Report

Envelope energy retrofit solutions – PART A

Technological overview for retrofitting of existing residential buildings

SINFONIA

"Smart INitiative of cities Fully cOmmitted to iNvest In Advanced large-scaled energy"

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START DATE	**2014-06-01**	**DURATION**	**60 MONTHS**

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Executive summary

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SINFONIA; “Smart INitiative of cities Fully cOmmitted to iNvest In Advanced large-scaled energy” has received funding from the European Union’s Seventh Programme for research, technological development and demonstration.

1. Introduction

In the Part A of the current report, a technological overview of innovative and multifunctional envelope related solutions for the energy retrofit of residential buildings is given. Several commercial – and to some extent innovative - products for envelope retrofit are reported with a short description. This chapter is intended to be a "state of the technology", facilitating the elaboration of a cost-effective and innovative retrofit concept: it clearly emerges that a commercial standardized unique definition of multifunctional façade for the retrofit doesn't exist, especially because of the need to tailor the final retrofit solution on the specific case study. However, a multifunctional façade for the retrofit - intended as an advanced envelope solution integrating different components in order to facilitate the achievmente of the renovation goals – is a feasible solution and it has to be designed for each case together with the whole team involved in the retrofit. Hence, this report can be helpful in the conceiving the solutions' concept starting from feasible and reliable existing solutions.

Furthermore, in "Envelope energy retrofit solutions – PART B" a short description of the actual state and of the retrofit goals of the "Passeggiata dei Castani" case study is given besides a simplified techno-economic analysis of possible scenarios of retrofit using traditional and innovative solutions.

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2. ENVELOPE TECHNOLOGY STATE OF ART

This chapter aims to describe those innovative (but not necessarily) components and systems suited for envelope retrofit interventions; since the market is huge and full of products for this purpose, it was not possible to collect each of them, hence a significant number of solutions is reported in order to give an idea of the possibilities to improve the envelope's retrofit.

Company names and website are given only as reference and it has not to be intended as indication of preference.

Technologies are shown as technical sheets and grouped in the following categories:

- BIST, Building Integrated Solar Thermal;
- BIPV, Building Integrated Photo Voltaic;
- Prefabricated multifunctional facade systems;
- ETICS (External Thermal Insulation Composite System) and thermal insulation;
- Decentralised mechanical ventilation;
- Windows, natural ventilation and shading system;
- Coatings and paints.

For every technology information about the implementation on building site are also provided. Particularly, the needed human resources and equipment, as well as the main installation operations are briefly reported. Furthermore some indication about the operation phase (e.g. maintenance) and system's management arereported. All these information give a quite complete frame for every solution, but for an exhaustive list of information a direct dialogue with producers is necessary.

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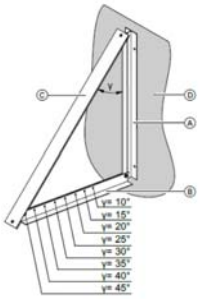
2.1 BIST (BUILDING INTEGRATED SOLAR THERMAL)

PRODUCT'S NAME	VITOSOL 200-F TYPE SH
PRODUCER	Viessmann
PRODUCT CATEGORY	BIST - Solar flat plate glazed collector
WEBSITE	http://downloads.viessmannitalia.it/documentazione/vitosol/vitosol-200-f-sv2e-sh2c/
PICTURES	 Solar collector  Façade mounting system
MAIN FEATURES	Solar absorber with high absorbtance rate and low emissivity Rear side wall resistent to drilling and corrosion Simple fixing system Fast hydraulic connection among collectors
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Availability of brackets for the sloped installation No flexibility in collector's shape and dimensions No choice for the colour and the surface texture of the absorber Different colours for the frame are available Dummies are not available
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Static verification of the wall support or structure Linea vita installation (poles, wires even for facade installation…) in case of maintenance from the top Collectors' substructure to be anchored to the existing wall/roof Predisposition of connections to the existing plant Façade/roof insulation ST/BIST panels installation Connection to the existing heating plant
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*Static engineer (structural survey), Installer, Plumber for connections, Architect for integration, Works director (material acceptance)* Storage tank, Pump, Tubes and valves, Crane or aerial platform, Linea vita devices
SERVICE LIFE MANAGEMENT	Linea vita_Periodical audit (1 y) Panels_Cleaning operation (2 y) Pumps, valves, storage tank_Substitution (15-20 y)

