solarcombi+

WP4 – Task1 :
Standard configurations' analysis

Solar Combi+ Project meeting

Gleisdorf 17th - 18th December 2009

Identification of most promising markets and promotion of standardised system configurations for the market entry of small scale combined solar heating & cooling applications
EIE/07/158/SI2.466793 09/2007 – 02/2010

Intelligent Energy Europe

Task 1 – Standard system configurations

Project proposal states:

Objective

Standard system configurations, independent of specific product, to be communicated and promoted towards a **wide audience**

Task

Definition of a reduced number of "standard system configurations" which can be promoted and applied **similarly to the standard systems for DHW** with **reasonably good results** in **typical/average cases** (mostly technology independent)

Outcome

Standard system configurations (3 to 5), which are independent of specific product and work best under different circumstances

Standard System Configuration

	WCT				HC				DC			
CC	ET		FP		ET		FP		ET		FP	
	A	X	A	X	A	X	A	X	A		A	
	B	X	B	X	B	X	B	X	B		B	
	C	X	C	X	C	X	C	X	C	X	C	X
	D	X	D	X	D	X	D	X	D		D	
	E		E	X	E		E	X	E		E	
FC	ET		FP		ET		FP		ET		FP	
	A	X	A	X	A	X	A	X	A		A	
	B	X	B	X	B	X	B	X	B		B	
	C	X	C	X	C	X	C	X	C	X	C	X
	D		D		D		D		D		D	
	E		E	X	E		E	X	E		E	

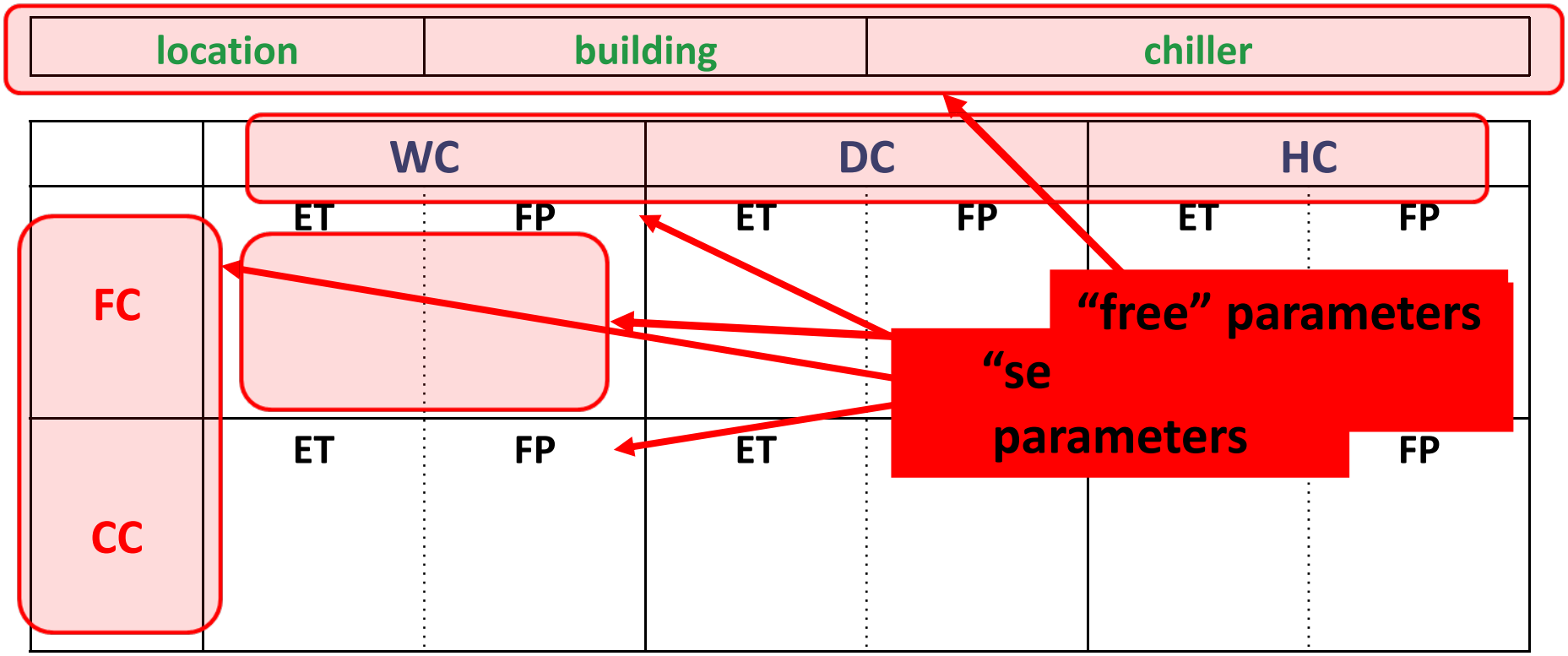
Task 1 – Standard system configurations

- total solar fraction
- total electrical efficiency
- yearly relative primary energy saved

$$Suitable\ solutions = \{solutions \mid SF_{tot} > 60\%, COP_{el} > 10, PES_{rel} > 0\}$$

$$Suitable\ solutions = \{solutions \mid SF_{tot} > 40\%, COP_{el} > 15, PES_{rel} > 0\}$$

Standard System Configuration



Standard System Configuration

NAPLES	OFFICE	ROTARTICA

	WC		DC		HC	
FC	ET	FP	ET	FP	ET	FP
	_ m^2/kW _ l/m^2	_ m^2/kW _ l/m^2	_ m^2/kW _ l/m^2	_ m^2/kW _ l/m^2	_ m^2/kW _ l/m^2	_ m^2/kW _ l/m^2
CC	ET	FP	ET	FP	ET	FP
	_ m^2/kW _ l/m^2	_ m^2/kW _ l/m^2	_ m^2/kW _ l/m^2	_ m^2/kW _ l/m^2	_ m^2/kW _ l/m^2	_ m^2/kW _ l/m^2

