

Control Boxes Development for Heating and Cooling Applications

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Statement of the problem

1. Solar cooling systems are complex ones due to the number of components used. High initial investment cost due to:

- Acquisition of single components
- high effort in design stage (both for layout and control definition)
- Long installation time

which are not affordable for small applications.

2. Cooling loads represent only a percentage of the entire building loads. This holds mostly for residential applications (also in southern regions...)

Around 5000 € production cost



Around 1000 € cost



How the problem is handled

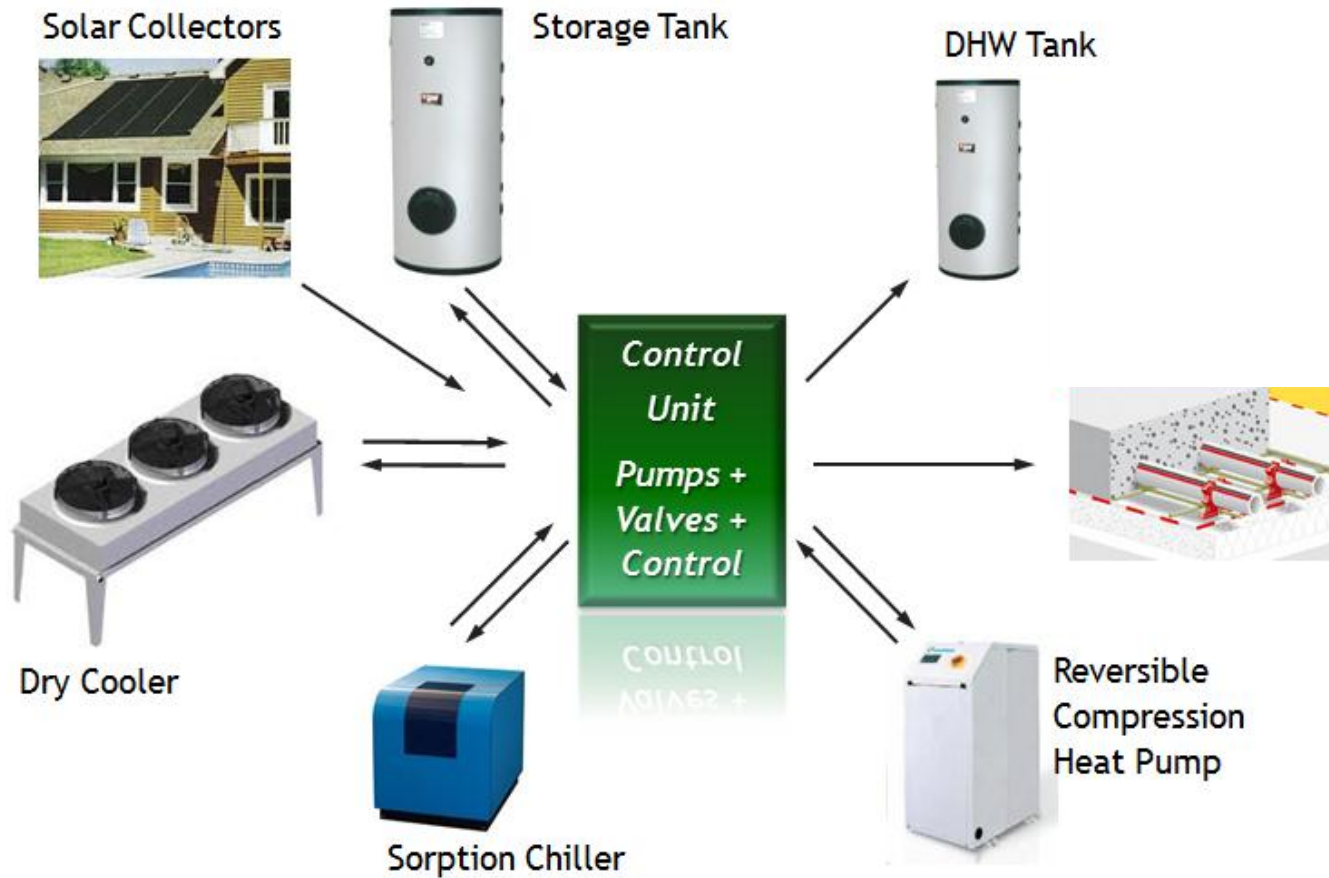
1. High initial investment cost.

