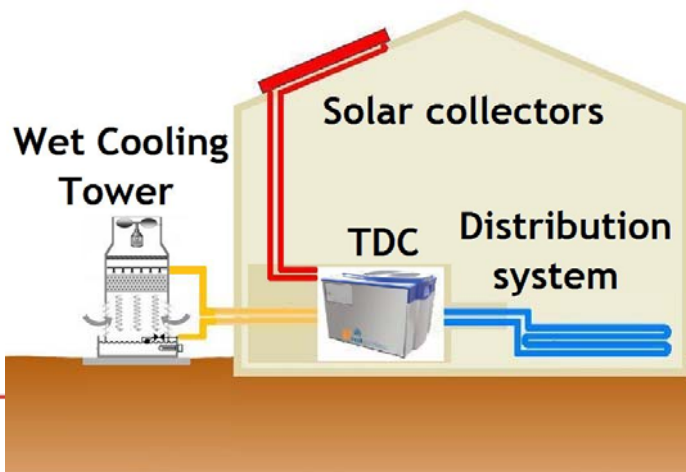
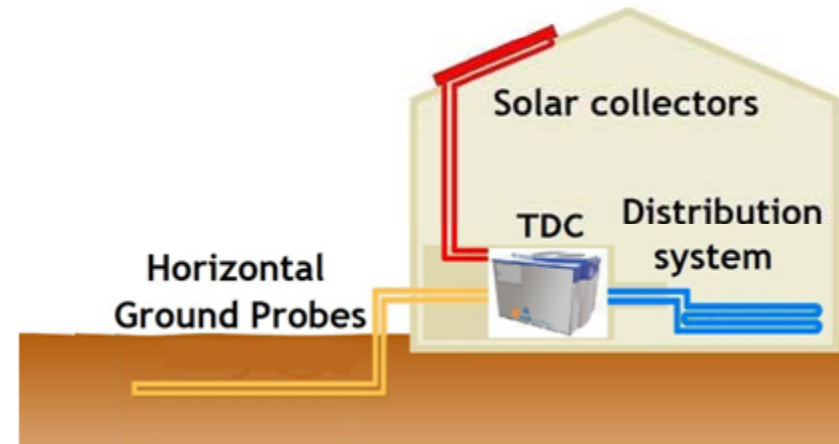
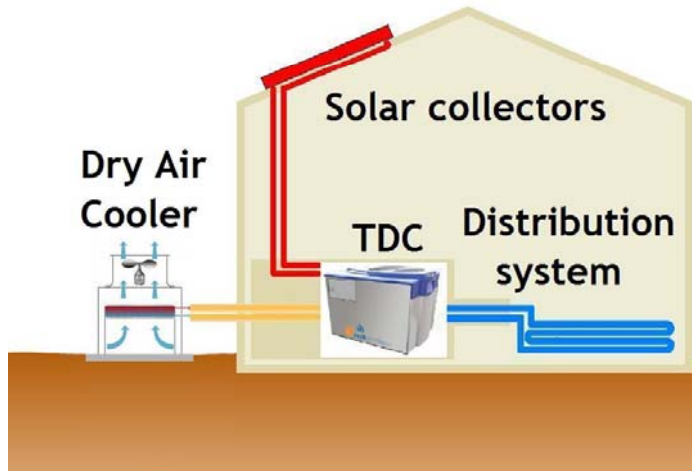
Sorption chiller



1. Huge reduction of electricity consumption (-98%)
2. Considerable heat flux needed in: it has to be cheap -> Solar energy
3. Considerable heat flux out: majority from the sun -> environmentally neutral