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PRODUCT'S NAME	VITOSOL 200-T TYPE SP2A
PRODUCER	Viessmann
PRODUCT CATEGORY	BIST - Heat pipe vacuum tube collector
WEBSITE	http://downloads.viessmannitalia.it/documentazione/vitosol/vitosol-200-t-sp2a/
PICTURES	 Solar collector  Example of application
MAIN FEATURES	Solar absorber surfaces with selective coating integrated inside the tubes Condenser totally wrapped (higher efficiency for heat transmission) Rotating tubes (+/- 25°) Dry connection of tubes (substitution also possible at filled plant)
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Installation on steel channels Special modules for balconies No flexibility in shape 3 dimensions are available No choice for the colour and the surface texture of the absorber Dummies are not available
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Static verification of the wall support or structure Linea vita installation (poles, wires even for facade installation…) in case of maintenance from the top Collectors' substructure to be anchored to the existing wall/roof Predisposition of connections to the existing plant Façade/roof insulation ST/BIST panels installation Connection to the existing heating plant
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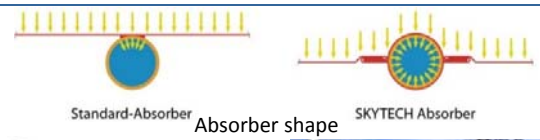
PRODUCT'S NAME	VARIOSOL E COLLECTORS SYSTEM
PRODUCER	Winkler SOLAR
PRODUCT CATEGORY	BIST - Solar flat plate glazed collector
WEBSITE	http://www.winklersolar.com/solar-facades-variosol-e.html
PICTURES	 Absorber shape  Solar collector and example of application
MAIN FEATURES	In-roof mounting for different kind of materials Façade installation Balcony installation Available both with reflecting and anti-reflecting glass Reflection reduced thanks to the glass (major energy yield) SKYTECH absorber with a copper tube fully integrated into the copper sheet (360° contact) which leads to an optimased heat transfer to the fluid inside
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Installation on steel channels Customization Flexibility in dimensions due to the possibility to connect single strips absorber: up to 24 m² in size No choice for the colour and the surface texture of the absorber Dummies are not available
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Static verification of the wall support or structure Linea vita installation (poles, wires even for facade installation…) in case of maintenance from the top Collectors' substructure to be anchored to the existing wall/roof Predisposition of connections to the existing plant Façade/roof insulation ST/BIST panels installation Connection to the existing heating plant
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PRODUCT'S NAME	H+S THERMIEPANEL 38
PRODUCER	H+S SOLAR
PRODUCT CATEGORY	BIST - Solar flat plate glazed collector
WEBSITE	http://www.hssolar.ch/thermiepanel/thermiepanel-38.html
PICTURES	 Example of application  Solar collector  Solar collector inside a window frame
MAIN FEATURES	Low thickness (38 mm) The gap is filled with argon gas Possibility to be installed on usual triple glazing window frames
RELEVANT FEATURES FOR FAÇADE INTEGRATION	The gluing of the glazing allows the use of any jointing system No flexibility in shape and size No choice for the colour and the surface texture of the absorber Dummies are not available
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Static verification of the wall support or structure Linea vita installation (poles, wires even for facade installation…) in case of maintenance from the top Collectors' substructure to be anchored to the existing wall/roof Predisposition of connections to the existing plant Façade/roof insulation ST/BIST panels installation Connection to the existing heating plant
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SERVICE LIFE MANAGEMENT	Linea vita_Periodical audit (1 y) Panels_Cleaning operation (2 y) Pumps, valves, storage tank_Substitution (15-20 y)

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PRODUCT'S NAME	POLYMER FLAT PLATE SOLAR COLLECTOR
PRODUCER	AventaSolar
PRODUCT CATEGORY	BIST - Solar flat plate glazed collector
WEBSITE	http://www.aventa.no/eng/Solar-Energy/AventaSolar-solar-collector
PICTURES	 Example of application
MAIN FEATURES	Polymeric based absorber Low weight technology (8 kg/m² without heat carrier) Low manufacturing energy consumption and complete recyclability
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Flexibility in size (8 formats with a fixed width of 60 cm) No choice for the colour and the surface texture of the absorber Dummies are not available
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Static verification of the wall support or structure Linea vita installation (poles, wires even for facade installation…) in case of maintenance from the top Collectors' substructure to be anchored to the existing wall/roof Predisposition of connections to the existing plant Façade/roof insulation ST/BIST panels installation Connection to the existing heating plant
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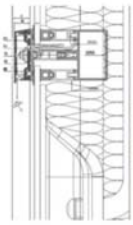
PRODUCT'S NAME	PRISMA SOLAR FLAT COLLECTOR
PRODUCER	S Solar
PRODUCT CATEGORY	BIST - Solar flat plate glazed collector
WEBSITE	http://en.ssolar.com/LinkClick.aspx?fileticket=A1ZhhzOzEek%3D&tabid=633&mid=1734
PICTURES	   Solar collector Example of application
MAIN FEATURES	Suited for facade glazing systems in aluminium, PVC or wood The solar collector is installed mechanically as an ordinary single pane of glass The absorber is treated with a selective layer of thin film to make the energy conversion more efficient Very high efficiency due to very low heat losses Weight excluding glass is 5 kg
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Flexibility in size (The dimensions of the façade element is adjusted after the façade proportions as well as the glass thickness in relation to building codes) → maximum size: 1200x2200 mm The color print at the edges of the glass can be customized No choice for the colour and the surface texture of the absorber Surface of the glass available can be in milky white or transparent Dummies are not available
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Static verification of the wall support or structure Linea vita installation (poles, wires even for facade installation…) in case of maintenance from the top Collectors' substructure to be anchored to the existing wall/roof Predisposition of connections to the existing plant Façade/roof insulation ST/BIST panels installation Connection to the existing heating plant
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SERVICE LIFE MANAGEMENT	Linea vita_Periodical audit (1 y) Panels_Cleaning operation (2 y) Pumps, valves, storage tank_Substitution (15-20 y)

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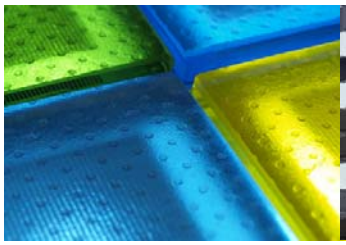
2.2 BIPV (BUILDING INTEGRATED PHOTO VOLTAIC)

PRODUCT'S NAME	PHOTVOLTAIC GLASS SEMITRANSPARENT
PRODUCER	ONYX Solar
PRODUCT CATEGORY	BIPV – Photovoltaic glazing system
WEBSITE	http://www.onyxsolar.com/it/vetro-fotovoltaico-colorato.html
PICTURES	  PV coloured glass Example of application
MAIN FEATURES	This material allows to recover the investment cost It allows daylight transmission Thermal insulation (double glaze system with air or gas argon within the gap)
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Customization in size Laminated glass is available Availability of different colours Glass surface treatments are possible to vary the transparence Dummies are available
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Static verification of the wall support or structure Linea vita installation (poles, wires even for facade installation…) in case of maintenance from the top Metallic substructure or window frame to be anchored to the existing wall/roof Predisposition of connections to the existing plant Façade/roof insulation PV/BIPV modules installation Connection to the existing electrical plant
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*Static engineer (structural survey), Installer, Electrician, Electrical service manager, Architect for integration, Works director (material acceptance)* Inverters, Batteries, Cables, Charge controllers, Crane or aerial platform, Linea vita devices
SERVICE LIFE MANAGEMENT	Linea vita_Periodical audit (1 y) Inverter_Substitution (10 y) Modules_Cleaning operation (2 y)