- Standardization of the systems → predefined layout and sizing
- Development of control units → reduction of installation time
→ reduction of cost of control components
→ reduction of errors
→ synergic integration of all components

2. Combined Heating and Cooling systems are developed allowing maximum

- Utilization through the year
- Integration of different technologies → i.e. sorption/compression HPs
- Harvest of RES to cover all building loads → solar + air + geothermal

Aim of the projects



FP7-Alone

- 3 Piani fuori terra
- 8 Appartamenti, 577m²



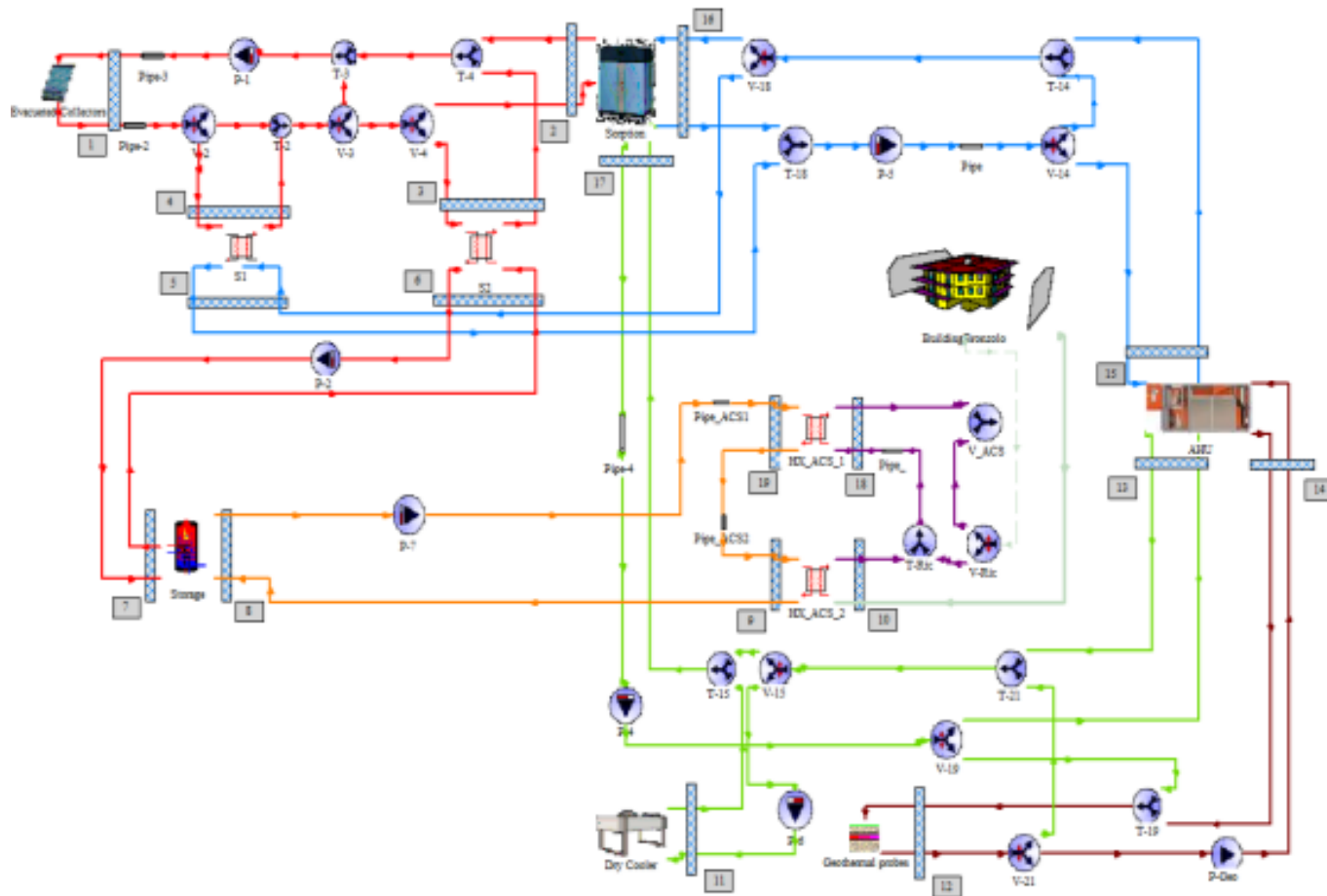
Istituto per l'edilizia sociale della
Provincia Autonoma di Bolzano



