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DD 1C.1 Architectural measures taken in each urban conversion project

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Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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1 Summary

Within the POLYCITY project some interventions for the Italian site in Torino have been planned. These measures are expected to reduce the demand for thermal, cooling and electrical energies in the Arquata district. They concern two main application fields: the ten-store ATC office building and 30 council buildings and their common spaces (courtyards, parking, internal streets and walking ways).
In brief the planned measures for the *residential buildings* are:

- *Thermal insulation of roofs* for the 30 residential buildings. The insulation has been applied to the floor of the garrets using a layer made of sintered expanded polystyrene with a thickness of 30 mm.
- *High efficiency glazing* will be applied on a significant part of the residential buildings. The conventional glazing will be substituted with low emittance glazing, mainly on the NE and SW sides (2 or 3 windows for each flat). The total window thermal transmission (frame + glass) will decrease from actual $U_w \approx 4$ to $U_w \leq 1.6$ W/m^2K.
- *High efficiency lighting in common spaces.* The lamps (about 100) in the internal courtyards of the council buildings will be substituted with induction lamps that assure a much greater energetic efficiency and duration. There will be no variation in the lighting level.

For what concerns the *ATC building*:

- *Reduction of thermal losses on North-East facade.* There will be two kinds of measures: the substitution of windows in the NE facade with low emittance double glasses and aluminium frames with thermal barrier (with an overall thermal transmission of 1.6 W/m^2K) and the insulation of thermal bridges caused by walls and balconies with application of wooden fibre panels.
- *Shading effect due to PV modules installation.* The lower portion of sun rays, entering from the windows into the offices or hitting the internal venetian blinds, would reduce the solar gains and consequently the cooling energy needs.

2 Deliverable objectives and starting point at the beginning of reporting period

This document is part of the Work Package DE1 ("Implementation of demand side efficiency measures"). It presents a description of the architectural measures that were initially planned and nowadays partially implemented on the Italian site of the POLYCITY project: the Arquata district in Torino.
The thermal insulation of district building roofs has been completed in February 2006. In the middle of 2006 a simulation analysis on ATC building has been carried out in order to define the best technical solutions for the reduction of thermal needs. Then the drawings, reports and bureaucratic documents for the call for tenders have been prepared. The tender for ATC building measures has been held in February 2007, while the tender for the Arquata district measures in March 2007.

3 Overview of the Arquata district

Arquata is a densely populated district of the city of Torino, constituted by 42 large council buildings, with approximately 900 dwellings, built at the beginning of the 20th century and by a 10 storey commercial building built in the 1970's which is the main premise of Agenzia Territoriale per la Casa (Housing Authority of the Province of Torino ATC), which almost entirely owns and develops the whole district.
Arquata is located close to the city centre of Torino, but is isolated from the surrounding urban areas by physical barriers such as two railway tracks and one bridge. The physical isolation generated a progressive social separation and marginalisation of the district. Social and occupational situation became critical and was accompanied by a progressive urban deterioration. Services and economical activities have been always locally absent.
The demonstration site for POLYCITY covers an area of 87.500 m^2 with 30 residential buildings with 622 dwellings. The population involved is between 2500 and 2600 persons, of which 2200–2300 are inhabitants of the council buildings and 300 are employees of ATC.

Figure 1 – Views of the Arquata district (residential buildings)

