



Energy in Buildings and
Communities Programme

CENERGIA
Energy Consultants Denmark



INSPIRATION AND EXPERIENCES FROM THE JOINT ANALYSIS OF SHINING EXAMPLES OF COMPREHENSIVE ENERGY RENOVATION BUILDING PROJECTS WITHIN IEA EBC ANNEX 56

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SCOPE OF THE WORK

Collected “shining examples” of comprehensive energy renovation building projects in the member countries:

- To support decision makers and experts with profound information for their future decisions;
- To show successful renovation projects as inspirations in order to motivate decision makers and stimulate the market.
- To understand barriers and constraints for high performance renovation.
- To align the methodology developed in Annex 56 with practical experiences;

CONTENTS OF THE PRESENTATION

1. Location of the Shining examples
2. One Shining Example – presenting the information gathered
3. Overview Of The Analyses:
 - Barriers / Solutions
 - Anyway measures
 - Which measures
 - Country/Climate specific measures
 - Co-benefits
4. Conclusions

LOCATIONS

Building types:

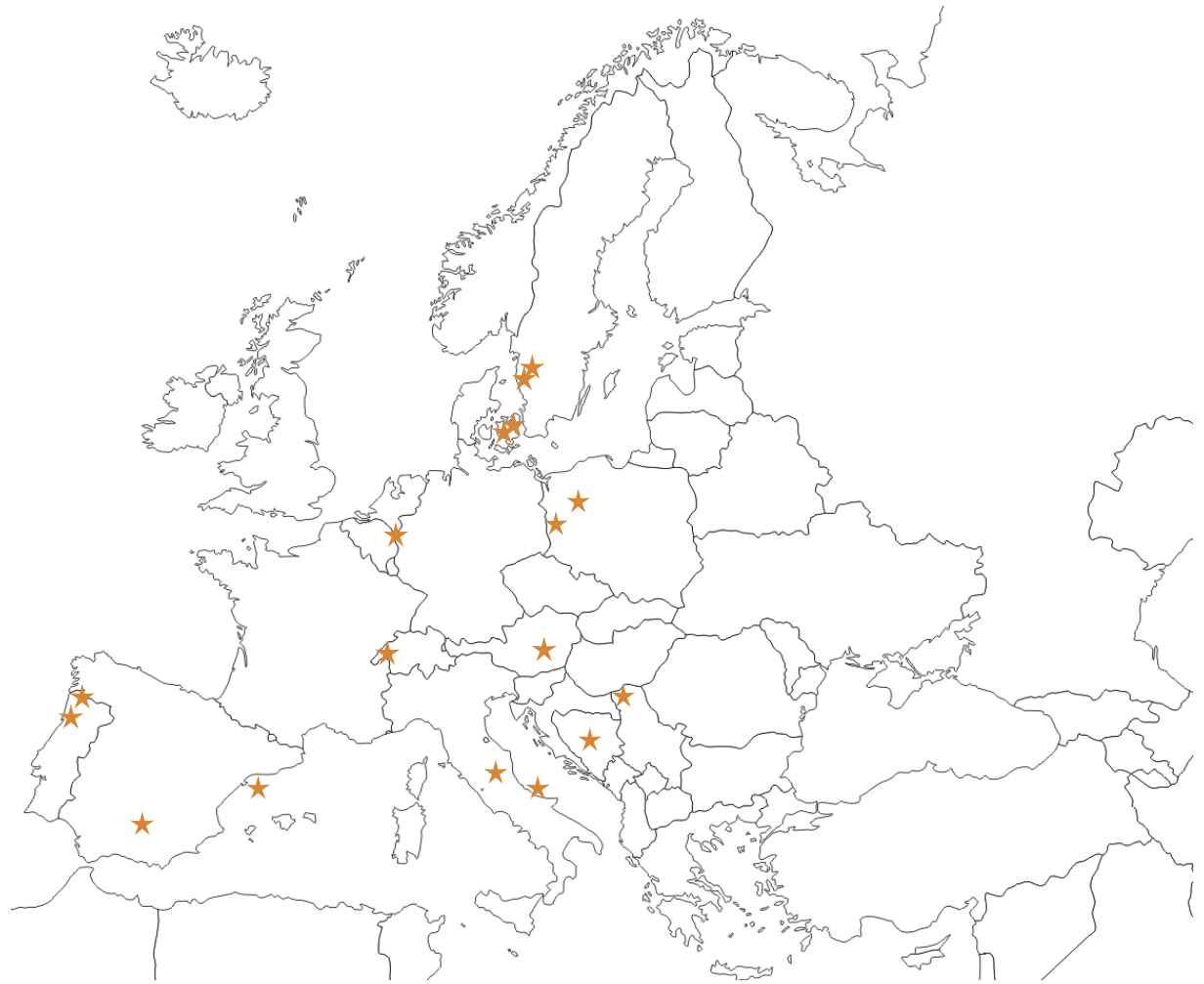
Multifamily: 11

Single family: 5

Office: 1

School: 1

Total: 18



Ca'S. Orsola, Treviso, Italy

Project summary

Energy concept: Insulation, mechanical ventilation, solar thermal and PV-system

Background for the renovation – reasons

The building was partly inhabited and used as a guesthouse of the convent of Order of St. Ursula and it was abandoned from 2000; It reached a serious state of degradation and a high renovation was needed, but there was a heritage architectural restriction about the external envelope.

Specific goal of project were:

- to achieve A class energy classification according to Italian regulations;
- to consolidate and to reinforce the building structure;
- to improve the indoor thermal and acoustic quality;
- to transform it in a prestigious residence with all comforts.



Site:	Treviso
Altitude:	15 m
Heating degree days:	2378
Cooling degree days:	
Owner:	Cazzaro Costruzioni S.r.l.
Architect:	Imago Design - Domenico Rocco
Engineer	Systems - Vincenzo Conte
	Structures - Giovanni Crozzolin



General view of the building before and after the intervention

Building description/tipology

Listed building located in Treviso, It was the old seat of a Polish Institute

Total site area: 4500 m²

Gross heated area: 1800 m²

Gross volume: 6300 m³

Contact Person:	Mauro Cazzaro