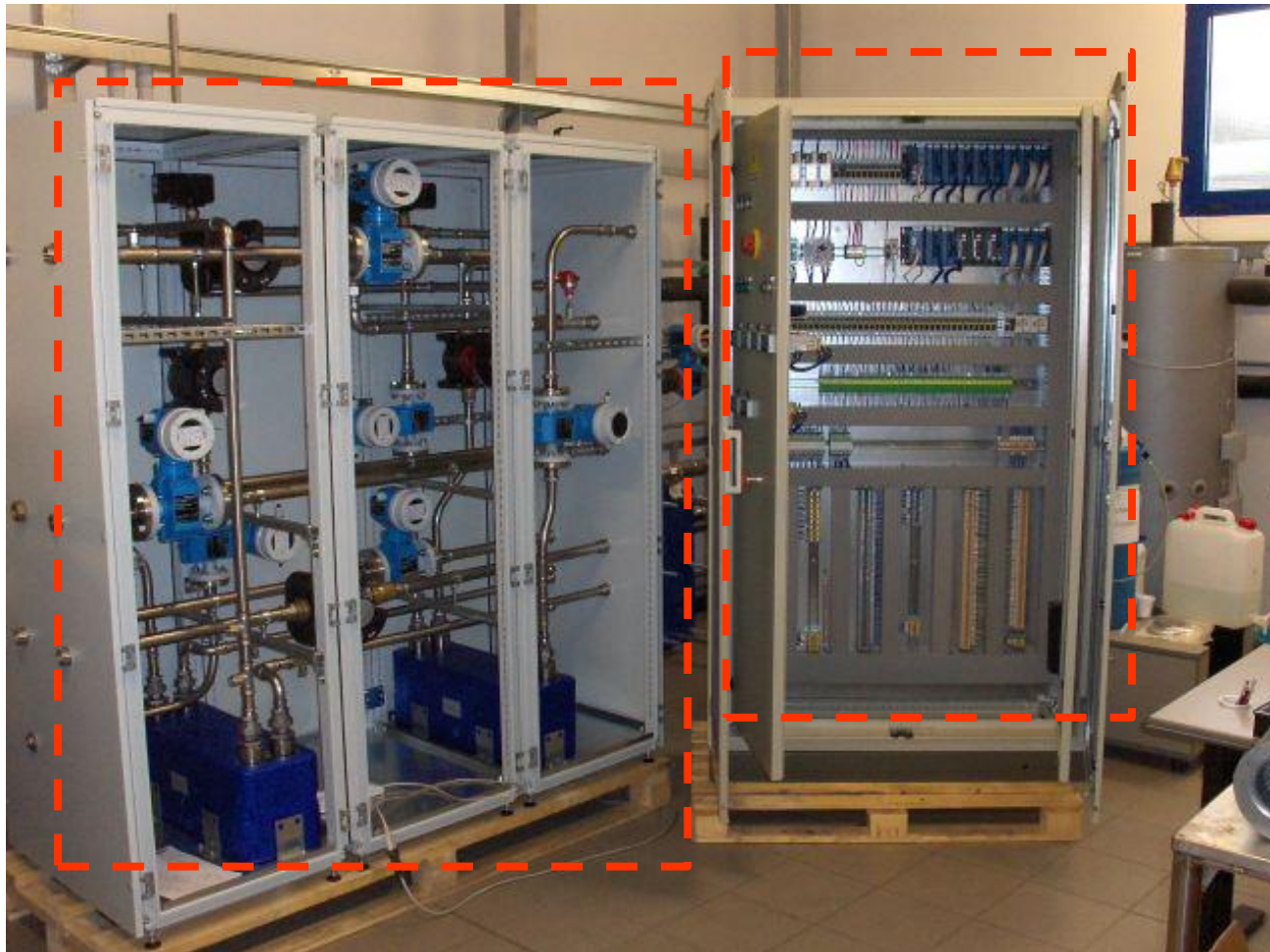
- Componenti Passivi:
Elevata massa termica; Triplo vetro; Isolamento(e.g. muratura esterna: 0.14 W/m²K); Riduzione ponti termici
- Componenti Attivi:
Sistema ventilazione centralizzato; Sonde geotermiche; Caldaia a pellet



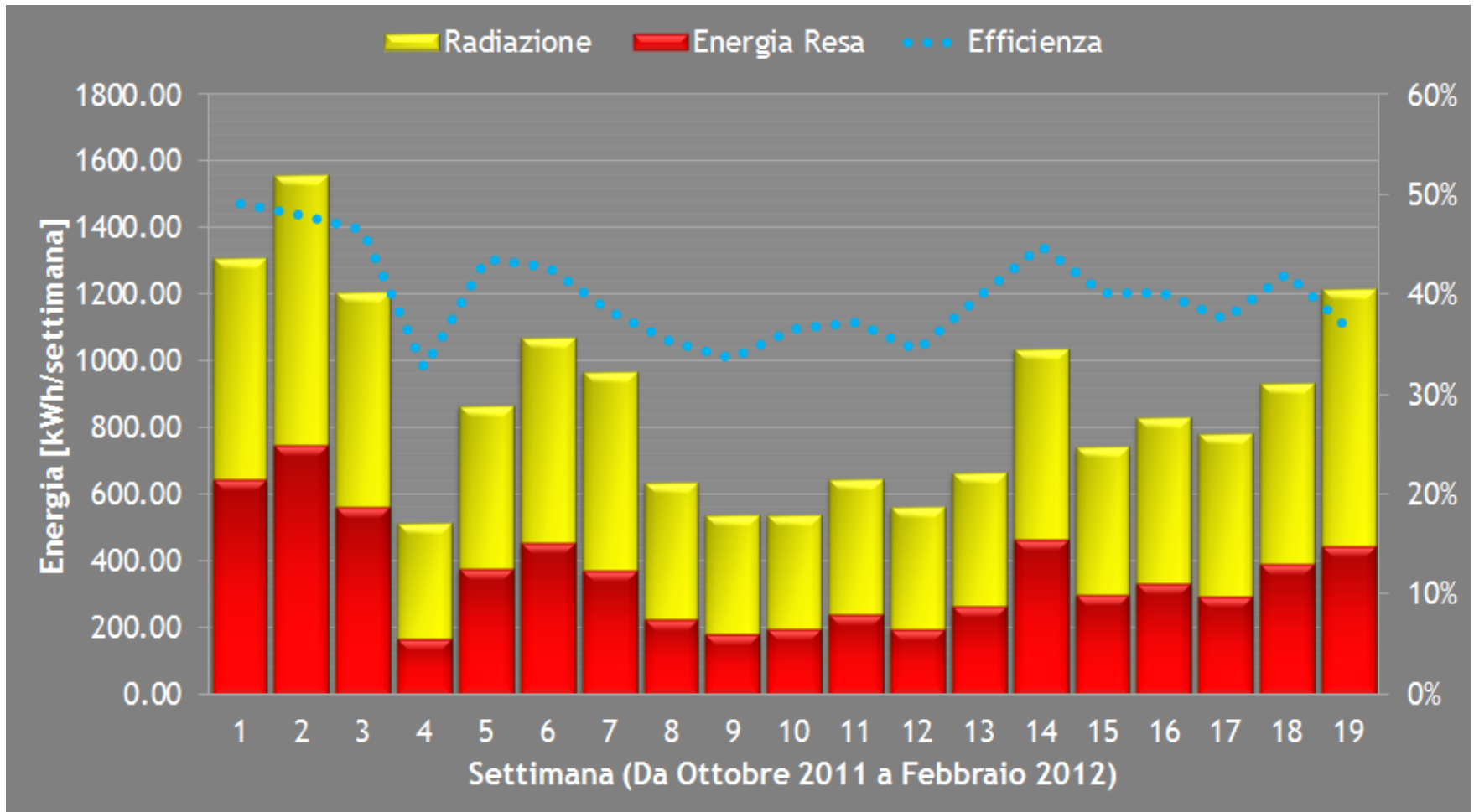
Simulation Activity for Design and Optimization