1.4 Heat Rejection Technologies



1.5 Final Comparison

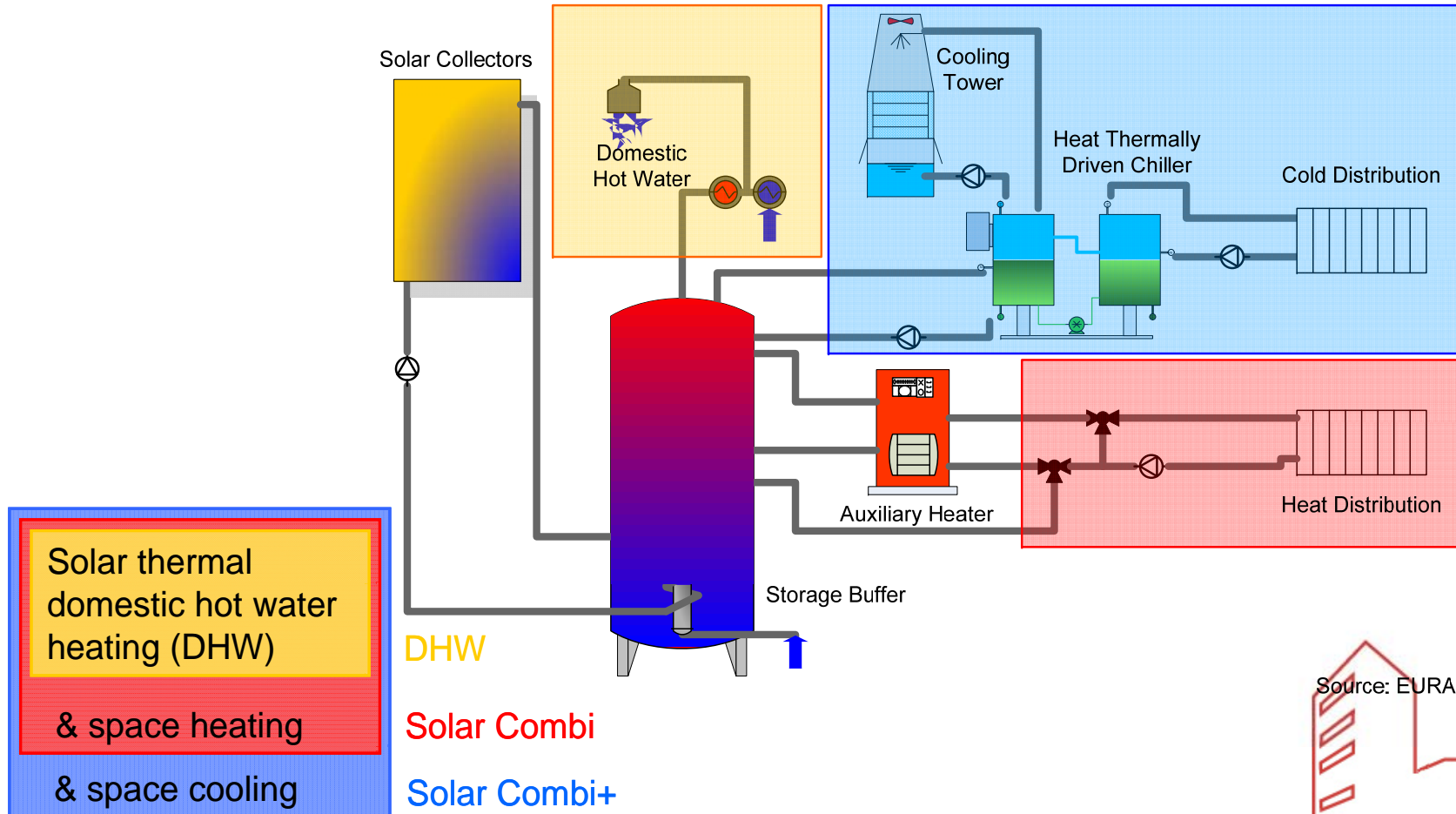
Reduced electricity consumption in cooling mode	+
High investment costs	-
Domestic hot water with same system	++
Space heating with same system	+
Extremely reduced electricity consumption in heating, domestic hot water mode with respect to cooling mode	+++



Use ***Solar Combi+ systems*** for combined space heating, space cooling and domestic hot water preparation