Important dates:	Originally built in 1300; Important renovations in 1923 and in 1950 Last renovation started in 2008 and completed in 2012
Date completed:	Template completed in 15-10-2014

BUILDING ENVELOPE, HEATING, VENTILATION, COOLING AND LIGHTING SYSTEMS BEFORE THE ENERGY RENOVATION

Description of building (building situation, building system, renovation needs, renovation options)

Ca' S. Orsola is located in the historic center of Treviso, in North East of Italy, very close to the Cathedral. The building was the old seat of Polish Institute and now it is a listed building by Historical and Architectural Heritage Superintendence of Veneto.

Originally it was a convent and it was inhabited until 2000 and during the time it kept intact the original structure and architectural distribution. Then it was bought in 2007 for acting a deeply renovation and converting it in a prestigious residential building. At the beginning of construction phase the structure revealed a quite ruined state of conservation: walls are crooked and presented different solutions, moisture affected wooden elements in the floors and in the roof.

Building envelope before renovation

The construction system was based on bearing masonry with covered solid bricks. The floor had a wooden structure, while the ground floor leaned directly on soil. The roof is made of hollow tiles sheets with a wooden structure and a lightweight ceiling slab. The windows frames were made of wood and the windows used to have a single glass. There is no insulation in the external walls, roof and floors.

Heating, ventilation, cooling and lighting systems before renovation

In the building heating or cooling system was not installed. Heating was provided by a fireplace, also used for cooking, occasionally an electric heater or portable fan coils was placed in any room.

The domestic hot water was supplied by electric heaters with storage tank; there wasn't a ventilation system, so ventilation was made by natural means.



Crooked walls, before renovation

Element	Area m ²	U-Value before renovation W/m ² K	U-Value after renovation W/m ² K
Façade	1300	0,90	0,180
Ceiling	508	1,65	0,788
Windows, doors	140	2,70	1,948-2,035
Roof	508	1,09	0,158



Demolished partition walls left and used as a substrate

ENERGY RENOVATION FEATURES

Energy saving concept

The restructuring aims not only to heal a property that was under the limit of sustainability from the structural point of view, but especially to retrain in terms of energy and acoustic complex.