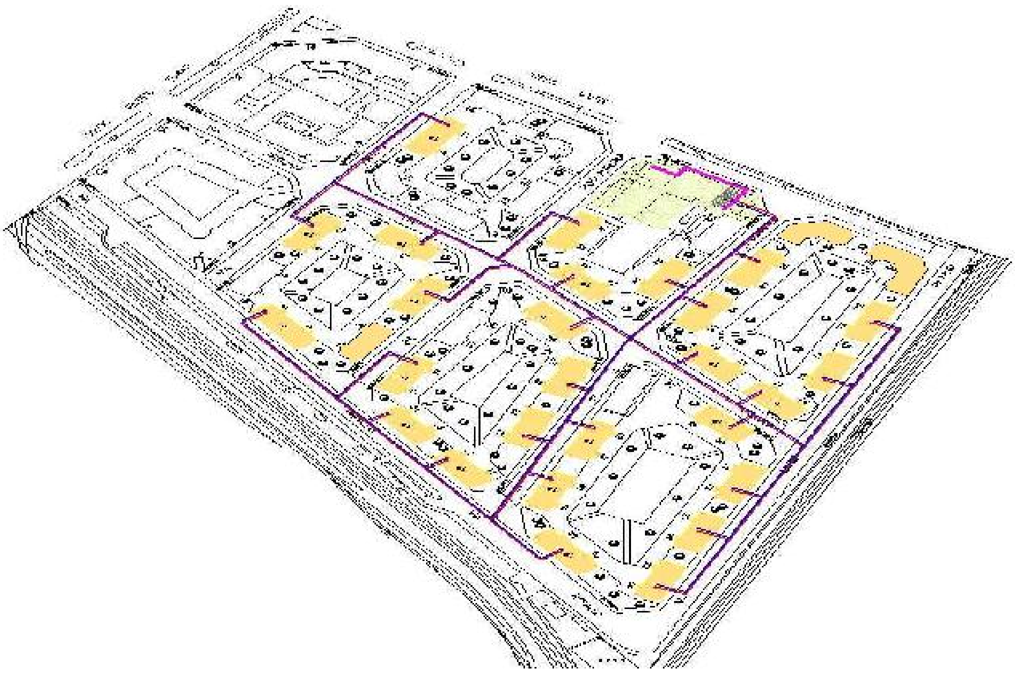

Figure 2 – Arquata district plan

4 Description of planned and implemented measures for the residential buildings

4.1 Thermal insulation of roofs

A thermal insulation of roofs has been provided for the 30 residential buildings pertaining to the POLYCITY project. This work has been finished in February 2006. The insulation has been applied to the floor of the garrets using a layer made of sintered expanded polystyrene. The application of the material pans has been more difficult than usual because of the curvilinear shape of the garrets.
The insulating material used is a product called “BITUROLL AE 20/G2V”. It is an insulating system in rolls, obtained with the coupling of a waterproof membrane of bitumen-polymer and panelists of sintered expanded polystyrene, with thickness of 30 mm.

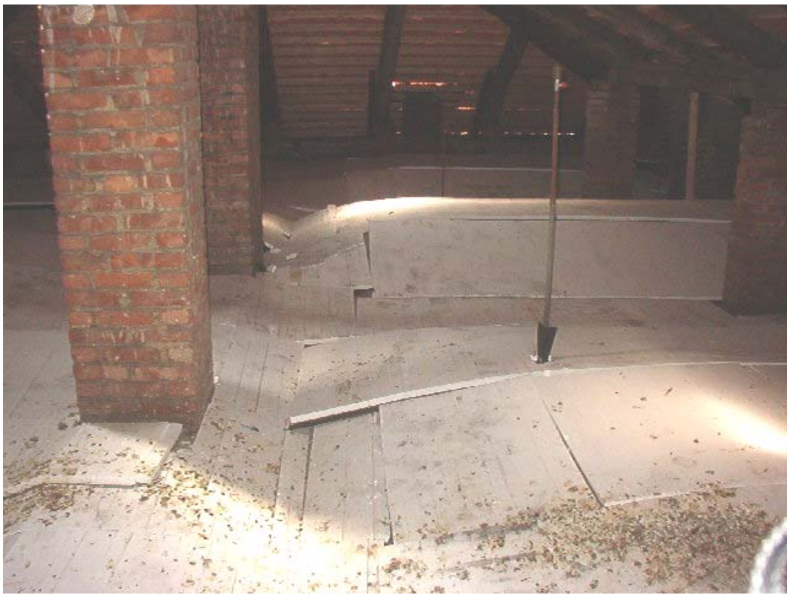

Figure 3 - Curvilinear garret in the district building

4.2 Application of high efficiency glazing

High efficiency glazing will be applied on a significant part of the residential buildings.
The conventional glazing will be substituted with low emittance glazing on the windows with large surface and mainly on the NE and SW sides, since they give the best ratio between energetic/comfort improvement and financial expenditure. Also the window frames will be substituted.
It must be said that the best thing would be the substitution of all the windows (about 2000), but the budget available for this measure doesn’t permit to accomplish it.
The total window transmission factor (frame + glass) will decrease from actual $U_w \approx 4$ to $U_w \leq 1.6$ W/m^{2}K.
The measure will be implemented in ATC owned apartments (on average 2 or 3 frames per apartment and 20-22 for each building with a total of approximately 500 windows). In the other flats it could be realised upon request of the renters or owners, on their charge.
Table 1 in the next page reports a preliminary plan of the windows that will be substituted.
This measure will allow to reduce heat losses, air infiltration and noise and is expected to improve the comfort conditions of the apartments.