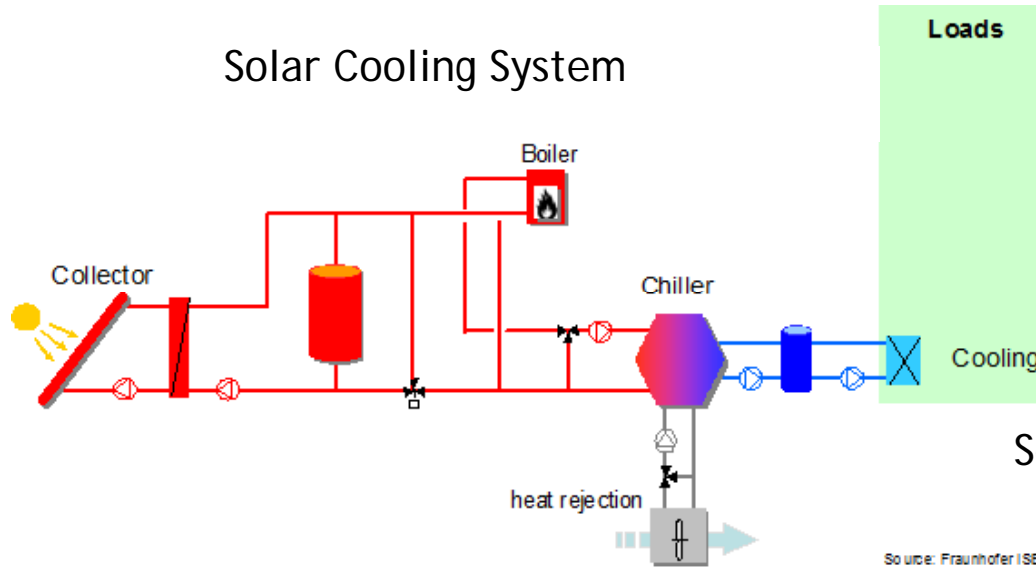


2.1 What is a Solar Combi+ system?

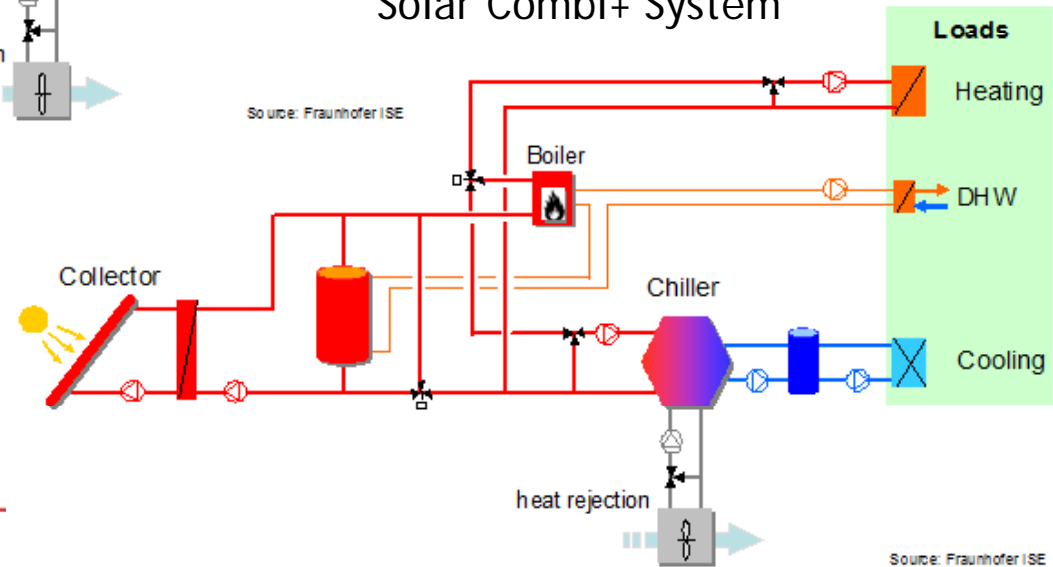


2.2 What is a Solar Combi+ system?

Solar Cooling System



Solar Combi+ System



Same
Investment
Cost

Source: Fraunhofer ISE

2.3 What is a Solar Combi+ system?

System performance depend on:

- *Integrated control of system's components*
- *Sizing of the components*
 - *with respect to the building*
 - *each component with regard to the other*

In particular the following ratios have to be respected:

- a) *Collectors' area/Chiller rated power*
- b) *Storage tank volume/Collectors' area*



2.4 Solar Combi+ systems state of the Art

SolarCombi+, main components and fast design:

- Small Thermally Driven Chiller → $XX \text{ kW}_{\text{cool}}$
- Large area of solar collectors → $4\text{-}5 \text{ m}^2/\text{kW}_{\text{cool}}$
- Hot storage buffer → $60 \text{ l}/\text{m}^2_{\text{coll}}$

EAW
(15 - 200 kW)

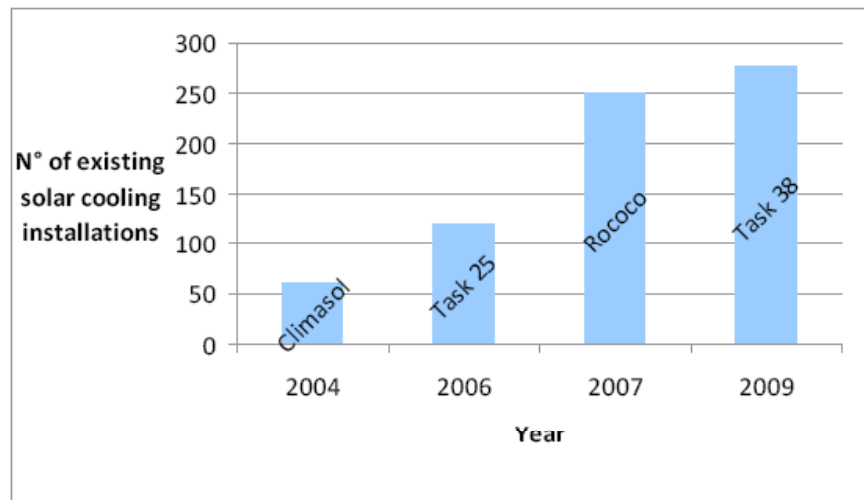


Source: EAW

SonnenKlima
(10 kW)



Source: SonnenKlima

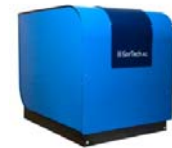


Rotartica
(4.5 kW)



Source: Rotartica

SorTech
(7.5 kW)



Source: SorTech

ClimateWell
(10 kW)



Source: Climatewell



3 Production

A system with:

- *Synergic control of all components*
- for 1 kW_{cold} chiller requires $4\text{-}5 \text{ m}^2$ collectors' area
- for 1 m^2 collectors' area requires $50\text{-}75$ liters storage tank

It harvest on an average of all collector technologies and European sites around 400 kWh/year of solar energy *per unit collectors' area (solar yield)*. Of those around 250 kWh/year reach the building as *heating, domestic hot water or cooling (solar fraction)*.

For example, a small system with :

32 m^2 collectors' area ($4 \text{ m}^2/\text{kW}_{cold}$)

2000 l storage tank (60 l/m^2)

8 kW sorption chiller

Collects $8'000\text{-}9'000 \text{ kWh/year}$ to the building



4.1 Costs

The investment cost is around *4000-5000 euro/kW_{cold}*,
1000-1300 euro/m² collectors' area.

For example, a small system with:

32 m² collectors' area (*4 m²/kW_{cold}*)

2000 l storage tank (*60 l/m²*)

8 kW sorption chiller

Costs around **40'000 euros** (1/3 chiller, 1/3 collectors, 1/3 ...)

A reference system with:

Gas boiler

8 kW compression chiller

Costs around **15'000 euros**



5.1 Mono-family House

Existing Application:

- ✓ Sevilla, Spain;
- ✓ 2 floors building;
- ✓ Total area: 150 m²;
- ✓ Air-conditioned total area: 60 m²;
- ✓ Average monthly occupancy: 50%
- ✓ Max occupancy profile: ca. 3-4 pp;