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PRODUCT'S NAME	PHOTVOLTAIC GLASS OPAQUE
PRODUCER	ONYX Solar
PRODUCT CATEGORY	BIPV – Photovoltaic glazing system
WEBSITE	http://www.onyxsolar.com/it/vetro-fotovoltaico-colorato.html
PICTURES	 BIPV opaque_Drawing  Example of application
MAIN FEATURES	This material allows to recover the investment cost Thermal insulation (double glaze system with air or gas argon within the gap)
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Customization in size Laminated glass is available Availability of different colours Glass surface treatments are possible to vary the transparence Dummies are available
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Static verification of the wall support or structure Linea vita installation (poles, wires even for facade installation…) in case of maintenance from the top Metallic substructure or window frame to be anchored to the existing wall/roof Predisposition of connections to the existing plant Façade/roof insulation PV/BIPV modules installation Connection to the existing electrical plant
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SERVICE LIFE MANAGEMENT	Linea vita_Periodical audit (1 y) Inverter_Substitution (10 y) Modules_Cleaning operation (2 y)

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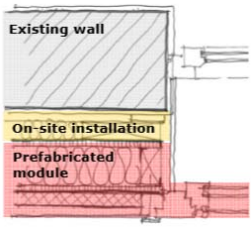
2.3 PREFABRICATED MULTIFUNCTIONAL FAÇADE

PRODUCT'S NAME	GAP SOLUTIONS
PRODUCER	GAP³ Facade
PRODUCT CATEGORY	Prefabricated multifunctional facades
WEBSITE	http://www.gap-solutions.at/en/solutions/gapskin/
PICTURES	 Mounting stage   Example of application  Wall construction
MAIN FEATURES	Prefabricated façade modules Low impact on users High insulation properties (opaque+transparent) Installation without scaffolding with an easy and dry procedure On-site work time reduced (compared to standard external thermal insulation)
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Possibility to integrate decentralized ventilation systems, solar thermal and PV panels Availability of different colours for the external layer
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Static verification of the wall support or structure Bottom support for the installation of the modules Predisposition of fixing points Predisposition of connections to the existing plant Façade insulation (adaptation layer) Linea vita installation (poles, wires)
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*Static engineer (structural survey), Installer, Electrician, Electrical service manager, Plumber, Works director (material acceptance)* Fixing system, Connections to existing plant, Mobile crane and aerial platform, Linea vita devices
SERVICE LIFE MANAGEMENT	Linea vita_Periodical audit (1 y) Facade modules_Substitution (?? Y) Facade modules_Cleaning in case of active facade (2 Y) Hydraulic components_Substitution (15-20 Y) Electrical components_Substitution (15-20 Y)

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PRODUCT'S NAME	TIMBER STRUCTURED FAÇADE MODULES (TES ENERGY FAÇADE)
PRODUCER	Gumpp & Maier
PRODUCT CATEGORY	Prefabricated multifunctional facades
WEBSITE	http://www.gumpp-maier.de/english/aktuelles/22032014---aktiv-stadthaus/22032014---aktiv-stadthaus.html http://www.tesenergyfacade.com/
PICTURES	 Mounting stage  Mounting stage
MAIN FEATURES	Prefabricated façade modules Low impact on users High insulation properties (opaque+transparent) → Uw=0.13-0.14 W/m²K and solution of façade related thermal bridges Installation with an easy and dry procedure On-site work time reduced (compared to standard external thermal insulation)
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Possibility to integrate decentralized ventilation systems Possibility to integrate solar thermal and PV panels Availability of different finishings for the external layer
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Static verification of the wall support or structure Bottom support for the installation of the modules Predisposition of fixing points Predisposition of connections to the existing plant Façade insulation (adaptation layer) Linea vita installation (poles, wires)
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*Static engineer (structural survey), Installer, Electrician, Electrical service manager, Plumber, Works director (material acceptance)* Fixing system, Connections to existing plant, Mobile crane and aerial platform, Linea vita devices
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PRODUCT'S NAME	MODERNIZATION FAÇADE ERC50
PRODUCER	SCHÜCO
PRODUCT CATEGORY	Prefabricated multifunctional facades
WEBSITE	http://www.schueco.com/web/uk/partner/fassaden/products/facades/aluminium/schueco_modernisierungsfassade?weblogin=weblogin1#pod
PICTURES	 Installation steps
MAIN FEATURES	Semi-prefabricated façade system (transom&mullion system) Low impact on users Aluminium windows system Installation without scaffolding with an easy and dry procedure On-site work time reduced (compared to standard external thermal insulation)
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Possibility to integrate decentralized ventilation systems Possibility to integrate Schüco Prosol TF PV modules Possibility to integrate solar shading system
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Static verification of the wall support or structure Predisposition of fixing points Substructure installation New windows Predisposition of connections to the existing plant Façade insulation (adaptation layer)
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*Static engineer (structural survey), Installer, Electrician, Electrical service manager, Works director (material acceptance)* Fixing system, Connections to existing plant , Mobile crane and aerial platform
SERVICE LIFE MANAGEMENT	Facade panels_Cleaning (2 Y) Electrical components_Substitution (15-20 Y)