Figure 4 – Residential building windows

Table 1 – Preliminary plan of window substitution

ADDRESS	SOUTH-WEST		NORTH-EAST		BATH-ROOMS	TOTAL
	Windows	Doors	Windows	Doors		
VIA ARQUATA 14/5	8	0	0	4	0	12
VIA ARQUATA 14/6	8	0	0	2	0	10
VIA ARQUATA 14/12	3	6	9	5	3	26
VIA ARQUATA 15/47	9	5	0	7	0	21
VIA ARQUATA 15/48	10	6	4	8	0	28
VIA ARQUATA 16/25	0	3	4	2	3	12
VIA ARQUATA 16/26	4	8	10	7	4	33
VIA ARQUATA 16/31	1	1	0	1	0	3
VIA ARQUATA 16/32	8	5	1	5	0	19
VIA ARQUATA 16/33	9	5	0	7	0	21
VIA ARQUATA 16/34	9	5	2	6	0	22
VIA ARQUATA 22/49	0	8	10	6	4	28
VIA ARQUATA 22/50	2	5	8	5	2	22
VIA ARQUATA 22/57	14	0	0	7	0	21
VIA ARQUATA 22/58	8	0	1	4	0	13
VIA ARQUATA 23/67	4	5	15	16	4	44
VIA ARQUATA 23/68	4	6	10	5	5	30
VIA ARQUATA 23/69	0	6	11	4	5	26
VIA ARQUATA 23/70	5	0	5	5	5	20
VIA ARQUATA 23/76	8	4	0	6	0	18
VIA ARQUATA 23/77	10	5	2	7	0	24
VIA ARQUATA 23/78	8	4	0	6	0	18
VIA ARQUATA 23/79	10	6	4	9	0	29
TOTAL	**142**	**93**	**96**	**134**	**35**	**500**

In April 2008 has started the substitution of windows in the Arquata district. This works have been delayed because of the difficulty of carrying out such kind of works during

winter months. This was done in order to avoid discomfort and troubles to the inhabitants, most of whom are aged.
By the end of April around 100 new windows have been installed. The remaining will be installed in May and June 2008.