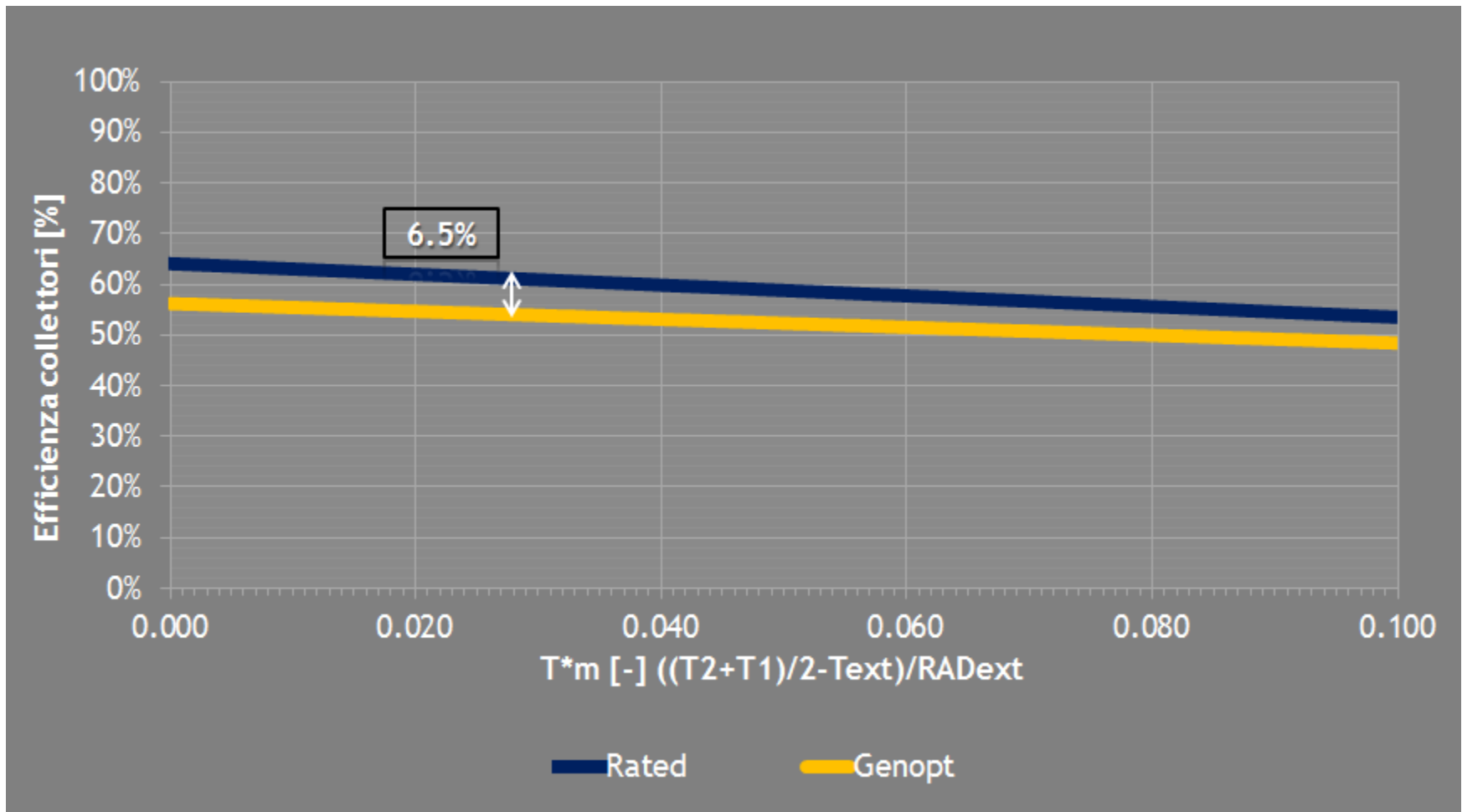
Energy Box



Monitoring Results



Components Validation through Monitoring



Velta Italia

Numerical simulations:

- validation of system components;
- optimization of the control strategy;

Experimental activities:

- monitoring;
- lab tests
 - Stationary done
 - Dynamic Starting

Expected commercialization:

- End 2012



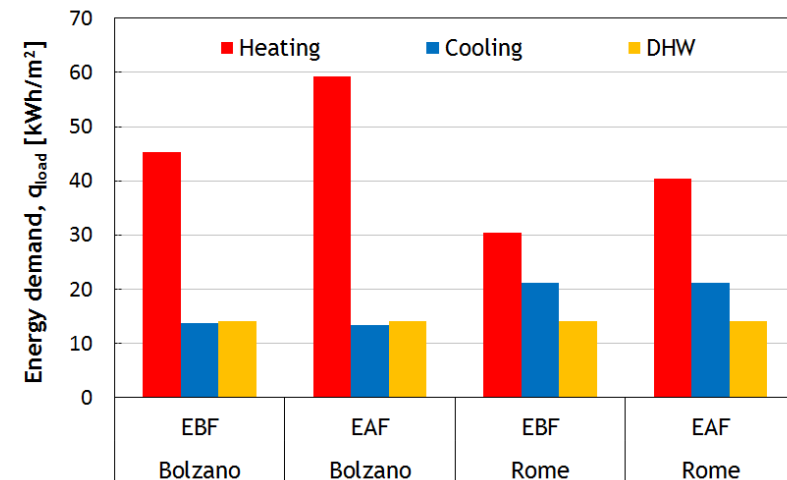
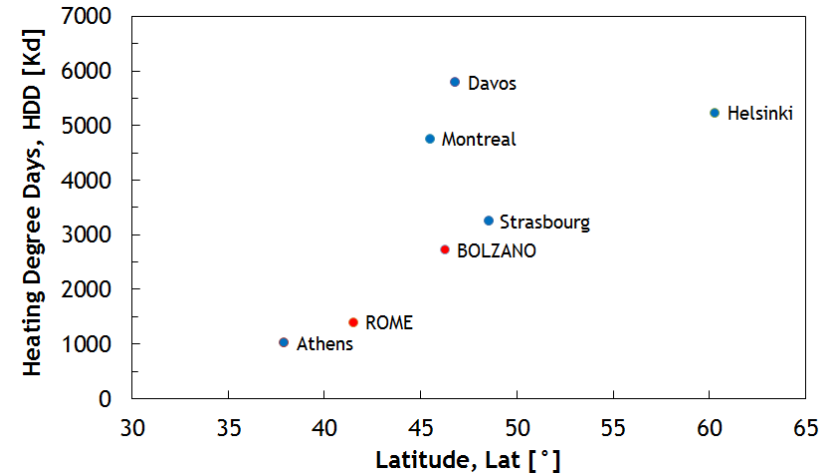
Boundary conditions

Locations:

- Bolzano and Rome

Commercial target:

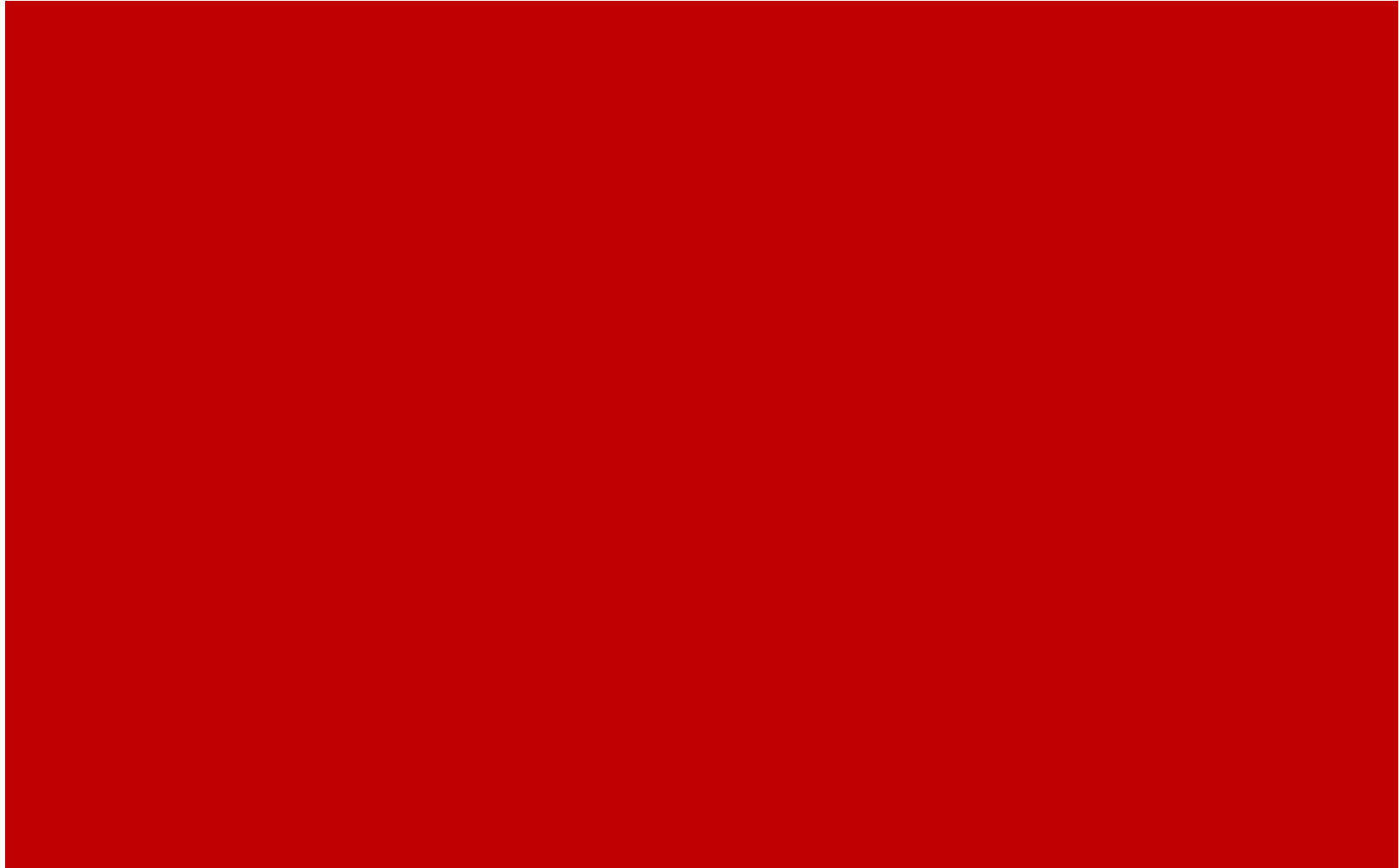
- 2-story SFH of 150-200 m²;
- EBF = complies with italian mandatory energy rating system;
- EAF = representative of italian building stock;
- DHW demand: 200 l/day @ 40 °C (14 kWh/m²);



System Layout



Dynamic Simulations



Control Box



Simulations Outcomes - 1

Clima	Tipo Edificio	Area collettori [m ²]	Fattori prestazione stagionali				Energia primaria				CO ₂
			SPFC	SPFH	SPFW	SPFT	EP_C kWh/(m ² a)	EP_H kWh/(m ² a)	EP_W kWh/(m ² a)	ΔEP kWh/(m ² a)	ΔCO ₂ tonn/a
BZ	EBF	24	6.9	2.9	14.8	3.8	4.2	36.4	2.7	34	1.7
	EBF	28	7.6	2.9	16.6	4.0	3.8	35.4	2.5	36	1.8
	EBF	32	8.0	3.0	19.1	4.2	3.5	34.1	2.2	38	1.9
RM	EBF	24	7.3	5.8	34.4	7.4	6.0	11.6	1.3	46	1.8
	EBF	28	8.0	6.4	43.4	8.0	5.5	10.7	1.0	48	1.9
	EBF	32	8.5	6.8	45.0	8.5	5.2	10.0	1.0	49	2.0