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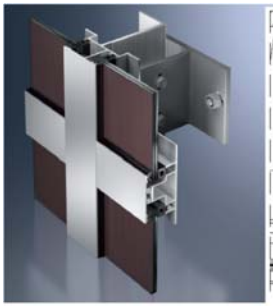
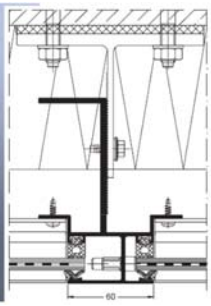
PRODUCT'S NAME	SCC 60 VENTILATED CLADDING
PRODUCER	SCHÜCO
PRODUCT CATEGORY	Prefabricated multifunctional facades – Ventilated facade
WEBSITE	http://www.schueco.com/web/uk/partner/fassaden/products/facades/aluminium/schueco_scc_50_60
PICTURES	   Façade structure Example of application
MAIN FEATURES	Semi-prefabricated façade system (transom&mullion system) Low impact on users Aluminium windows system Installation without scaffolding with an easy and dry procedure On-site work time reduced (compared to standard external thermal insulation)
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Possibility to integrate solar shading system Thin film PV technology (high production in diffuse light and low sensitivity to partial shading and high outside temperatures) Flexibility in pattern, colour and size
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Static verification of the wall support or structure Predisposition of fixing points Substructure installation New windows Predisposition of connections to the existing plant Façade insulation (adaptation layer)
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*Static engineer (structural survey), Installer, Electrician, Electrical service manager, Works director (material acceptance)* Fixing system, Connections to existing plant , Mobile crane and aerial platform
SERVICE LIFE MANAGEMENT	Facade panels_Cleaning (2 Y) Electrical components_Substitution (15-20 Y)

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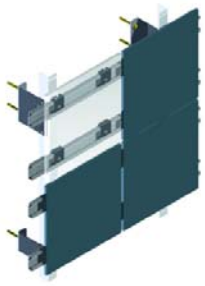
PRODUCT'S NAME	INPEK VENTILATED CLADING
PRODUCER	INPEK
PRODUCT CATEGORY	Prefabricated multifunctional facades – Ventilated facade
WEBSITE	http://www.inpek.it/inpek-it-facciate-ventilate.html
PICTURES	 Façade structure  Example of installation
MAIN FEATURES	Semi-prefabricated façade system (transom&mullion system) Low impact on users Installation without scaffolding with an easy and dry procedure On-site work time reduced (compared to standard external thermal insulation)
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Flexibility in pattern, colour and size HPL or Rockpanel cladding (easy to cut on-site)
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Static verification of the wall support or structure Predisposition of fixing points Substructure installation New windows Façade insulation (adaptation layer)
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*Static engineer (structural survey), Installer, Electrician, Electrical service manager, Works director (material acceptance)* Fixing system, Connections to existing plant , Mobile crane and aerial platform
SERVICE LIFE MANAGEMENT	Facade panels_Cleaning (10 Y) Electrical components_Substitution (15-20 Y)

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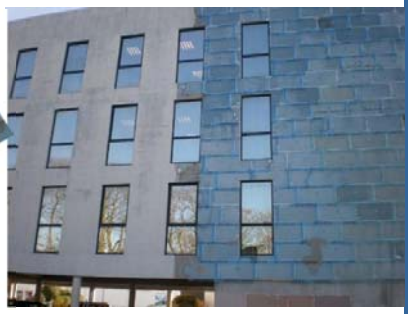
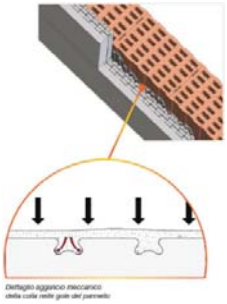
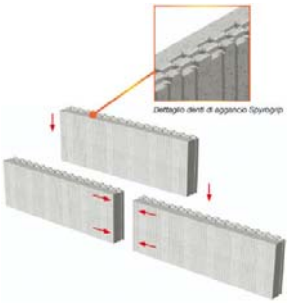
2.4 ETICS (EXTERNAL THERMAL INSULATION COMPOSITE SYSTEM) AND THERMAL INSULATION

PRODUCT'S NAME	ECAP SYSTEM
PRODUCER	EDILTECO group
PRODUCT CATEGORY	ETICS
WEBSITE	http://www.edilteco.com/en/catalog/thermal/thermal-insulation-of-walls-and-ceilings/prefinished-thermal-iinsulating-boards/ecap-l
PICTURES	 ECAP panel  Example of installation
MAIN FEATURES	Thickness available from 3 to 20 cm Available insulation material: EPS, Stiferite, EPS+Grafite Predrilled fixing dowel sites
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Flexibility in pattern, colour and size HPL or Rockpanel cladding (easy to cut on-site) 60% time saving compared to other typical solutions (14 m²/day/man → 8 m²/d/m on average)
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Scaffolding installation Removal of existing plaster Installation starting profile Application panels by means of gluing Second leveling layer Finishing Balconies insulation (if any) with panels (for intrados) and new premixed insulating substrates
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*ETICS installer, Windows installer, Works director (material acceptance)* Dowels (if necessary) depending on the support (Concrete, Brick, Hollow brick, Light concrete), Insulation panels, Angle profiles (starting profile, corner protection), Scaffolding, Crane
SERVICE LIFE MANAGEMENT	ETICS_Substitution (30-40 y) depending on the installation, the periodical maintenance and exposure External plaster_Maintenance (10-15 y)

SINFONIA; "Smart INitiative of cities Fully cOmmitted to iNvest In Advanced large-scaled energy" has received funding from the European Union's Seventh Programme for research, technological development and demonstration.