Figure 5 – The new windows waiting to be installed

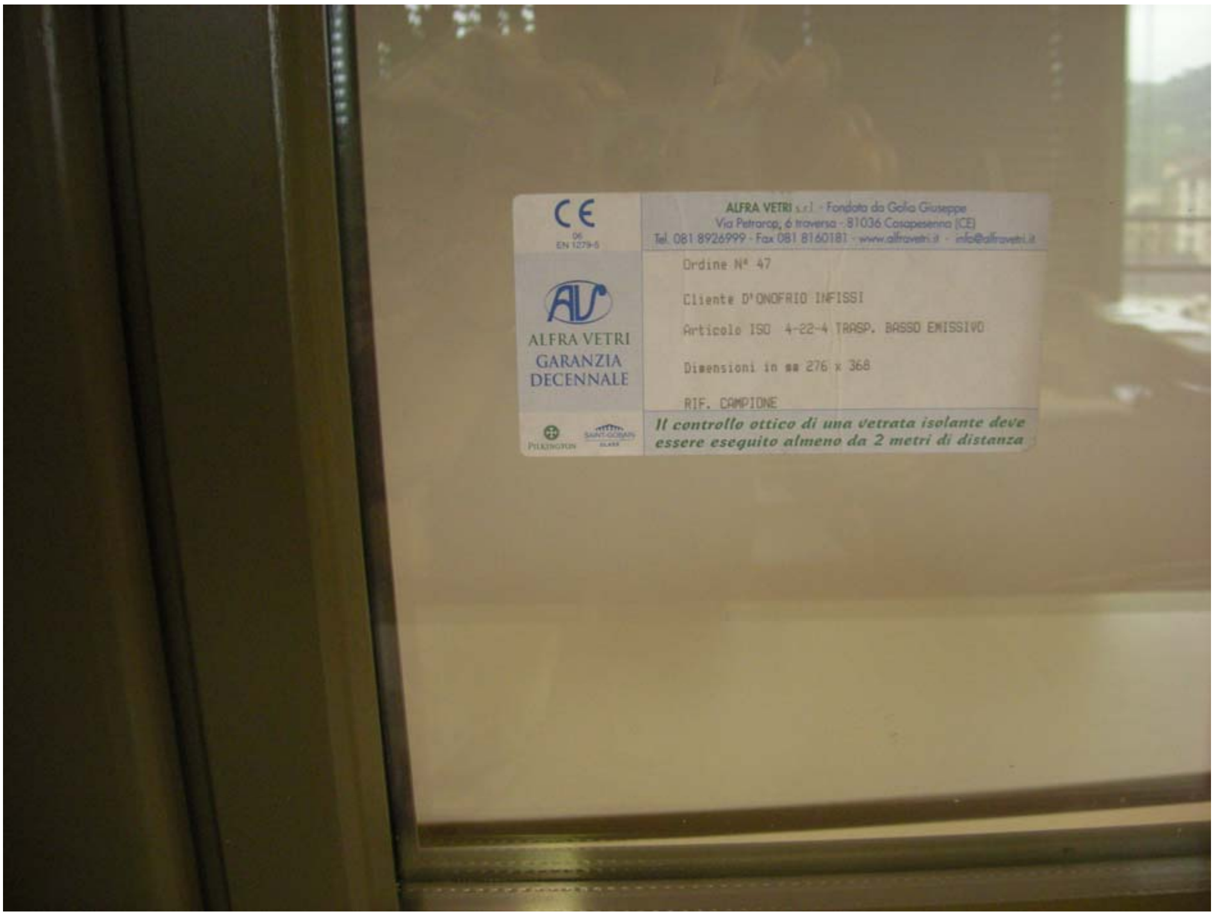

Figure 6 – Label of low-emittance glazing

4.3 High efficiency lighting in common spaces

The lamps (about 100) in the internal courtyards of the council buildings will be substituted with induction lamps that assure a good level of energetic efficiency and a much greater duration. There will be no variation of quality in the lighting level.

The actual lighting system includes two typologies of lamps:

- Internal streets: mercury vapour lamps with 125W power posed on 4.2 m high poles
- Walking ways and court gardens: mercury vapour lamps with 80W power posed on 2.5 m high poles

These two types of lamps could be substituted without changing the lighting level with induction lamps, respectively with 55 W and 85 W of power.

Characteristics of induction lamps:

- The average life of this kind of lamps is 60’000 hours (up to 100'000 in some cases), about ten times common lamps and 4/5 times High Intensity Discharge (HID) lamps
- The Colour Rendering Index [Ra8] is ≥ 80
- Colour temperature 2600-3000-3800 [K] (Indicative values)
- Absence of flickering
- High luminous efficiency ~ 65 lm/W
- High initial cost (over 10x the cost of conventional HID lamps)

Figure 7 – Internal courtyards lamps

5 Description of planned measures for ATC building

5.1 Reduction of thermal losses on North-East facade

Actually the ATC building has continuous windows frames along all facades. The frames are made of aluminium, sliding type construction. The glazing are double glass with 3 mm of thickness each and overall transmission factor of 3.8 W/m²K.
The walls are made of reinforced concrete, have thickness of 15 cm, conductivity of 1.91 W/m K and specific heat of 920 J/kg K. The walls create, together with the balconies that hang all around the building and in all the floors, a series of "*thermal bridges"* that cause a great heat loss during the cold season.

A deep analysis of the thermal behaviour of the ATC building has been carried out in spring/summer 2006. We are dealing with a dynamic energetic simulation, done using the software tool "Energy Plus". The simulation took into consideration the various technical and energetic aspects concerning the ATC building: materials composing the structure, geometrical dimensions, internal gains due to workers and PCs, features of windows, orientation and insulation of facades, air infiltrations and others.
The results of the analysis proved that a substitution of windows in the NE facade with low emittance double glasses and aluminium frames with thermal barrier (with an overall transmission of 1.65 W/m²K) could give a remarkable reduction on winter thermal demand (the study showed a result of about 60 kWh/m^2 instead of actual 74.8).
The chosen new type of windows is not anymore the sliding window type as now it is, but transom windows to the external (see drawing in Figure 8). This because this opening system permits to achieve higher performance at lower cost (than the sliding one) and to avoid interference with desks, furniture or Venetian blinds inside the offices (as could happen with traditional side hinged opening system).