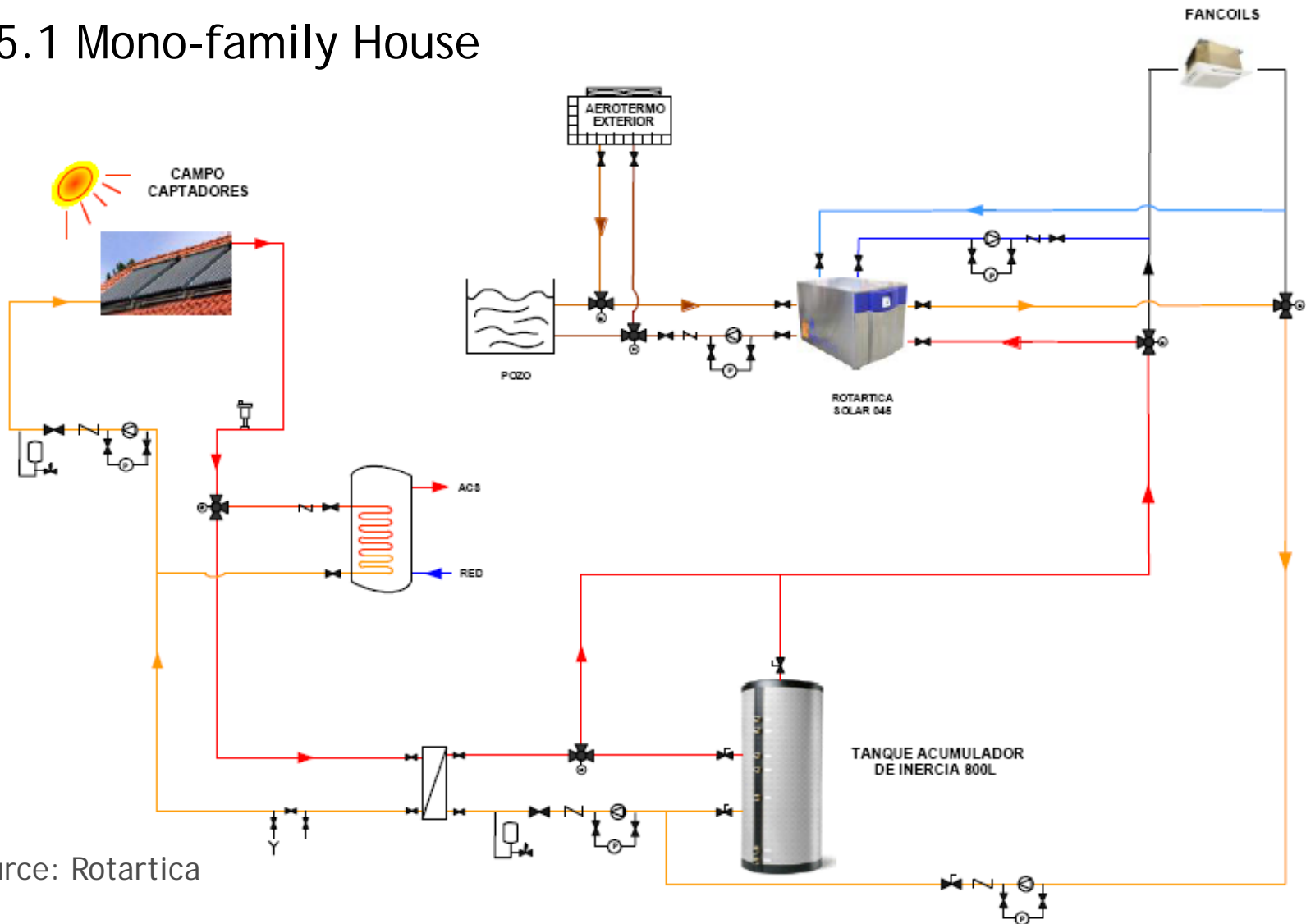
Source: Rotartica

Proposed SolarCombi+ System:

- ✓ Solar FP collectors: 10 units → 25,9 m²;
- ✓ DHW storage: 150 l;
- ✓ H&C storage: 800 l;
- ✓ Chiller: 1 unit of Rotartica SOLAR 045 → 4,5 kW_{cool} nominal capacity.