PRODUCT'S NAME	ISOLCAP SYSTEM
PRODUCER	EDILTECO group
PRODUCT CATEGORY	Thermal insulation
WEBSITE	http://www.edilteco.com/en/catalog/thermal/thermal-insulation-for-ceilings-and-roofs/sottofondi-leggeri-termoisolanti-premiscelati/isolcap
PICTURES	 ISOLCAP subfloor application
MAIN FEATURES	Premixed lightweight thermal insulating substrate It contains superlight aggregates made of virgin expanded polystyrene beads Installation from bottom to the top
RELEVANT FEATURES FOR FAÇADE INTEGRATION	It allows to solve the thermal bridge due to the balcony's slab
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Remove any fragments and vacuuming powders on the surface Structural reinforce Moisten the laying surface (if absorbent) taking care not to create puddles Slope creation with the new thermal premixed substrate New floor or re-use of the existing one Intrados balconies insulation (with panels)
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*Static engineer, Building operator, ETICS installer, Works director (material acceptance)*
SERVICE LIFE MANAGEMENT	Structural survey (40 y) Insulation panels on intrados (30-40 y) External plaster_Maintenance (10-15 y)

SINFONIA; "Smart INitiative of cities Fully cOmmitted to iNvest In Advanced large-scaled energy" has received funding from the European Union's Seventh Programme for research, technological development and demonstration.

PRODUCT'S NAME	SPYROGRIP
PRODUCER	Pontarolo Engineering
PRODUCT CATEGORY	ETICS
WEBSITE	http://www.pontarolo.com/ita/spyrogrip/cappotto-isolante.html
PICTURES	 SPYROGRIP panel  Installation mode
MAIN FEATURES	Thickness available are 6.4, 9.4, 12.4, 18.4 cm Available insulation material: EPS (lambda 0.033-0.036 W/mK) Installation from bottom to the top Offsetting of 25 cm at least among panels
RELEVANT FEATURES FOR FAÇADE INTEGRATION	No need of dowels thank to the omega shape Complanarity assured by the teeth (no mattress effect) Impact resistance: 100 and 170 kPa E Fire Safe class
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Scaffolding installation Removal of existing plaster Installation starting profile Application panels by means of gluing/mortar Leveling layer with reinforced mesh Finishing Balconies insulation (if any) with panels (for intrados) and new premixed insulating substrates
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*ETICS installer, Windows installer, Works director (material acceptance)* Insulation panels, Angle profiles (starting profile, corner protection), Scaffolding, Crane
SERVICE LIFE MANAGEMENT	ETICS_Substitution (30-40 y) depending on the installation, the periodical maintenance and exposure External plaster_Maintenance (10-15 y)

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PRODUCT'S NAME	AEROPAN
PRODUCER	AMA composites
PRODUCT CATEGORY	ETICS
WEBSITE	http://www.aeropan.it/
PICTURES	 Aeropan panel  Example of installation
MAIN FEATURES	Panels are made of aerogel (lambda 0.015 W/mK) Thickness available from 10 to 40 mm
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Flexible material, suited for curved surfaces Special applications as wall of balconies, windows (imbotte), lower part of external walls (urban constraints) C Fire Safe class
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Scaffolding installation Removal of existing plaster Installation starting profile Application panels by means of gluing/mortar Leveling layer with reinforced mesh Finishing Balconies insulation (if any) with panels (for intrados) and new premixed insulating substrates
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*ETICS installer, Windows installer, Works director (material acceptance)* Insulation panels, Angle profiles (starting profile, corner protection), Scaffolding, Crane
SERVICE LIFE MANAGEMENT	ETICS_Substitution (30-40 y) depending on the installation, the periodical maintenance and exposure External plaster_Maintenance (10-15 y)

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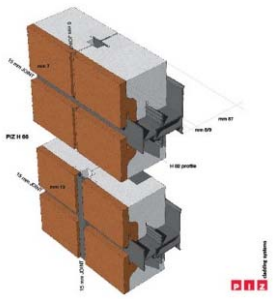
PRODUCT'S NAME	PIZ SYSTEM
PRODUCER	PIZ cladding system
PRODUCT CATEGORY	ETICS
WEBSITE	http://piz.it/?page_id=2&lang=it
PICTURES	  PIZ cladding system
MAIN FEATURES	Standard available panel's thickness 54 mm (45 EPS insulation + 9 mortar), 66 mm (57+9) and 89 mm (80+9) Fiber-reinforced mortar as external cladding
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Dry construction system (aluminium transoms fixed to the wall) Horizontal joint: 15 mm Vertical Joint can be avoided Availability of several external finishing layers
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Scaffolding installation Removal of existing plaster Installation of horizontal profiles Panel insertion Balconies insulation (if any) with panels (for intrados) and new premixed insulating substrates
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*ETICS installer, Windows installer, Works director (material acceptance)* Insulation panels, Angle profiles (starting profile, corner protection), Scaffolding, Crane
SERVICE LIFE MANAGEMENT	ETICS_Substitution (30-40 y) depending on the installation, the periodical maintenance and exposure External plaster_Maintenance (10-15 y)

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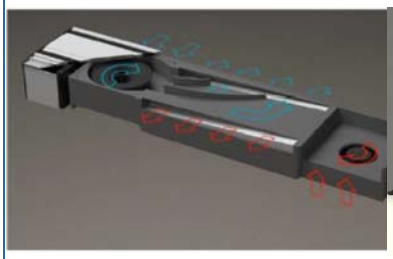
2.5 MECHANICAL VENTILATION