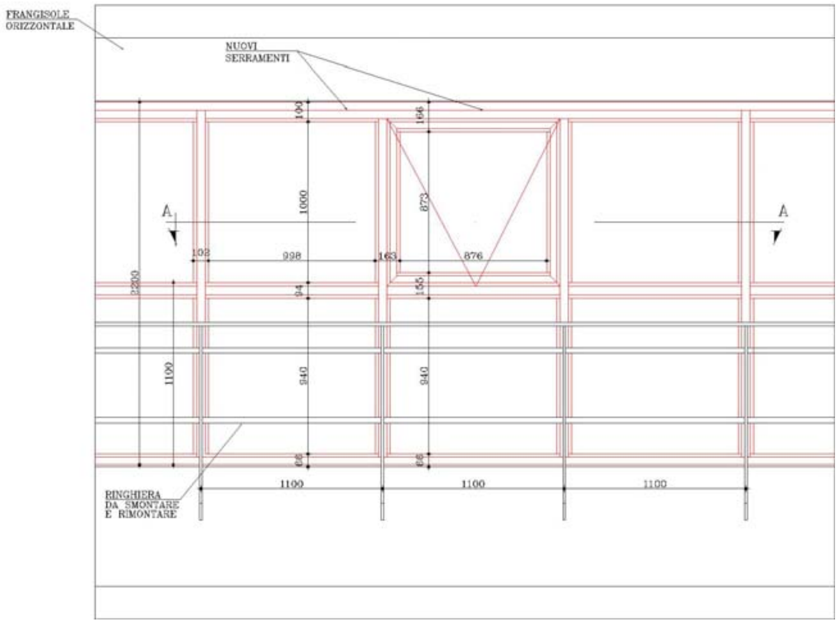

Figure 8 – Prospect of new windows in the ATC building

The study also pointed out the importance and necessity of the insulation of thermal bridges with the laying of insulating material.
The executive project prescribed, for this point, the application of insulating panels made of wooden fibre all over the walls and the overhangs, as showed in Figure 9.
The effect of insulating panels is the drastic reduction of thermal losses, as shown in Figure 10; in the left image the red/violet colours indicate the heat flows from inside to the outside that in the right image result considerably blocked. The effect of this measure, according to the simulation, is the decrease of thermal needs from actual 74.8 to about 65 kWh/m^2.