5.1 Mono-family House



Source: Rotartica

5.2 Multi-family House

Existing Application:

- ✓ Sangerhausen, Deutschland;
- ✓ Refurbishment of a quarter;
- ✓ All 141 flats in several blocks;



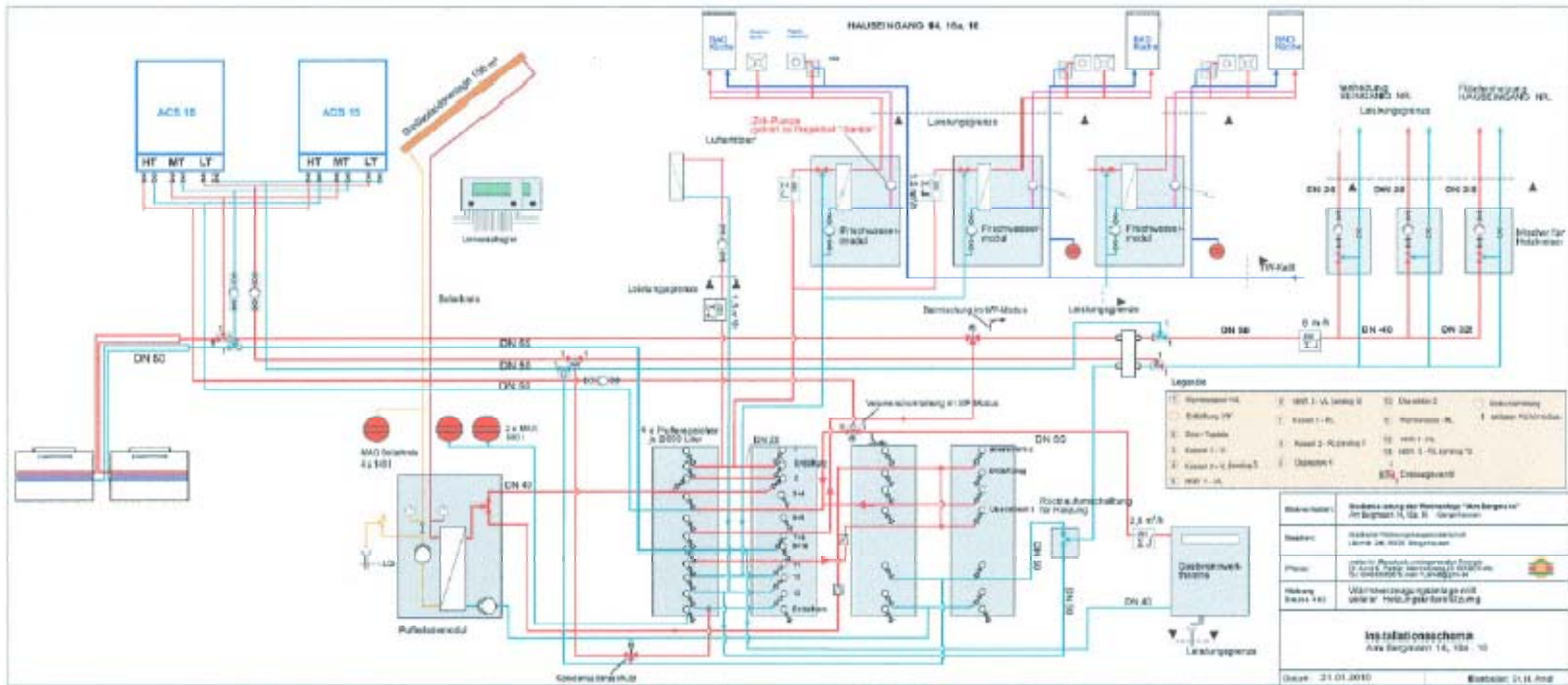
Source: SorTech

Proposed SolarCombi+ System per building:

- ✓ Solar collectors: 156 m²;
- ✓ DHW storage: 4 x 2000 l;
- ✓ H&C storage: 800 l;
- ✓ Chiller: 2 unit of SorTech ACS15 → 30 kW_{cool} nominal capacity.



5.2 Multi-family House



Source: SorTech

5.3 Hotel

Existing Application:

- ✓ Massa Marittima, Italy;
- ✓ 3 Floors building;
- ✓ 25 Appartament rooms;