Task 1 – Standard system configurations

		WCT				HC				DC			
		ET		FP		ET		FP		ET		FP	
Total Solar Fraction [%]	CC	5.0	m^2/kW	5.0	m2/kW	5.0	m^2/kW	5.0	m2/kW	5.0	m^2/kW	5.0	m^2/kW
		75.0	l/m^2	75.0	l/m2	75.0	l/m^2	75.0	l/m^2	75.0	l/m^2	75.0	l/m^2
		A	86.1	A	81.4	A	86.2	A	81.4	A	0.0	A	0.0
		B	73.3	B	67.1	B	0.0	B	73.1	B	0.0	B	0.0
		C	87.0	C	83.0	C	82.5	C	77.1	C	80.2	C	74.2
		D	82.5	D	77.8	D	81.5	D	76.6	D	0.0	D	0.0
		E	0.0	E	90.3	E	0.0	E	0.0	E	0.0	E	0.0
		ET		FP		ET		FP		ET		FP	
	FC	5.0	m^2/kW	5.0	m2/kW	5.0	m^2/kW	5.0	m2/kW	5.0	m^2/kW	5.0	m^2/kW
		75.0	l/m^2	75.0	l/m2	75.0	l/m^2	75.0	l/m^2	75.0	l/m^2	75.0	l/m^2
		A	87.1	A	81.8	A	86.4	A	81.0	A	0.0	A	0.0
		B	0.0	B	0.0	B	0.0	B	0.0	B	0.0	B	0.0
		C	0.0	C	0.0	C	0.0	C	0.0	C	0.0	C	0.0
		D	0.0	D	0.0	D	0.0	D	0.0	D	0.0	D	0.0
		E	0.0	E	89.1	E	0.0	E	0.0	E	0.0	E	0.0

Task 1 – Standard system configurations

BEST Configurations:

All the best configurations are related to the largest collectors' area (**5 m^2/kW_{ref}**) and storage volume (**75 l/m^2**) simulated: in fact, even though smaller areas allow to cover rated heat fluxes at the generator of the sorption chillers to cover most of the cooling load at summer time, in winters, larger areas are required if heating and DHW preparation are needed, due to the significantly reduced radiation available.

The residential applications in Naples feature values of total solar fraction that vary between 67% and 87% for the low consumption building (R60) and 60% - 78% for the average consumption building (R100). Toulouse applications range between 46% and 55% in the case of low consumption building and between 40% and 46% for the average consumption building

Task 1 – Standard system configurations

Primary energy saved in Naples varies between 30%-70% and 25%-60% for the R60 and the R100 building. In Toulouse, values vary between 23%-45% and 25%-40% for the R60 and the R100 building respectively.

- **Higher regimes for the Heat rejection and high night loads in Naples.**

Between 12 and 24 for the low consumption building (R60), 12 and 30 for the average consumption building (R100) in Naples, between 24 and 50 for the R60 building and 30 and 70 for the R100 in Toulouse

- **Lowest values with fan coils: lower limit reached in many cases.**
- **Highest values whit SonnenKlima …**

Task 1 – Standard system configurations

In office applications, mostly SonnenKlima “survives” to COP check.

For chiller “A” in office applications, the relative PES ranges between 63% and 78% in Naples, 55% and 71% in Toulouse and 26% and 40% in Strasbourg. The total solar fraction approaches the unity in Naples, varies between 80% and 90% in Toulouse and ranges between 50% and 60% in Strasbourg.

Only one case with chiller “E” (Solution/EAW) “survives” in Strasbourg.

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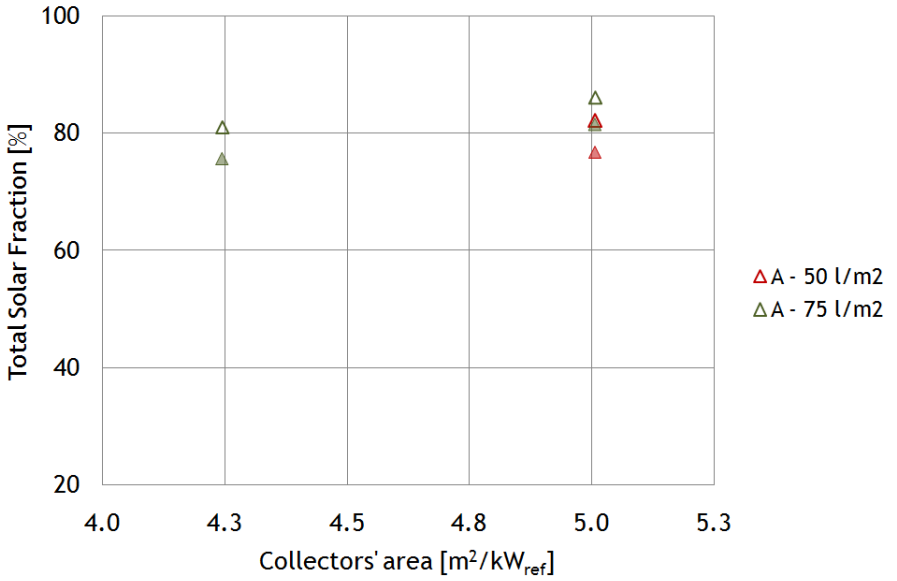
STANDARD Configurations:

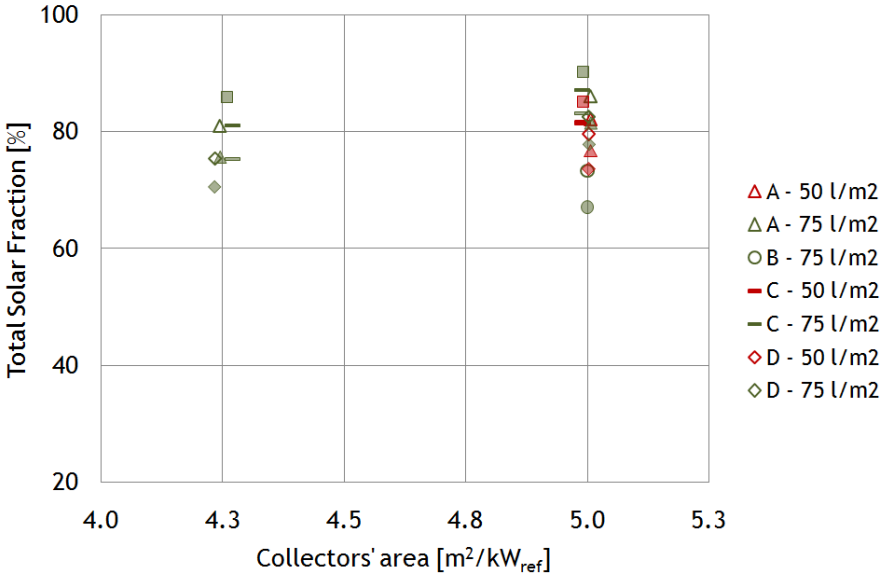
The **three best configurations** for each set of parameters were selected as **standard configurations** and a sensitivity analysis was carried out on the basis of:

- total solar fraction
- cooling solar fraction
- relative primary energy saved
- total electrical efficiency
- gross solar yield

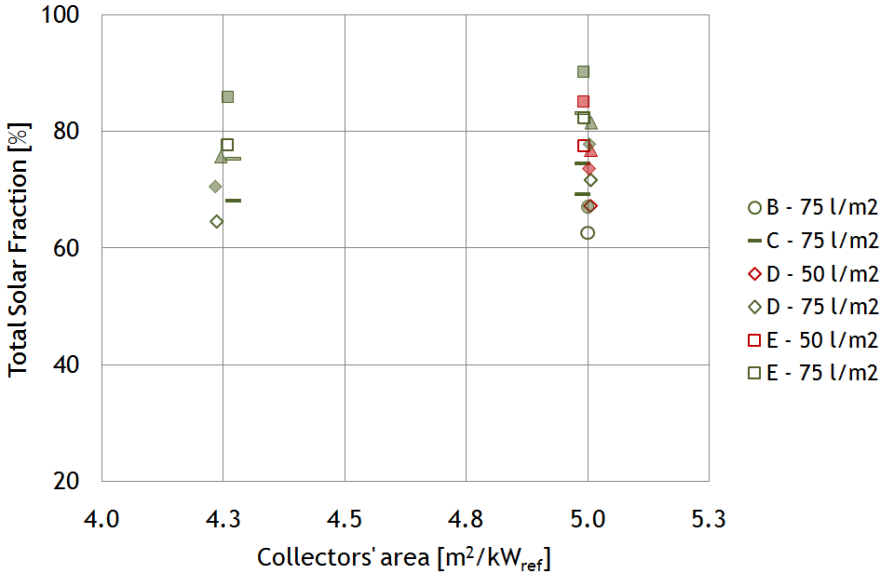


Task 1 – Standard system configurations

Collectors comparison



Building comparison



In Naples the evacuated tubes allow increasing the performance of 5 to 7%, while in Toulouse the gain is higher, but still limited to around 10%

The impact of the building efficiency is a reduction of 7 to 10% when going from R60 to R100

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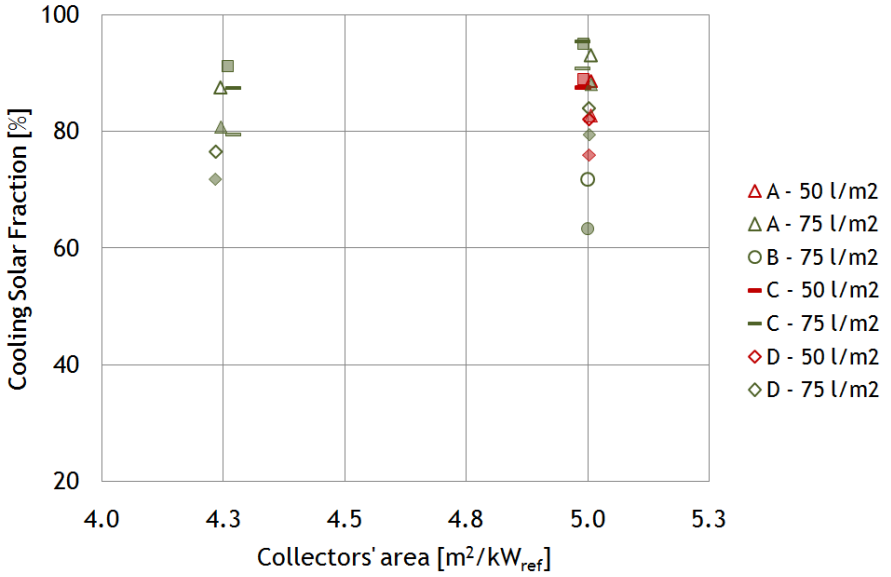
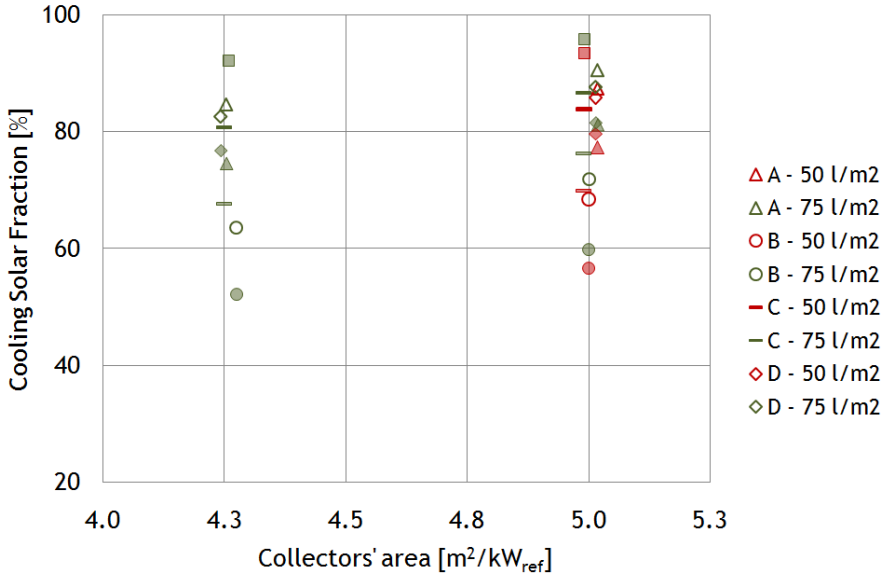
Collectors comparison - Naples



Collectors comparison - Toulouse



The values are higher than the corresponding total solar fraction ones: in Naples they are in the range 70%-95%, whereas in Toulouse they vary from 50% to 95%. A large variability of values is detected in Toulouse: being lower the radiation levels, only machines working at lower temperatures can reach nominal operating conditions for large periods of time.

