POLYCITY

SIXTH FRAMEWORK PROGRAMME

SUSTAINABLE ENERGY SYSTEMS

Report and demonstration of architectural measures

Table of contents

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 glazings* will be applied on a significant part of the residential buildings. The conventional glazing will be substituted with low emittance glazing (1 W/m^2K vs. the actual 3.2), mainly on the NE and SW sides (2 or 3 windows for each flat).
- *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 are two options that are under study: an external glazing applied on the whole facade or the substitution of windows with low emission double glasses (1.1 W/m^2K vs. actual 3.8) plus the insulation of thermal bridges caused by walls and balconies.
- *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 roofs has been completed in February 2006. The common spaces lamps substitution will be done in September 2006. For all other measures an analysis of expected energy need reduction and a project definition is foreseen in July 2006. Subsequently the related calls for tenders will be held (in September/October 2006).

The end of works should be December 2006/January 2007 for the substitution of windows in residential buildings and April 2007 for ATC building measures.

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)

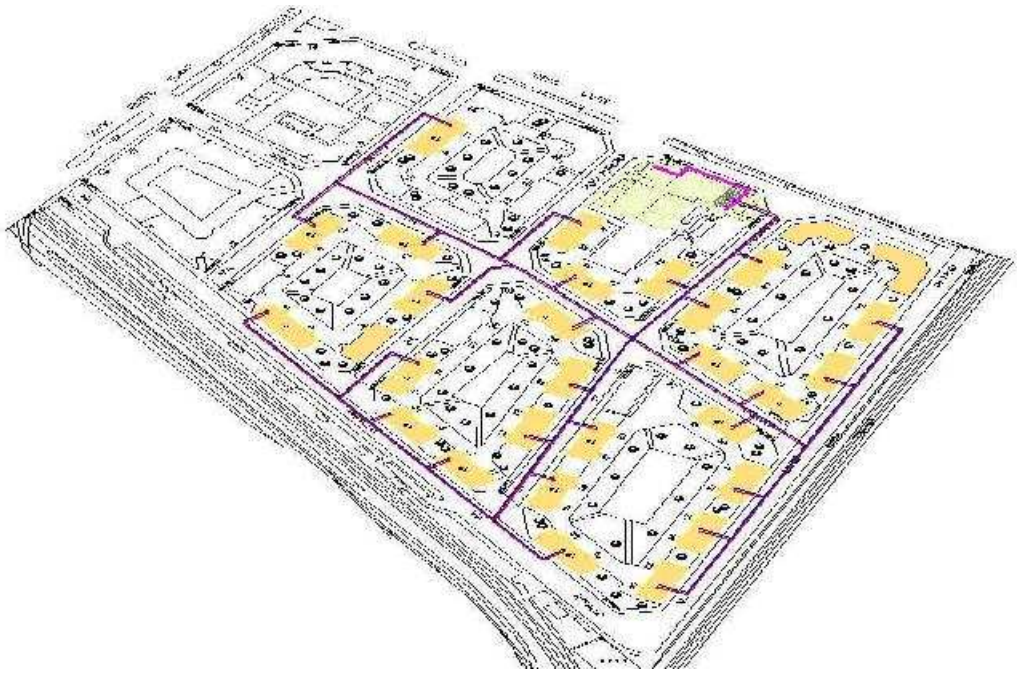

Figure 2 – Arquata district plan

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

4.2 Application of high efficiency glazings

High efficiency glazing will be applied on a significant part of the residential buildings.
The conventional glazing will be substituted with low emittance glazing (1 W/m^{2}K vs. the actual 3.2) 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. 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 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.
The heat transmission is expected to be reduced by an additional 9–10% (approximately down to 0.39 W/m^{3}K) depending on the number and orientation of the substituted windows.

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**

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 much greater energetic efficiency and 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 5 – 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 and the glazing are double glass with 3 mm of thickness each and conductivity of 3.8 W/m^{2}K.
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.

The reduction of thermal loads and losses is actually under analysis by an external company. The final study results are expected at the end of June 2006.

A preliminary step of the study consider two types of interventions:

- **Solution A**: substitution of windows in the NE facade with low emittance double glasses (with conductivity of 1.1 W/m^{2}K) and insulation of thermal bridges with the laying of insulating material all over the walls and the balconies.
- **Solution B**: installation of an external additional glazing on the entire NE facade.

Both solutions are expected to significantly reduce the heat losses of the building.

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.

An accurate calculation of how much the cooling energy would decrease will be available in July 2006.

Figure 6 – PV panels on SE facade (graphic simulation)

Figure 7 – PV panels on SW facade (graphic simulation)

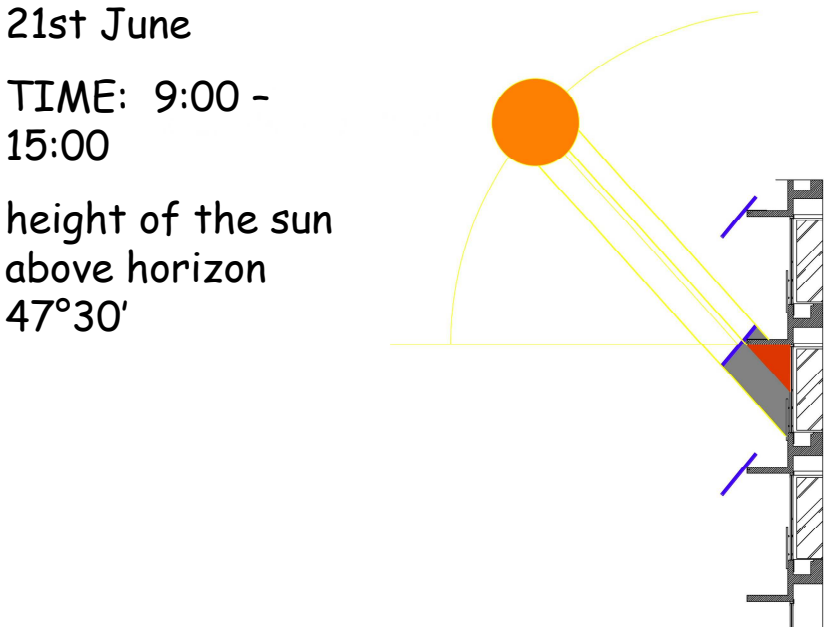

Figure 8 – Graphic simulation of shading effect with (in grey) and without PV panels (in red)