Technologies

The A energy class has been achieved by means of several design topics among which:

- high insulated windows
- high level of opaque walls insulation
- mechanical ventilation system with heat recovery
- solar thermal panels and PV systems
- water to water heat pumps and chillers

Building

The first step has been the measures taken to consolidate the building structure. Subsequently a detailed study on thermal and acoustic bridges has been developed with the aim to improve the indoor thermal and acoustic quality.

- Walls: the insulation is placed on the inner part of the wall and this solution meet the requirements of the Superintendent preserving the existing materials and the external architectural identity of the building. Specifically, two types of insulating are used: an expanded polystyrene (EPS) foam, placed directly on masonry, and a rigid rockwool panel with a plasterboard cover;
- Roof: it was replaced with a new wooden structure and it was insulated with wood fiber and water tight covering;
- Windows: all existing windows are replaced with a low-energy double layer ones within wooden frames.

Technical systems

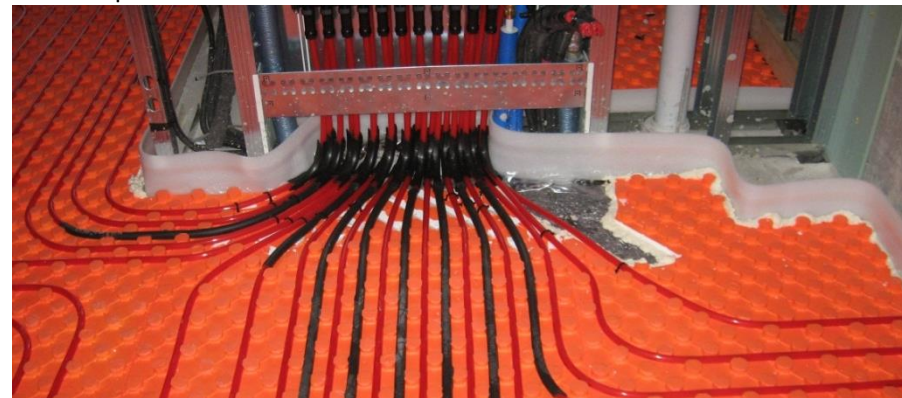
The HVAC generation system is a water to water centralized heat pump/chiller. The underlying well is the hot/cold water source and internal comfort is achieved exploiting a radiant system installed in the floor together with a dehumidification system for the summer period.

Systems

- Heating and Cooling: 32 kW heat pump and distribution with radiant floor system;
- DHW: 20 kW heat pump;
- Ventilation: mechanical ventilation system with heat recovery box with 95% efficiency.

Renewable energy systems

- Thermal solar panels for DHW production (20 m²) installed in vertical;
- Photovoltaic power plant producing 3230 kWh of total annual energy. The panels are installed on the roof and oriented to the south.



Radiant system

ACHIEVED ENERGY SAVINGS, CO₂ REDUCTIONS AND COSTS

Energy need		Before renovation	After renovation	Saving
Heating	<i>kWh/m²a</i>	342,7	42,3	88%
DHW	<i>kWh/m²a</i>	44,4	33,6	24%
Total	<i>kWh/m²a</i>	387,1	75,9	80%
Energy label		G	A+	
Carbon emissions	<i>kg CO₂Eq/m²a</i>	29,8	5,8	81%

Energy savings and CO₂ reduction

Before renovation there wasn't non-renewable energy consumption, so values for calculated energy needs are presented and provide comparable thermal comfort conditions.

Value for DHW needs already includes the solar thermal contribution.

Costs	EUR	EUR/m ²
Craftsmen	2.94 million €	1463,41 €/m ²
Consultants	130.000,00 €	64,71 €/m ²
Electrical and Plumbing	700.000,00 €	348,43 €/m ²
Total construction	3.77 million €	1876,56 €/m ²
Thermal solar and PV system	32.000,00 €	15,92€/m ²
NPV	13 Years	

Renovation costs

Construction cost excludes the costs for heating and DHW, the costs related to the purchase of the area, charges, interest, taxes.