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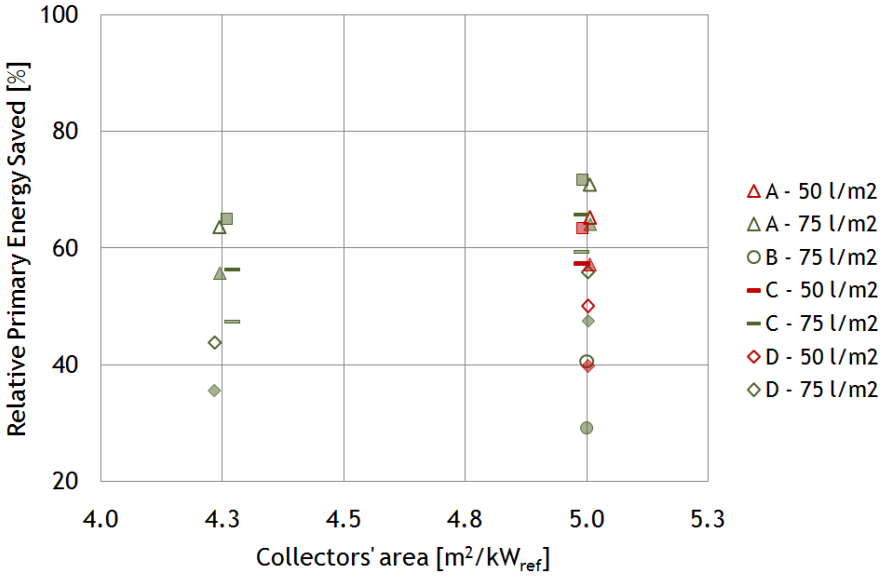
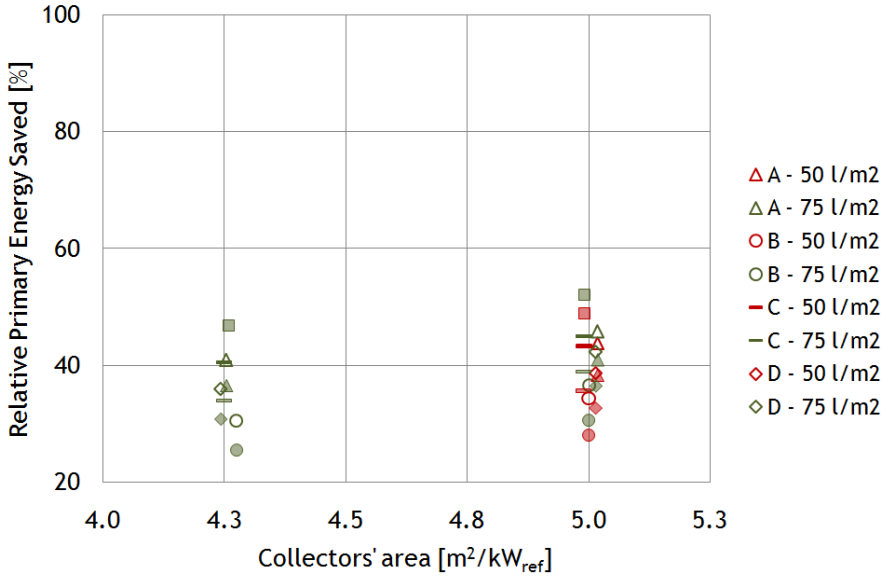
Collectors comparison - Naples



Collectors comparison - Toulouse



The effect of reducing the storage volume from 75 l/m^2 to 50 l/m^2 is a quite significant reduction of about 9-10%. The outcome of additionally reducing the collectors area is a drop of the values calculated of around 12-17%.
Relative primary energy saved varies of about 10% in Naples and 5% in Toulouse, depending on the collectors technology used: variations in a range of 15-30%.