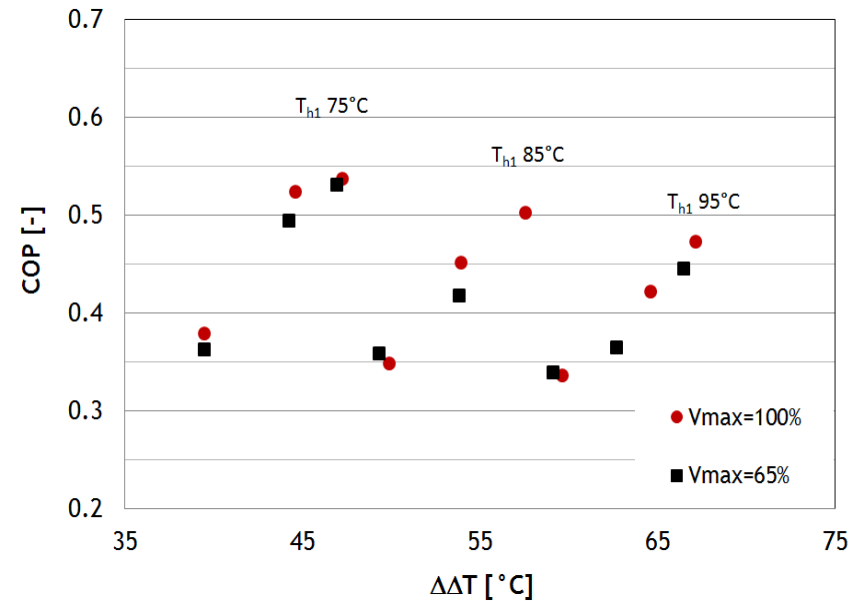
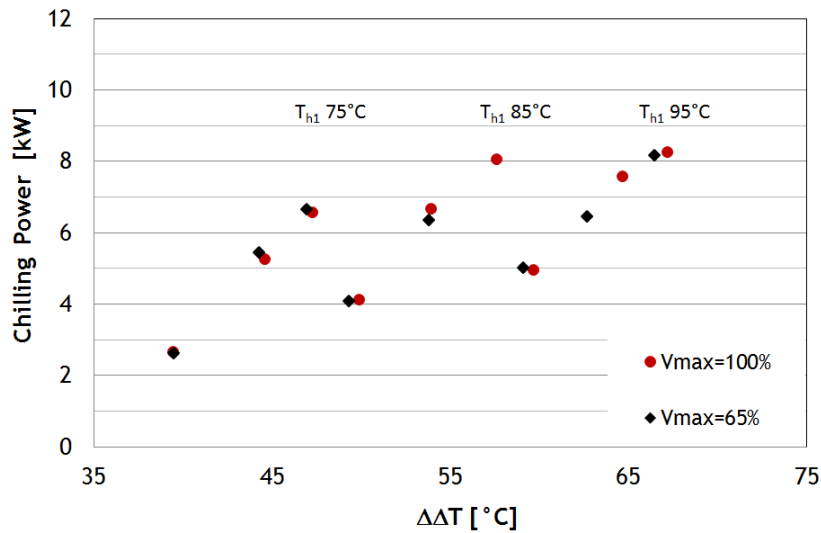
Simulations Outcomes - 2

Clima	Tipo Edificio	Area collettori [m ²]	Frazioni solari (SF)				Frazioni Aerotermiche (AF)		
			SF_C	SF_H	SF_W	SF_H+W	AF_H	AF_W	AF_H+W
BZ	EBF	24	58%	42%	93%	57%	42%	5%	31%
	EBF	28	69%	45%	94%	59%	39%	5%	29%
	EBF	32	75%	48%	95%	62%	37%	4%	27%
RM	EBF	24	67%	69%	98%	80%	31%	2%	20%
	EBF	28	77%	72%	98%	82%	28%	2%	18%
	EBF	32	85%	74%	98%	85%	26%	2%	15%

Simulations Outcomes -3

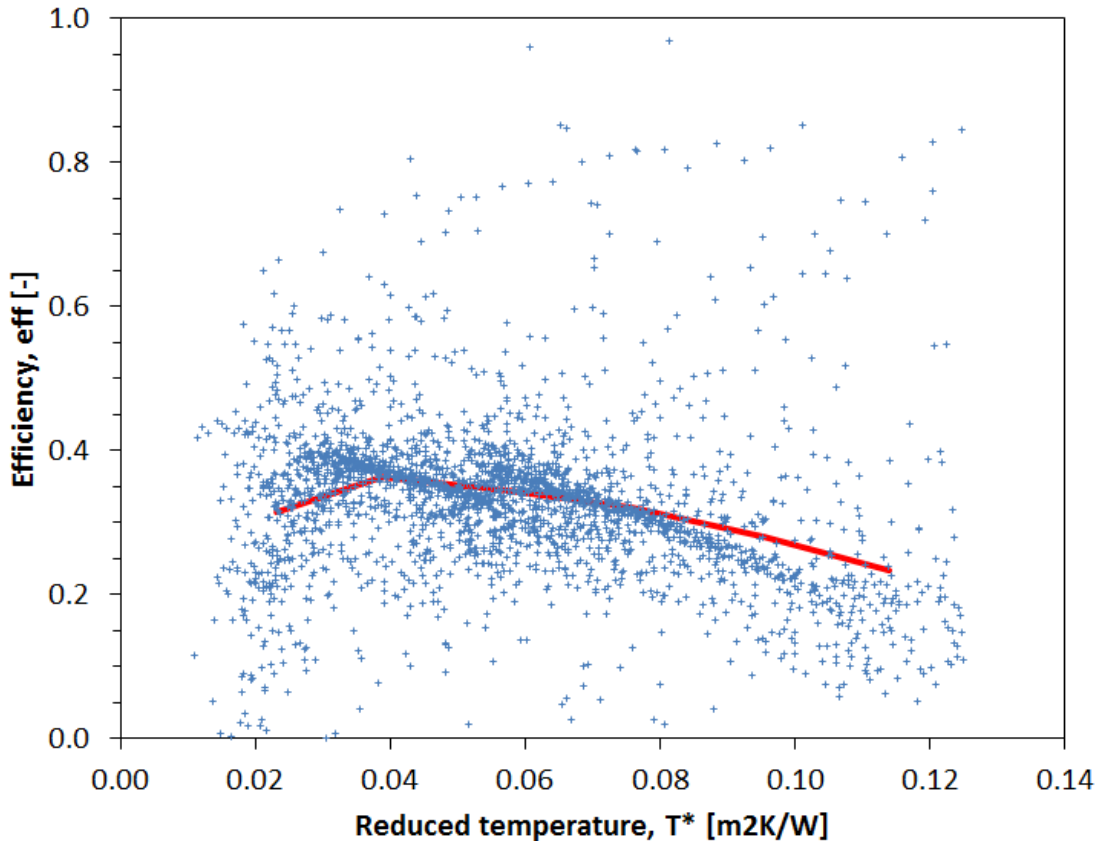
Clima	Tipo Edificio	Area collettori [m ²]	Sistema solare [kWh/(m ² a)]			Sistema di riferimento [kWh/(m ² a)]		
			EP _C	EP _H	EP _W	EP _C	EP _H	EP _W
BZ	EBF	28	3.8	35.4	2.5	8.1	53.0	16.5
	EAF	28	3.8	45.0	2.7	7.9	69.5	16.5
RM	EBF	28	5.5	10.7	1.0	12.6	35.7	16.5
	EAF	28	5.8	15.4	1.1	12.5	47.3	16.5