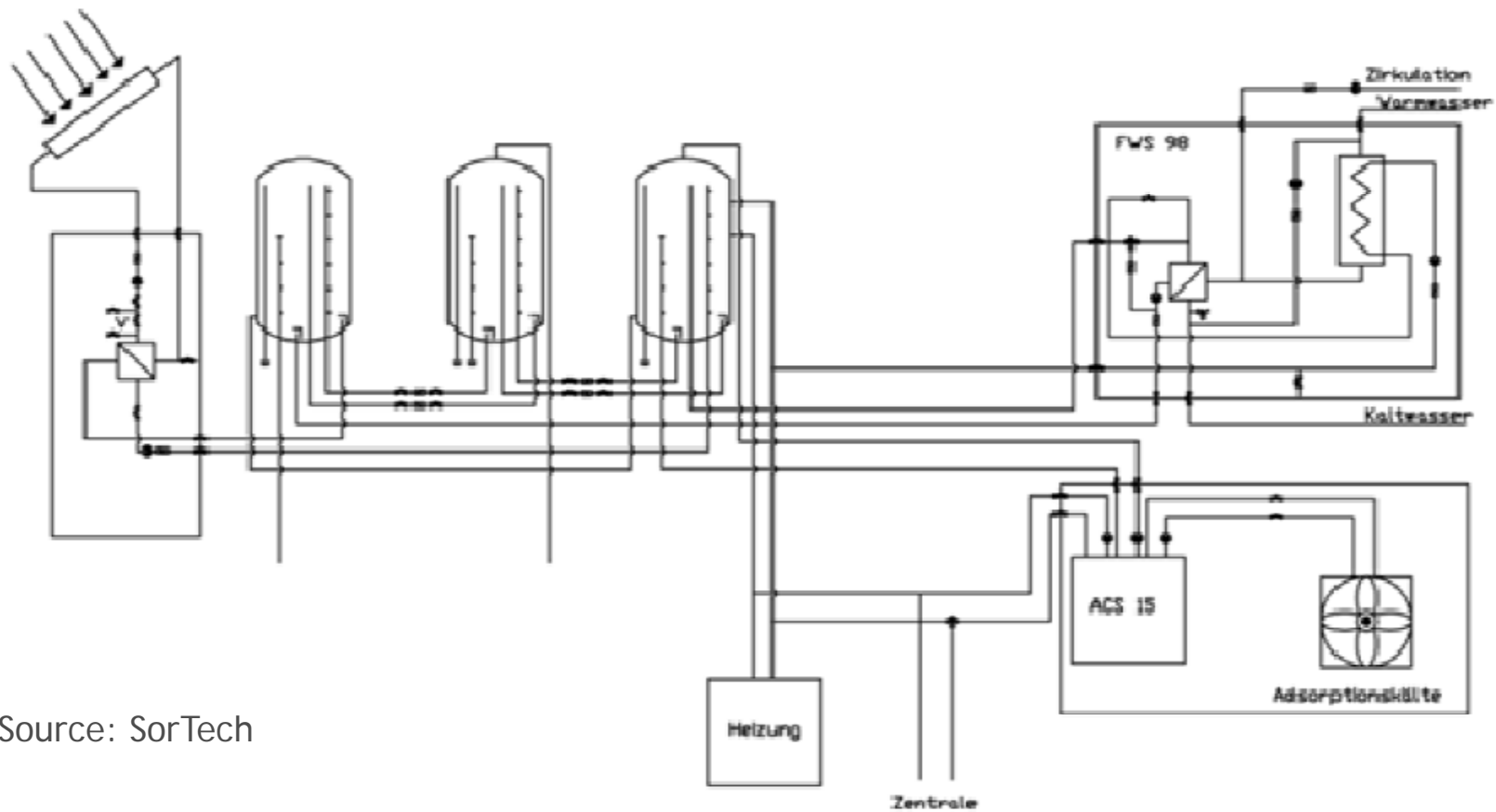
Source: SorTech

Proposed SolarCombi+ System per building:

- ✓ Solar collectors: 80 m²;
- ✓ Storages: 3 x 1850 l;
- ✓ Chiller: 1 unit of SorTech ACS15 → 15 kW_{cool} nominal capacity.



5.3 Hotel



Source: SorTech

7.1 Conclusions

1. Systems have to be promoted that are suitable for space cooling, space heating and domestic hot water preparation: *Solar Combi+ system*
2. Incentive schemes must promote both capital costs and production
3. Few initial “good” systems have to be promoted





Thank you



STIFTUNG SÜDTIROLER SPARKASSE
FONDAZIONE CASSA DI RISPARMIO DI BOLZANO