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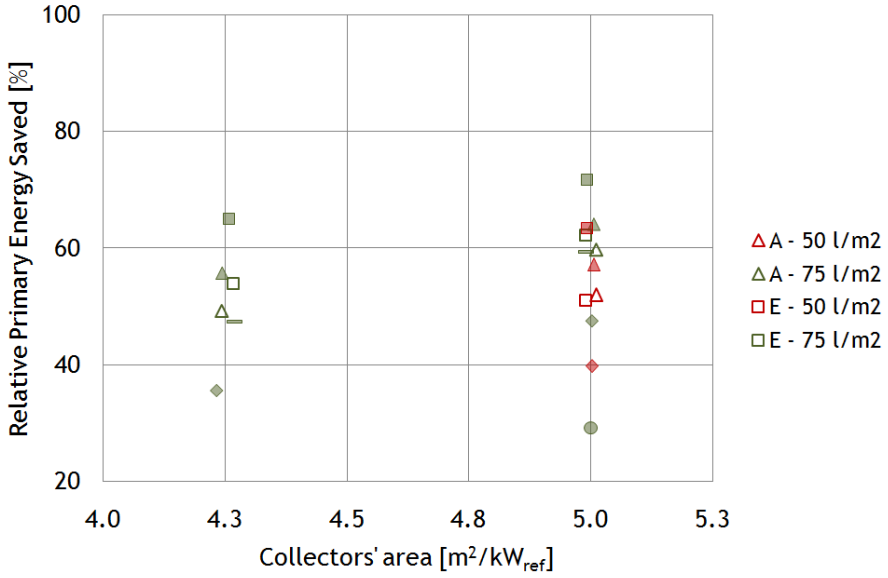
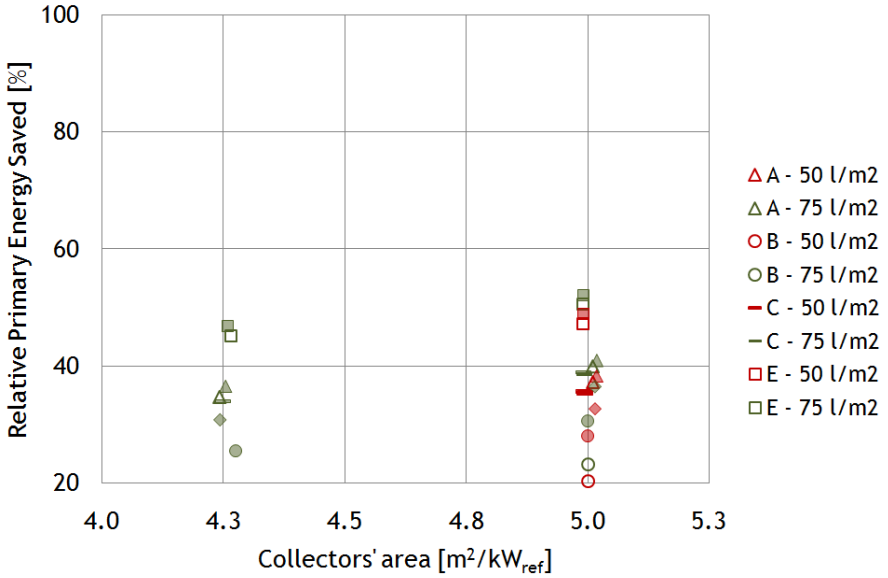
Distribution system - Naples



Distribution system- Toulouse



Fan coils utilization requires a higher heat rejection, producing larger electrical energy consumption; the effect is still very limited in Toulouse, while it might result in a quite large reduction of the system performance (5-10%) in Naples.

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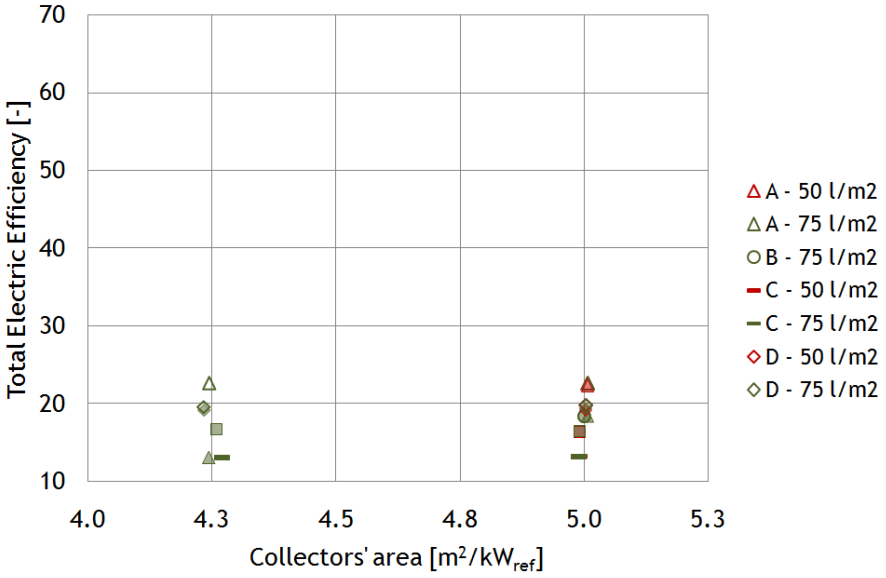
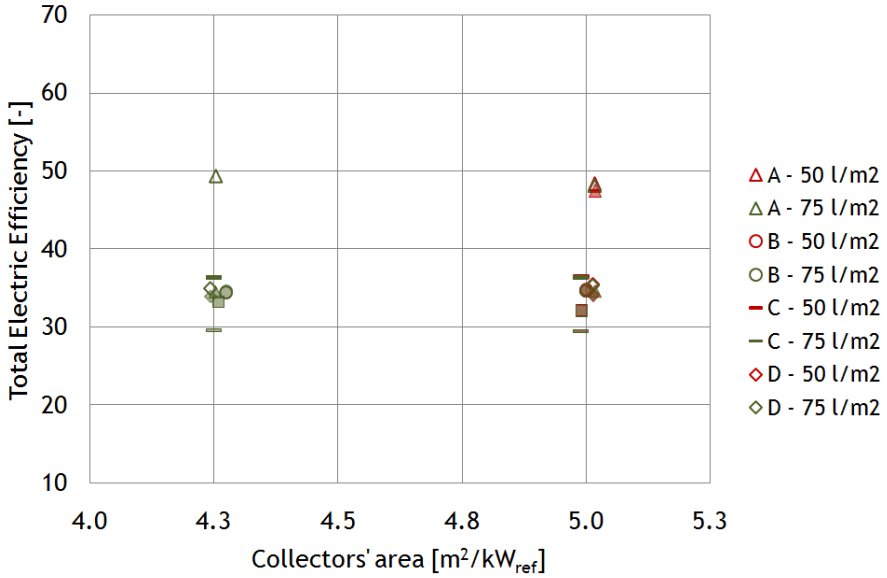
Collectors comparison - Naples



Collectors comparison - Toulouse



The latter analysis holds also regarding the total electrical efficiency: higher summer electrical energy consumption brings to much lower data in Naples (i.e. range 10-25%) than in Toulouse (range 25-40%).