RES contribution

PV energy contribution: 3680 kWh a



Photovoltaic system - TNT underflooring above systems



Mechanical ventilation system

OVERALL IMPROVEMENTS

Energy benefits

Energy savings: 311,2 kWh/m²a (heating, DHW, ventilation)

Indoor climate technical improvements

The indoor climate was improved due to:

- Mechanical balanced ventilation with heat recovery and a carefully adjusted supply temperature;
- Reduction of losses through walls, roof and windows;
- Reduction of the thermal bridges allowing to eliminate related condensation problems;
- Upgrade of the building energy performance. The standard energy performance for new buildings in Italy has been achieved;
- Control of indoor temperature and humidity without relevant energy costs.

Economics

Renovation of existing buildings, especially if listed, is too much expensive than standard, because it need specialized operations and the preliminary count evaluation is upset during the construction phase. After intervention, however, market value increased for this property and also for the surrounding area: all apartments have been sold by the end of the construction phase.

Decision process – barriers overcome

The investment costs were incurred by the contractor, that is also the owner: in this particular situation themes such as sustainability and energy retrofiting were understood and applied; the major barrier was essentially related with the bureaucracy for obtaining the permission by Historical and Architectural Heritage Superintendence of Veneto.

Non-energy benefits

- Radical renovation that transformed a historic building in a prestigious and comfortable residence;
- Better living conditions with more qualified living spaces;
- Improved structural conditions in an uninhabited and listed building by implementing a seismic consolidation;
- Reached acoustic first class according to national standard UNI 11367 that ensures privacy to the occupants;
- Aesthetical improvement returning the identity of the original building and increasing the market value;



Typical living room in a dwelling

SUMMARY

In Treviso, Ca' S.Orsola is a listed building completely renovated and converted into a residential building, with offices and shops at floor plan and dwellings above.

Renovation aimed not only to restore the structure, but also to redevelop the energetic and acoustic situation. The building is equipped with a seismic structure, and each unit is certified in Class A: using low energy glasses, creating a thermal insulation of important thickness and a mechanical ventilation system with heat recovery, integrating solar panels for DHW and heating are main themes for achieving the certification. Living comfort is assured through the use of interior materials with low harmfulness, underfloor heating and cooling with humidity control. Renovation measures decreased global energy consumption, reducing up to 90%; solar and photovoltaic system contributed to minimized energy consumption.

A prestigious location, a renovated historic building with the most innovative technical solutions made a safe and long-lasting investment.



Courtyard from west perspective

Acknowledgements

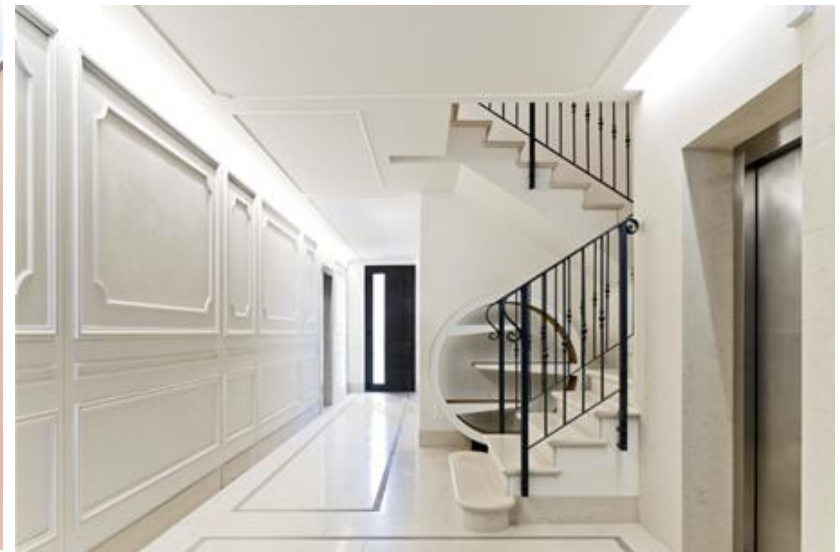
Special thanks belong to:

- **Cazzaro Costruzioni Staff** for interest in collaboration on this project
- Ing. Vincenzo Conte for sharing the necessary data about heating system
- **Apartment inhabitants** for cooperation during in-situ inspections and interviews

References

[1] <http://www.cazarocostruzioni.it/>

[2] CASA&CLIMA, n.47, "Storico, antisismico e in Classe A", pg. 36-44, Quine Business Publisher Edition