PRODUCT'S NAME	AIRRIA WINDOW VENTILATION
PRODUCER	AIRRIA
PRODUCT CATEGORY	Decentralised mechanical ventilation
WEBSITE	http://www.airria.be/page-product-details,Airria-AAerateur-fenAetre,,10,0.html
PICTURES	 Mechanical ventilation box  Integration in window
MAIN FEATURES	Decentralized ventilation system Flow from 15 to 75 m³/h It can be installed in all types of windows (PVC, aluminium and wood)
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Completely hidden system
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Removal of existing windows Walls breaking at the top of windows (or not, but new windows will be smaller) AHU installation in the thickness of the wall
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*AHU installer, ETICS installer, Windows installer, Works director (material acceptance)* Scaffolding, Crane
SERVICE LIFE MANAGEMENT	Filter_Substitution (1-2 y)

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PRODUCT'S NAME	ZEHNDER COMFAIR 70
PRODUCER	Zehnder
PRODUCT CATEGORY	Decentralised mechanical ventilation
WEBSITE	http://www.zehnder.it/comfosystems/Schede-tecniche,189.html
PICTURES	 Mechanical ventilation box  Integration in wall
MAIN FEATURES	Decentralized ventilation system Wall installation Flow from 15 to 65 m^3/h (4 speeds) Enthalpic recover Power: from 4 to 19 W Heat recovery efficiency: from 73% to 88%
RELEVANT FEATURES FOR FAÇADE INTEGRATION	No pipes are needed respect to centralized systems (no distribution network) Suited for retrofit scenario since usually there's no place for a distribution plant Possibility to ventilate two adjacent rooms
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Walls breaking and drilling AHU installation in the thickness of the wall
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*AHU installer, ETICS installer, Windows installer, Works director (material acceptance)* Scaffolding, Crane
SERVICE LIFE MANAGEMENT	Filter_Substitution (1-2 y)

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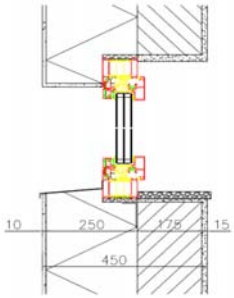
2.6 WINDOWS, NATURAL VENTILATION AND SHADING SYSTEMS

PRODUCT'S NAME	TOP 90 FINSTRAL
PRODUCER	Finstral
PRODUCT CATEGORY	Windows, natural ventilation and shading systems – Window triple glazing system
WEBSITE	http://www.finstral.com/it/finestre-e-porte-finestre/pvc/top-90/21-44.html
PICTURES	 Window  Example of application
MAIN FEATURES	Triple glazing system Uw 0.75 W/m²K Uf 1.0 W/m²K g-value 50% Light Transmittance 71%
RELEVANT FEATURES FOR FAÇADE INTEGRATION	High performance window renovation through tailored solutions
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Removal of the existing windows and sills Installation of new sills and thermal break creation Predisposition for shading system and window (e.g. monoblock) Installation of new windows Frame extensions insulation
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*Windows installer, AHU installer, ETICS installer, Works director (material acceptance)* Scaffolding, Crane
SERVICE LIFE MANAGEMENT	Windows_Substitution (30-35 y)

SINFONIA; "Smart INitiative of cities Fully cOmmitted to iNvest In Advanced large-scaled energy" has received funding from the European Union's Seventh Programme for research, technological development and demonstration.

PRODUCT'S NAME	WICLINE 95
PRODUCER	WICONA
PRODUCT CATEGORY	Windows, natural ventilation and shading systems – Window triple glazing system
WEBSITE	http://www.guidafinestra.it/news/prodotti/2015/02/04/news/wicline_95_sistema_in_alluminio_per_finestre_di_case_passive-56978/
PICTURES	 Window  Cross section
MAIN FEATURES	Triple glazing system with one low-e surface Uw 0.80 W/m²K Thickness 95 mm Complanarity between fixed and mobile frame
RELEVANT FEATURES FOR FAÇADE INTEGRATION	New thermal break (ETC Intelligence) The poyamide profile has a low emissive surface which reflects the thermal radiation No presence of insulating foam inserts
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Removal of the existing windows and sills Installation of new sills and thermal break creation Predisposition for shading system and window (e.g. monoblock) Installation of new windows Frame extensions insulation
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*Windows installer, AHU installer, ETICS installer, Works director (material acceptance)* Scaffolding, Crane
SERVICE LIFE MANAGEMENT	Windows_Substitution (30-35 y)

SINFONIA; "Smart INitiative of cities Fully cOmmitted to iNvest In Advanced large-scaled energy" has received funding from the European Union's Seventh Programme for research, technological development and demonstration.

PRODUCT'S NAME	TRAVFRAME MONOBLOCK
PRODUCER	HELLA
PRODUCT CATEGORY	Windows, natural ventilation and shading systems
WEBSITE	http://www.hella.info/it/sturzsysteme/pID/itp4d2d7bf7e9d190.64064718.html
PICTURES	 Monoblock system  Application
MAIN FEATURES	Thermal bridges resolution Lamellae system can be studied to avoid glare but ensure outdoor visibility
RELEVANT FEATURES FOR FAÇADE INTEGRATION	High invasivity in removing the old window and frame and window box and applying the new system
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Removal of the existing shading system Removal of existing windows Installation of the new shading system
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*Windows installer, AHU installer, ETICS installer, Works director (material acceptance)* Scaffolding, Crane
SERVICE LIFE MANAGEMENT	Shading system_Substitution (30-35 y)

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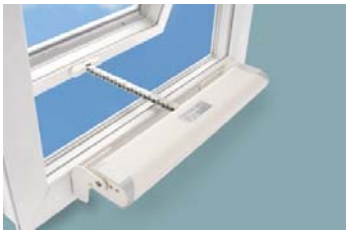
PRODUCT'S NAME	ROLLER BLIND BOX
PRODUCER	HELLA
PRODUCT CATEGORY	Windows, natural ventilation and shading systems
WEBSITE	http://www.hella.info/it/sturzsysteme/pID/itp4c7e219d5e3d40.05109078.html
PICTURES	 New roller blind monoblock  Insulation of the existing
MAIN FEATURES	Directly integrated into the wall Low invasity
RELEVANT FEATURES FOR FAÇADE INTEGRATION	In alternative to the total substitution, the existing box can be left on site and insulated
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Removal of existing roller blind box New roller blind (thinner)
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*Windows installer, Works director (material acceptance)*
SERVICE LIFE MANAGEMENT	Shading system_Substitution (30-35 y)

SINFONIA; "Smart INitiative of cities Fully cOmmitted to iNvest In Advanced large-scaled energy" has received funding from the European Union's Seventh Programme for research, technological development and demonstration.