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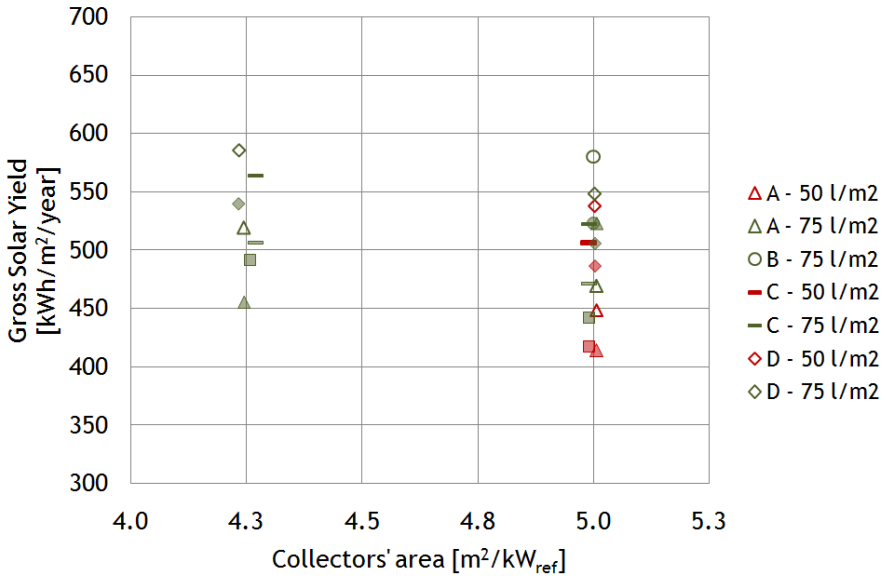
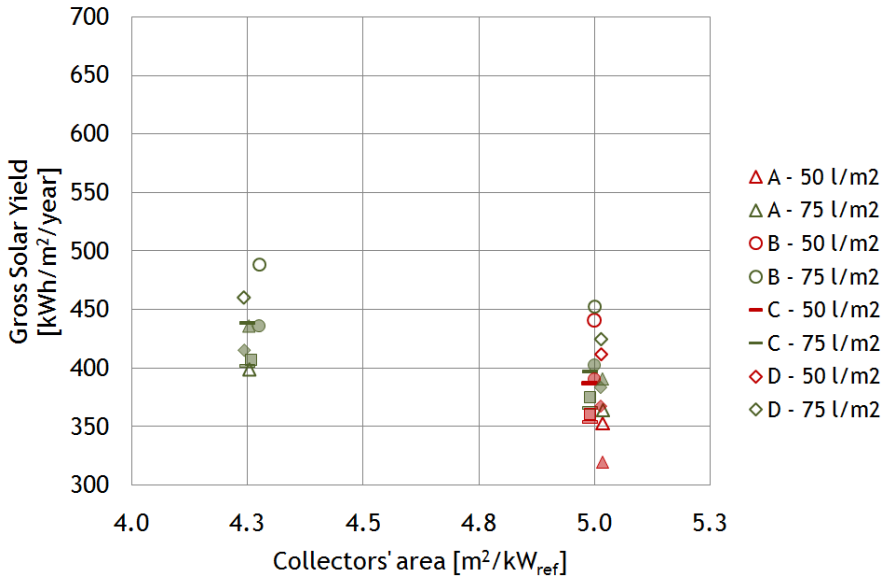
Collectors comparison - Naples



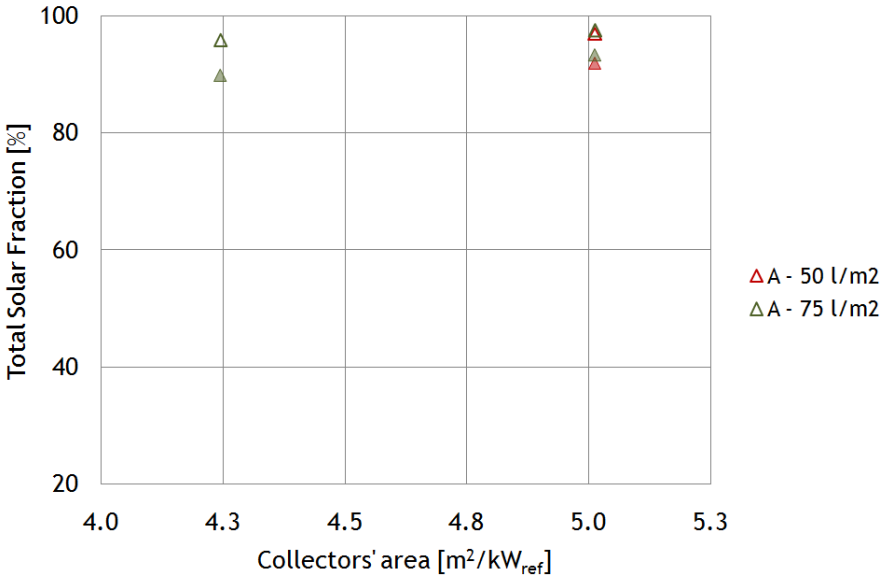
Collectors comparison - Toulouse



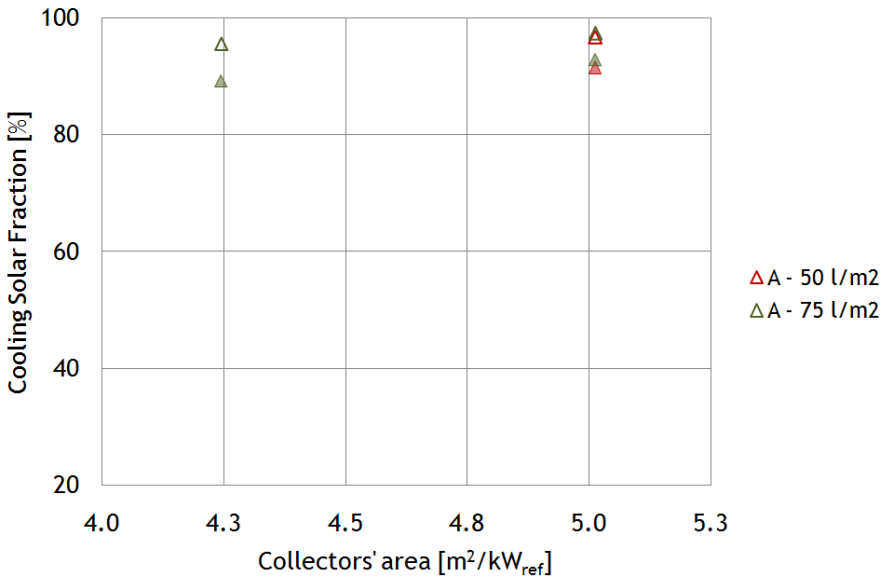
A strong dependence on the collectors area is evident: smaller areas work better since the ratio between the energy gathered and the loads is lower; the energy is therefore better used in the system and the return temperature to the collectors is lower. This produces lower thermal losses toward the environment. For the same reason much lower stagnation is encountered.