Main entrance to the building from via Riccati

ANALYSES CARRIED OUT

- Anyway measures
- Which measures
- Country/Climate specific measures
- Barriers / Solutions
- Co-benefits

ANYWAY MEASURES:

Anyway measures, here defined as

“a set of actions, products and services necessary to guarantee the regular, safe and legal functioning of buildings, as well as aesthetics, technological and contemporary evolutions that societal changes require of them”

Examples of anyway measures found in the Shining Examples:

- Exterior painting (scaffolding)
- Heating systems in need of repair, renewal
- Lighting levels outdated
- Water and electricity networks needed renewal

WHICH MEASURES (RUE/RES BALANCE)

Many of the Rational Use of Energy (RUE) measures were currently less expensive than the use of Renewable Energy Sources (RES), due to the need for “Anyway measures”.

Rational Use of Energy (RUE) measures were taken as a first step.

The implemented RES were:

- PV - 7
- Solar Thermal - 9
- Heat Pump - 2
- District Heating - 2

COUNTRY/CLIMATE SPECIFIC MEASURES

Energy renovation features		Insulation, Wall, roof, floor	Window glazing, double/triple	Mech. ventilation w. HR	Solar thermal	PV	Efficient lighting	Air condition	Heat distribution system	New heat supply
Ca`S. Orsola, IT	A	1,2	6	21	9	√				34
Ranica, IT	A	1,2	7,37	36	9					35,19
Pontes Country House, PT	A	1, 2,	6	22	9		√		23	15
Rainha Dona Leonor, PT	A	1, 2	6		9			√		14
Montarroio,PT	A	32, 33			9, 10			Ice-production		31
Corazón de Maria, ES	A	1,2	6		9		√	√		19
Kapfenberg, AT	B	1, 2, 3	7	21	8	√				16
Bruck an der Mur	B	1,2	7,37	22		√		HP		38,39
Kaminky, CZ	B	1,2	6, 7	21, 29		√	√		30	
Koniklecová, CZ	B	1,2	7	28			√		24, 25, 26, 27	
Wijk van Morgen, Kerkrade, NL	B	1, 2, 3	7	21	9, 10	√				18
Les Charpentiers, CH	B	1, 2	7	21			√		20	17
Skodsborgvej, DK	C	1, 2,	7	21	9				13	19
Traneparken, DK	C	1, 2, 3	7	21		√				
Sems have, DK	C	2,3	7	21		√	√		46, 41	45
Backa röd, SE	C	1, 2, 3	7	21			√		11	
Brogården, SE	C	1, 2, 3	7	21			√		12	
Maratonägen, SE	C	1,2,	7	21			√		40, 41, 42, 43	44

South Europe: A

The Alps and Central Europe: B

North Europe: C

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BARRIERS/SOLUTIONS

General barriers - from an earlier study of the annex:

- Information issues;
- Technical issues;
- Ownership issues;
- Economic issues.

Designation	Barriers	Solutions
Kapfenberg	<ul style="list-style-type: none"> The financing of the renovation was a barrier because, due to governmental regulations, it was not possible to excessively increase the rental prices for the apartments; Additionally, the renovation works inside the building, such as the change of the layout, made a resettlement of the residents necessary. 	<ul style="list-style-type: none"> Other funding and financing solutions were found to realise the renovation; Due to the fact that there were no apartments available in Kapfenberg at the time of the renovation, this process could only be put into practice in two different construction phases in order to guarantee the residents an apartment during the renovation period.
Traneparken, Hvalsø	<ul style="list-style-type: none"> There were practical administrative barriers to convince the tenants that it was a good idea to carry out the energy renovation. 	<ul style="list-style-type: none"> These barriers were overcome without too much trouble by thoroughly informing the tenants about potential benefits and added values of the project.
Sems Have, Roskilde	<ul style="list-style-type: none"> The Housing Association experienced difficulties in obtaining approval from the municipality to change the status of the buildings from dormitory/day-care centre to residential. 	<ul style="list-style-type: none"> The building association had to make a cost-benefit analysis to show that it was meaningful to change to another use. This was based on a technical report on the actual state of the building before renovation, including a proof that the load-bearing structure was adequate for the new use.
Ca' S. Orsola, Treviso	<ul style="list-style-type: none"> The major barrier was related with the bureaucracy for obtaining the permission by Historical and Architectural Heritage Superintendence of Veneto. Another barrier was the high costs 	<ul style="list-style-type: none"> The investment costs were incurred by the contractor, that is also the owner: in this particular situation themes such as sustainability and energy retrofitting were understood and applied.
Pontes Country House	<ul style="list-style-type: none"> With respect to the investment costs, the building owners not always understood the unconventional nature of the renovation project and, therefore, expected only conventional costs, both for the renovation works and for the consultants. 	<ul style="list-style-type: none"> This barrier was overcome giving substantial information to the owners about potential benefits and added values of the project.