Laboratory tests in Stationary Cond.



Monitoring - Dynamic Behavior

Solar Collector efficiency 32 m² | 1300 kg/hr | BMA

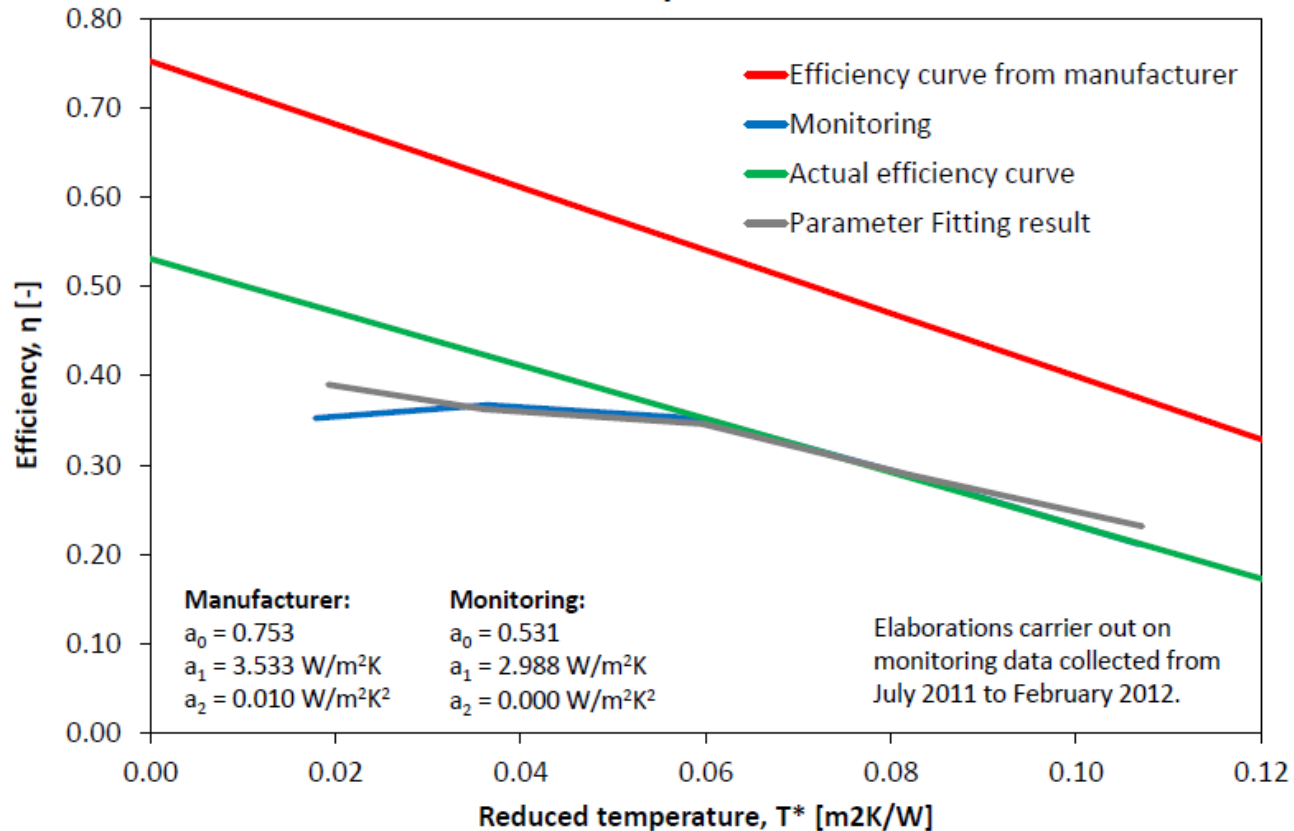


Notes:

- analysis carried out on monitored data until 16.03.2012;
- average time: **5 min.**;
- **75.9%** of monitored data;

Monitoring Results - Stationary Behavior

**Solar Collector
Efficiency curve**



Outcomes

Performance figures “promoted”:

- SPF
- PE consumption
- Renewable Energy Ratio

Components/Systems performance evaluation:

- Tests in real installations or in laboratory under real-like conditions.
- Performance verification after first working time