Task 1 – Standard system configurations

Total solar fraction



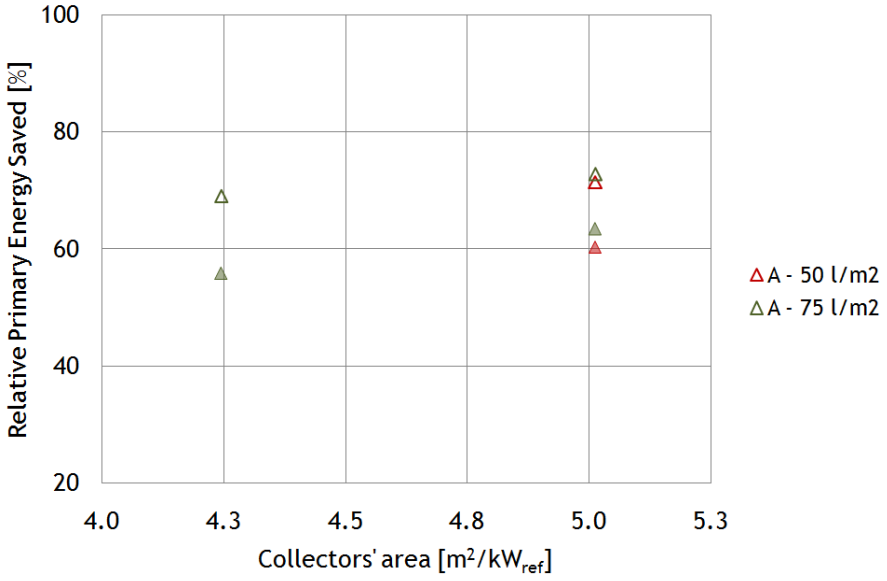
Cooling solar fraction



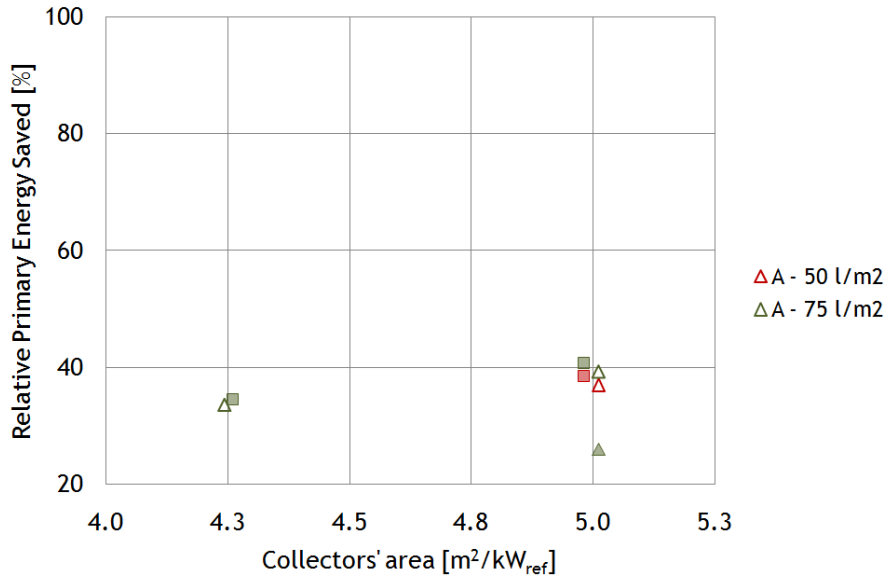
Office buildings

Task 1 – Standard system configurations

Relative PES - Naples



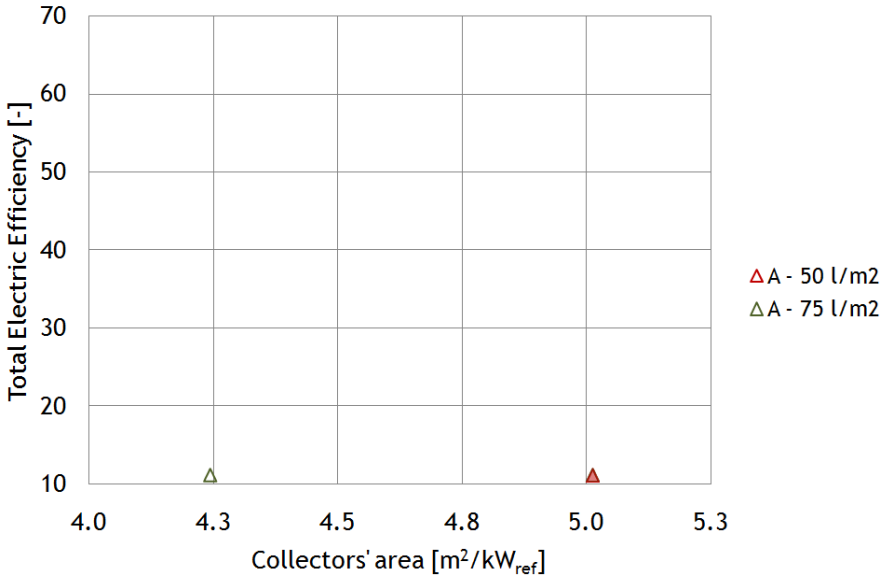
Relative PES - Strasbourg



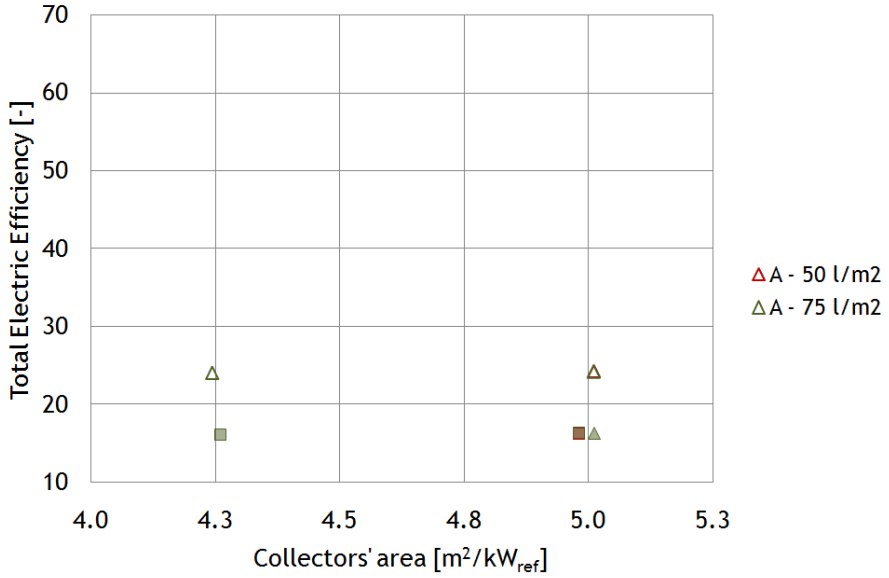
Office buildings

Task 1 – Standard system configurations

El COP - Naples



El COP- Strasbourg



Office buildings

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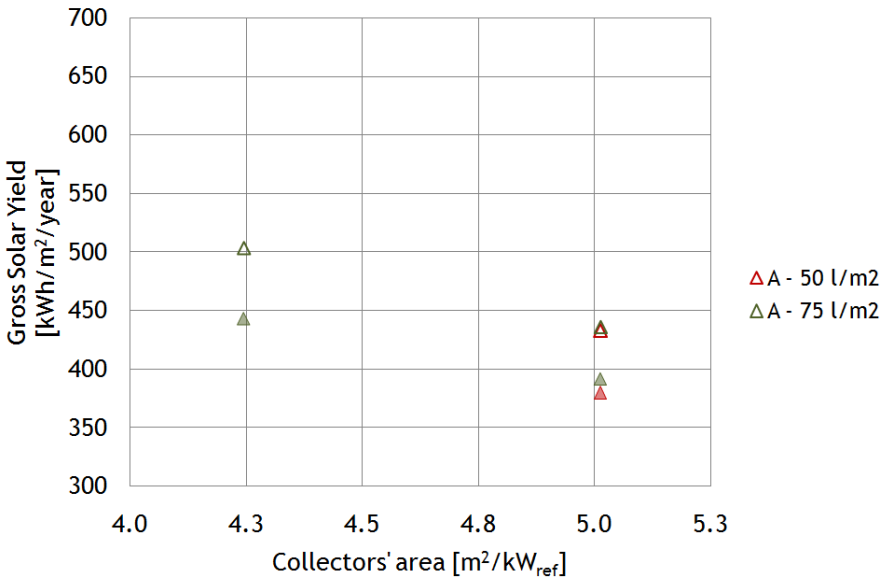
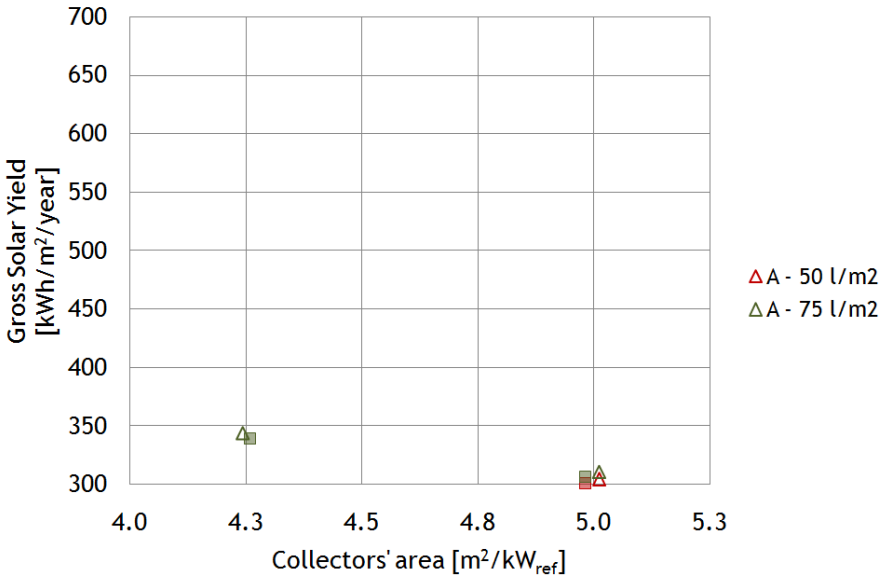
GSY - Naples



GSY - Strasbourg



Office buildings

Task 1 – Standard system configurations

Cooling solar fraction decreases if the backup heater is not used. This is due to the fact that the heater allows higher temperatures at chillers inlet (and also at the outlet); therefore, also higher temperatures at the collectors are temporarily produced and thus higher solar fractions. In Naples the decrease is around 3%-5%, while higher values are encountered in Toulouse, i.e. around 5%-10%.

The largest effects are however encountered if yearly relative primary energy is considered. The saving of fossil fuel increases this figure in a range of 10%-30% (absolute). For the same reasons reported above, the best effects are encountered in Naples where 20%-30% higher savings are obtained, while in Toulouse more moderate increases are achieved around 10%.