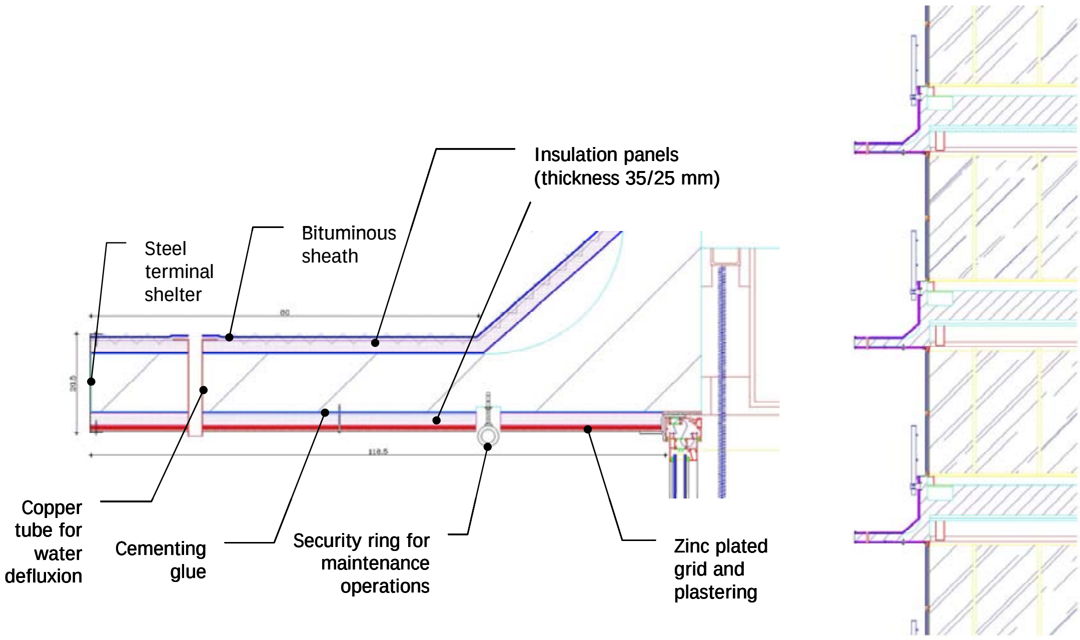

Figure 9 – The planned insulation of thermal bridges

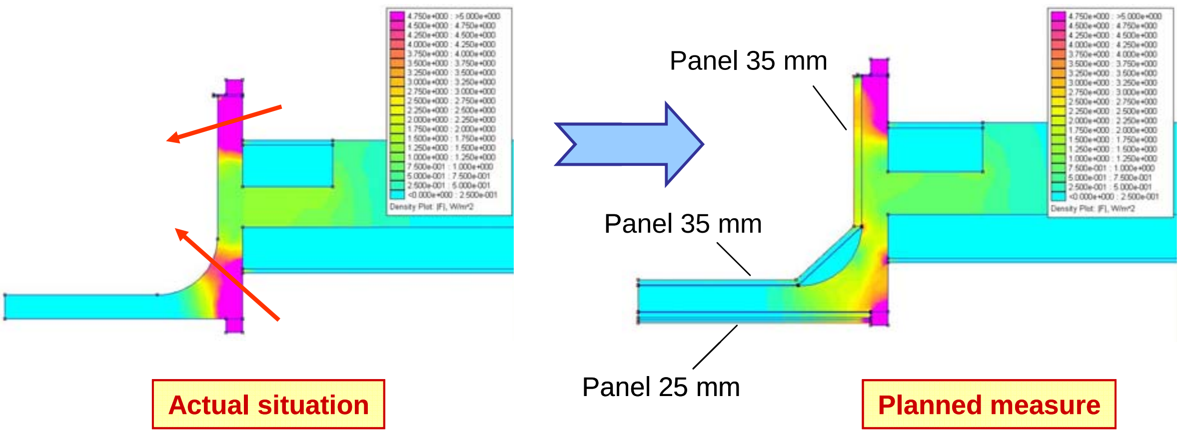

Figure 10 – Thermal bridges before and after planned insulation

By the end of April 2008 the insulation of thermal bridges has been completed in SE, SW and NW facades of the ATC building. The works have been realized as planned.
In Figure 11 are shown the wood fibre panels posed over the overhangs' surface and walls. Their thickness is 35 mm, the thermal conductibility is 0,063 W/mK and the U-value is 1,8 W/m^{2}K. The visible wood strips are in correspondence of where the steel frames that bear the Photovoltaic panels have been fixed.
In Figure 12 there is an image of the insulating panels applied on the bottom surface of the overhangs. In this case the thickness is 25 mm, the thermal conductibility is 0,063 W/mK and the U-value is 2,52 W/m^{2}K. In the following pictures other images of the realized insulation with the bituminous sheet applied for rain shelter.

Figure 11 – Wood fibre panels posed over the overhangs' surface and walls

Figure 12 – insulating panels applied to the lower surfaces of the overhangs

Figure 13 – The insulation completed with the bituminous sheet for rain shelter

Figure 14 – The insulation completed with the bituminous sheet for rain shelter

5.2 Shading effect due to PV modules installation

Sun beams hit almost entirely SW and SE windows during the hottest hours of summer days. Due to this fact the temperature in zones next to windows reaches 40° C approximately, creating a greenhouse effect. For this reason a large amount of cooling energy is needed to ensure comfortable climatic conditions in the offices.

The planned installation of Photovoltaic panels on the two facades should give to the offices behind them a shading effect, especially in the middle of the day. So the sun rays entering from the windows into the offices or hitting the internal venetian blinds would be less than actual and the solar gains would be reduced.

The dynamic energetic simulation above mentioned has also concerned the calculations of expected results coming from the shading effect of PV panels. Different tilt angles and panels' positioning have been compared, so to give the best energetic performance, taking into account the corresponding production of electric energy.

The solution that could give the best combined result, also considering architectural aspects and installation constraints, is the one showed in

Figure 15, with a tilt angle of 35° and the panels hanging out of the balconies for half their length. The overhangs result therefore horizontally extended of 60 cm and consequently the shadowing effect towards the windows is amplified. In the image the green parts are the insulating panels, in purple the steel bearing structure and in blue the PV panels.

From Figure 16 to Figure 23 are reported some images representing the PV system and graphic simulations of the shading effect of PV panels.

With this solution the cooling energy needs should decrease from actual 20.78 to 17.55 kWh/m^2 for the floors where both south-facing facades present PV panels.