PRODUCT'S NAME	CHAIN ACTUATOR VMX 826-2G500
PRODUCER	WindowMaster
PRODUCT CATEGORY	Windows, natural ventilation and shading systems – Window chain actuators for natural ventilation
WEBSITE	http://www.windowmaster.com/files/billeder/ecom/images/pdf/datablade/WMX_826_data_UK-5.pdf https://windowmaster.uberflip.com/i/385360
PICTURES	 Actuator  Application on window
MAIN FEATURES	50-550 mm in increments of 10 mm Opening speed: programmable from 3 to 9.5 mm/s Nominal voltage 24V DC To be used with tophung, bottomhung and turning windows To be used together with ± 24V control units or control units with MotorLink
RELEVANT FEATURES FOR FAÇADE INTEGRATION	Integration inside the window frame is possible
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Fixing of the actuator to the window by means of brackets Electrical connections
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*Actuator installer, Windows installer, Works director (material acceptance)* Brackets, Cables
SERVICE LIFE MANAGEMENT	Windows actuator_Substitution (?? y) Actuator components_Cleaning and periodical audit of fixing system (0.5 y)

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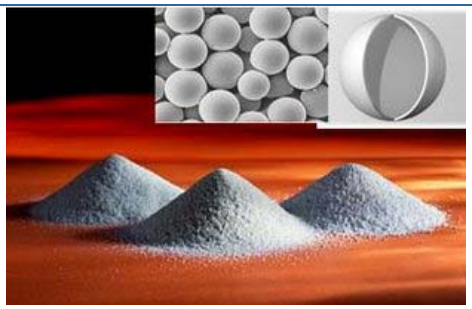
2.7 COATINGS AND PAINTS

PRODUCT'S NAME	3M GLASS BUBBLES
PRODUCER	3M
PRODUCT CATEGORY	Coatings and paints – Heat reflective coatings
WEBSITE	http://solutions.3m.com/wps/portal/3M/en_US/Energy-Advanced/Materials/Product/~/Advanced-Materials?N=5581377+7570097+5002440&loc=en_US&plmlblid=136158191881 0&rt=r3
PICTURES	 Glass bubbles
MAIN FEATURES	High solar reflectance and high emittance in the thermal infrared region It can be applied as roof coating or wall façade paint Available in a wide range of strengths, densities and particle sizes
RELEVANT FEATURES FOR FAÇADE INTEGRATION	The hollow structure gives a low refractive index (greater influence on reflectance than common materials) It can contribute to the reduction of cooling loads It can improve abrasion resistance and reduce thermal expansion
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Removal of the existing plaster Insulation material Coating application
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*Painter, ETICS installer, Works director (material acceptance)* Scaffolding, Crane
SERVICE LIFE MANAGEMENT	Coating_Renovation (15 y)

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PRODUCT'S NAME	MIG ENERGIE SAVING PAINT
PRODUCER	MIG
PRODUCT CATEGORY	Coatings and paints – Heat reflective coatings
WEBSITE	http://www.mig-mbh.de/index.php/produktdaten-download http://www.migesp.cz/wp-content/uploads/LET%C3%81K-Tepeln%C4%9B-vlhkostn%C3%AD-hodnocen%C3%AD-etc..pdf
PICTURES	 Reflectance property
MAIN FEATURES	High solar reflectance and high emittance in the thermal infrared region It supports thermal insulation (not substitute) Protection against algae and dirt
RELEVANT FEATURES FOR FAÇADE INTEGRATION	It can be applied both on external and internal surface
PRELIMINARY ACTIVITIES AND INSTALLATION OPERATIONS NEEDED	Removal of the existing plaster Insulation material Coating application (1 litre per 3.5-5 m² depending on the surface; 2 coats are recommended)
BUILDING SITE IMPLEMENTATION Complementary *Human resources* and equipment	*Painter, ETICS installer, Works director (material acceptance)* Scaffolding, Crane
SERVICE LIFE MANAGEMENT	Coating_Renovation (15 y)

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3. ENVELOPE TECHNOLOGY COST ANALYSIS AND IMPACT

Within this chapter a first economic indication about envelope retrofit solutions is reported. We simply did not indicate any price in the technical sheets because these are sensible. Mostly, costs are available on demand but very rarely they are public and easily findable on the web.

In order to have an idea of the costs, a range of values is below reported for every envelope solution shown in the previous chapter. All the data are summarized in Table 1, more specifically some information about what the cost concerns and others are reported under the column titled 'Notes'.

The costs here shown do not include any added tax and are related only to the supply at the construction site except where specified in the notes.