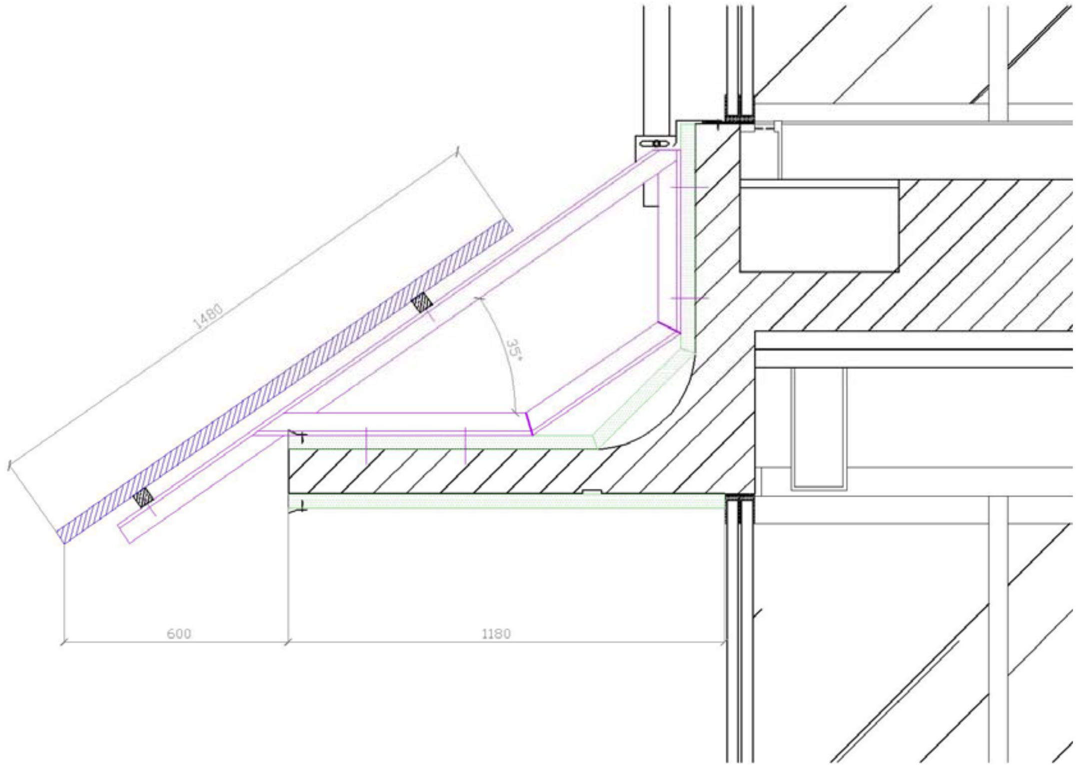

Figure 15 – PV panels installation solution

Figure 16 – Image showing the extension of the overhangs shape thanks to PV panels

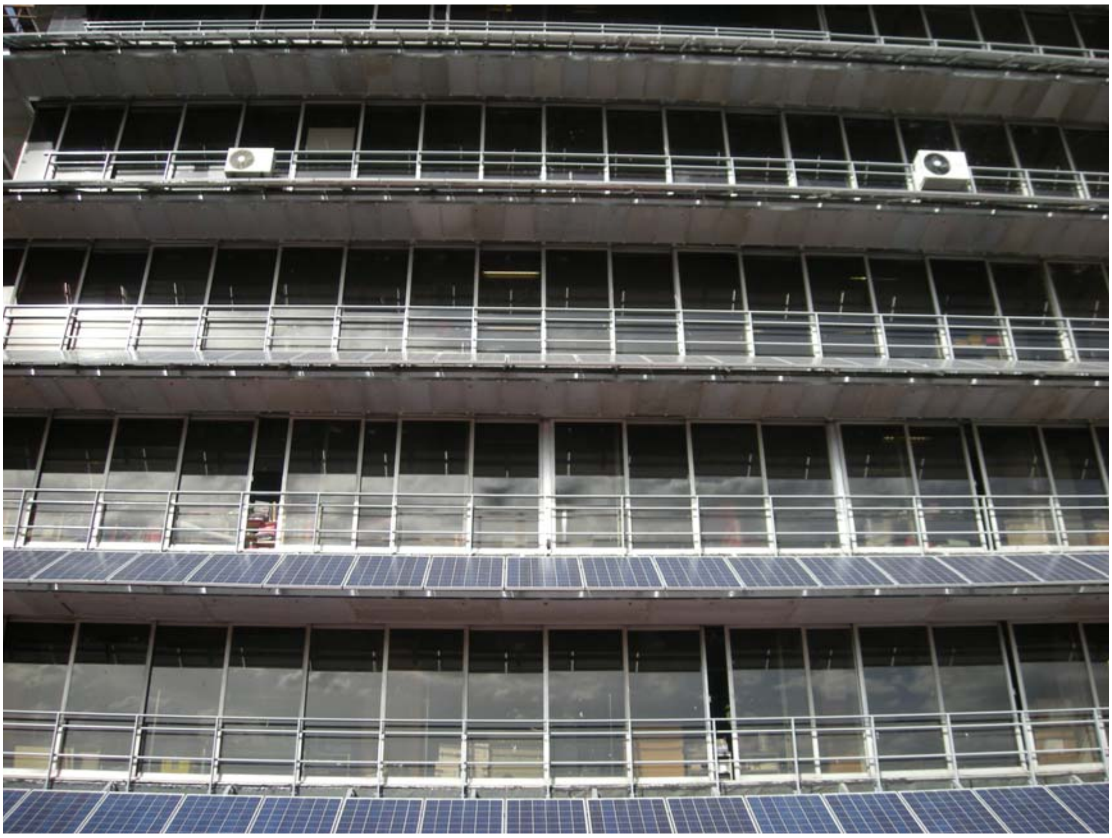

Figure 17 – PV panels on SW façade

Figure 18 – PV panels on SW facade

Figure 19 – PV panels on SW facade

Figure 20 – PV panels on SW facade

Figure 21 – PV panels on SE facade

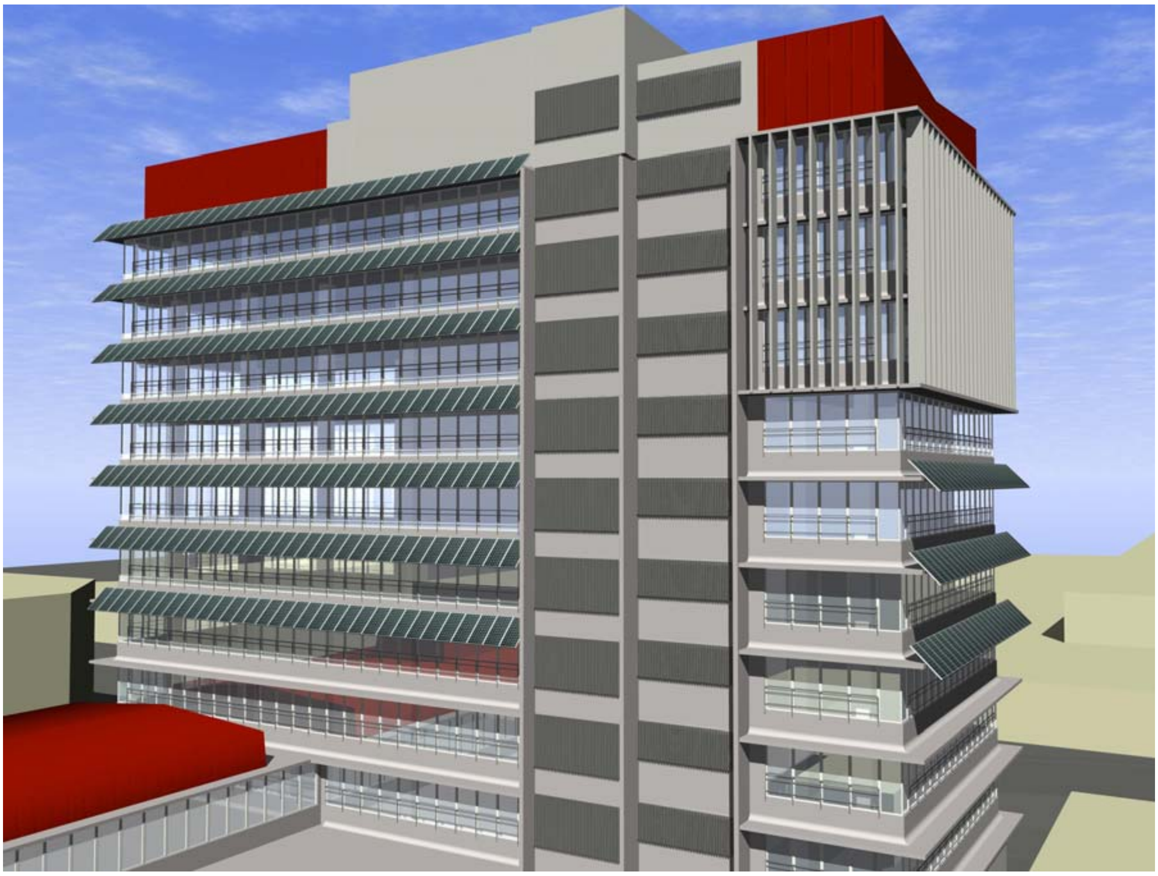

Figure 22 – PV panels on SW and SE facades (graphic simulation)

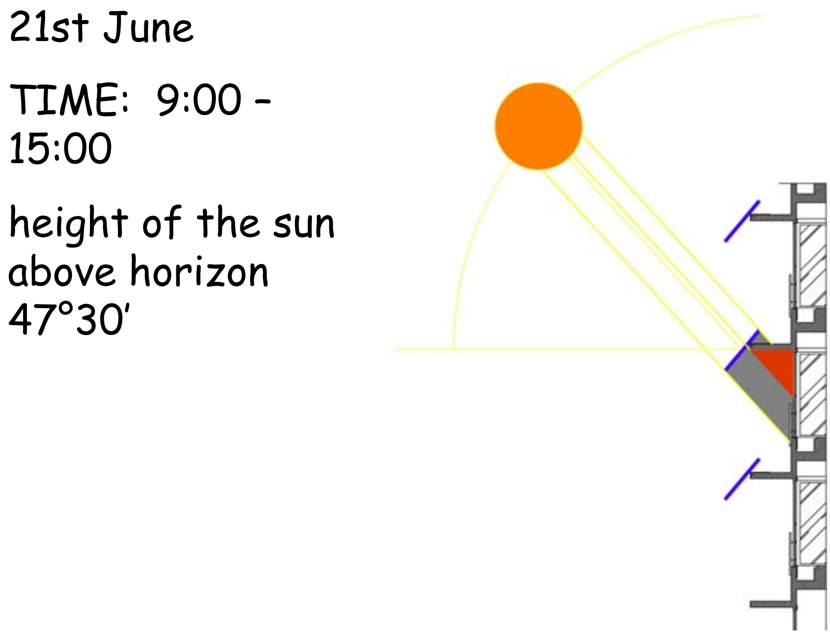

Figure 23 – Graphic simulation of shading effect with (in grey) and without PV panels (in red)