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TABLE 1 - COST RANGE FOR EVERY CATEGORY SOLUTION

TECHNOLOGY	MIN	MAX	UNIT COST	NOTES
SOLAR THERMAL COLLECTORS_SINGLE PRODUCT	340	750	€/m²	Only collectors are included and depend from collector technology
SOLAR THERMAL COLLECTORS_BIST SOLUTION	500	800	€/m²	Fastening system, connection kit and tubes are included
PV PANELS_SINGLE PRODUCT_OPAQUE	70	290	€/m²	Amorphous (5% efficiency) --> 20 m²/kWp Cristaline (14-15% efficiency) --> 7 m²/kWp
PV PANELS_SINGLE PRODUCT_SEMITRANSPARENT	110	260	€/m²	3% efficiency --> 34 m²/kWp
PV PANELS_BIPV SOLUTION	+150	+350	€/m²	Extra cost in comparison with standard facades Fastening system, connection kit and cables are included
PREFABRICATED MULTIFUNCTIONAL FACADE MODULES	500	800	€/m²	Transport, installation of passive/active facade modules (integration of insulation, new windows, pv, decentralized ventilation)
WALL INSULATION MATERIALS (Λ <= 0.3)	2.2	90	€/m²/cm	Polyurethane, Aerogel, Vacuum panel
WALL INSULATION MATERIALS (Λ 0.3-0.4)	1.7	3.5	€/m²/cm	Rock mineral wool, Cellulose fiber, EPS, XPS, Fiberglass, Woodfiber, Cork, Polyester fiber, Glass wool
WALL INSULATION MATERIALS (Λ >0.4)	1.6	4.4	€/m²/cm	Mineral woodfiber, Foamglas
FLOOR INSULATION MATERIALS	20		€/m²	Expanded clay, Foamcem, Vermiculite
ETICS (EXTERNAL THERMAL INSULATION COMPOSITE SYSTEM)	80	120	€/m²	Starting profile installation, gluing for panels, dowels, levelling layer, primer and finishing layer are included
MECHANICAL VENTILATION (INTEGRATED IN FACADE)	800	1600	€/unit	From 15 to 100 m³/h depending on the velocity
WINDOWS	300	400	€/m²	Triple glazing system
SHADING SYSTEMS	100	400	€/unit	Simple roller-blind block Monoblock system
NATURAL VENTILATION SYSTEMS	170	190	€/unit	1 unit is made of 1 chain actuator and brackets for installation
REFLECTIVE COATINGS	3	4.5	€/m²	Equivalent insulation thickness?

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Potential expected benefits of some retrofit scenarios including different technology categories explained above are reported in Table 2. As general indicators, energy demand, energy production, comfort and some critical points are considered.

TABLE 2 - RETROFIT SCENARIO'S IMPACT

SCENARIO		ENERGY DEMAND				ENERGY PRODUCTION		COMFORT		CRITICAL POINTS		
#	Short description	H	C	DHW	EL	TH	EL	V	HT	TB	IC	INV
1	ETICS + New Windows + Heating System	+	?	N	?	N	N	+	?	+	+	-
2	ETICS + New Windows + Heating System + Centralized Mechanical Ventilation	+	+	N	?	N	N	+	+	+	+	-
3	ETICS + New Windows + Heating System + Centralized Mechanical Ventilation + Solar Thermal Collectors on Roof (50% DHW) + PV Panels on Roof	+	+	+	+	+	+	+	+	+	-	-
4	ETICS + New Windows + Heating System + Decentralized Mechanical Ventilation + Solar Thermal Collectors on Facade (50% DHW)	+	+	+	?	+	N	+	+	+	-	-
5	ETICS + New Windows + Heating System + Decentralized Mechanical Ventilation + PV Panels on Facade (50% DHW)	+	+	+	+	N	+	+	+	+	-	-
6	ETICS + New Windows + Heating System + Decentralized Mechanical Ventilation + Solar Thermal Collectors on Facade (50% DHW) + PV Panels on Roof	+	+	+	+	+	+	+	+	+	-	-
7	Prefabricated Multifunctional Facades integrating Insulation, New Windows, Decentralized Mechanical Ventilation, PV (50% DHW)	+	+	+	+	N	+	+	+	+	-	+

No solution is considering natural ventilation strategies, shading systems and reflective coatings:

On Hygrothermal comfort: If the environment becomes too much airtight there's no more air circulation; humid ambient could favor mold formation:

On electrical uses: new windows can favor illuminance or not; hence, lighting demand can vary:

On invasiveness: it depends on the ETICS system

We have seen that there are more and less invasive solutions

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TABLE 3 - RETROFIT SCENARIO'S LEGEND

LEGEND	
H	HEATING
C	COOLING
DHW	DOMESTIC HOT WATER
EL	ELECTRICAL
TH	THERMAL
V	VISUAL
HT	HYGROTHERMAL
TB	THERMAL BRIDGES
IC	INVESTMENT COST
INV	INVASIVENESS
+	POSITIVE IMPACT
-	NEGATIVE IMPACT
?	IMPACT TO BE ASSESSED
N	NO IMPACT

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4. CONCLUSIONS

The current report shows a series of products that can be used for the retrofit of the existing building envelope in order to improve comfort and the energy performances.

The final concept of the retrofit solution has to be conceived tailored on the case study: hence, Envelope energy retrofit solutions – PART B will propose some quantitave pictures of retrofit solutions' scenarios. Starting from these and thanks to the Integrated Design Process, **the final "multifunctional envelope" solution can be properly designed: modelling and testing activity can give adequate answers to the questions concerning the performances of the conceived system**.

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Annex: DOCUMENT INFORMATION

SINFONIA DELIVERABLE FACT SHEET	
PROJECT START DATE	1 June 2014
PROJECT DURATION	60 months
PROJECT WEBSITE	http://www.sinfonia-smartcities.eu
DOCUMENT	
DELIVERABLE NUMBER:	
DELIVERABLE TITLE:	
DUE DATE OF DELIVERABLE:	
ACTUAL SUBMISSION DATE:	
EDITORS:	
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