Designation	Barriers	Solutions
Neighbourhood Rainha Dona Leonor	<ul style="list-style-type: none"> The lack of financing to carry out the works at once was a big barrier; The need to have the buildings vacant to carry out the renovation works. 	<ul style="list-style-type: none"> The works have been divided in several phases over several years; Vacant dwellings from other neighbourhoods have been used to temporarily house the tenants.
Montarrioio, Coimbra	<ul style="list-style-type: none"> Obtaining permit for the building renovation 	<ul style="list-style-type: none"> The IEA EBC Annex 56 methodology was important by providing means to visualize options to municipal stakeholders, thus helping them to understand the individual and collective implications.
Corazón de María, Bilbao	<ul style="list-style-type: none"> The main barrier was the low income profiles of the residents. This was linked to the other significant barrier, which was the residents' reluctance to carry out the renovation works only under energy motivations. Improving the building accessibility (lift installations, moreover) was the main incentive for the tenants. 	<ul style="list-style-type: none"> This was overcome thanks to funding sources obtained from the public administration, (funding given with the aim of boosting the energy renovations).
Brogården, Alingsås	<ul style="list-style-type: none"> A delay was caused by poor project management. The preservation of the area and accessibility questions took much time in the planning process; The energy issues were first almost neglected. 	<ul style="list-style-type: none"> The project management was replaced; A person was put in charge of the energy issues.
Les Charpentiers	<ul style="list-style-type: none"> The challenge was to perform the renovation keeping the largest possible number of tenants. 	<ul style="list-style-type: none"> Some tenants were moved several times.

BARRIERS/SOLUTIONS

General barriers - from the early study:

- Information issues;
- Technical issues;
- Ownership issues;
- Economic issues.

– for the shining examples:

- No barriers (7);
- Administrative issues (7);
- Economical/financing (6);

So: the general barriers were overcome for the Shining examples, which can be characterised as "forerunner" projects. This was primarily due to persistence/endurance of a single person or a team to e.g.:

- Find additional funding, introduce phases, replace project manager and insert a person responsible for energy,
- improve information, use vacant buildings in the neighbourhood

CO-BENEFITS ~ non-energy benefits

The following co-benefits were identified in the Shining Examples:

- 1) Thermal comfort,
- 2) Natural lighting and contact with the outside environment,
- 3) Improved air quality,
- 4) Reduction of problems with building physics, (e.g. condensation)
- 5) Noise reduction,
- 6) Operational comfort,
- 7) Reduced exposure to energy price fluctuations,
- 8) Aesthetics and architectural integration,
- 9) Increased useful building areas,
- 10) Safety (intrusion and accidents),
- 11) Pride, prestige, reputation

Designation	Co-benefits from energy related measures	Benefits from non-energy related measures
Kapfenberg	<ul style="list-style-type: none"> • Improved thermal quality by reduction of thermal bridges; • Better indoor climate by mechanical ventilation system with heat recovery; • Renewal of old heating and domestic hot water systems improve the operational comfort by a new centralized and automatically controlled system. 	<ul style="list-style-type: none"> • Barrier-free access to all flats by the installation of an elevator and an arcade; • Changed layout of the flats enables new modern living with openable windows to both, east and west sides; • New and larger balconies for all flats; • Improvement of the reputation of the building; • New functional area for the residents.
Bruck and der Mur	<ul style="list-style-type: none"> • High thermal comfort in summer and winter • Acoustic comfort • High ratio of daylight 	<ul style="list-style-type: none"> • Barrier free access to all parts of the building
Kaminky	<ul style="list-style-type: none"> • Comfort of the users (students and staff) e. g. the new equipment is easier to use and maintain 	<ul style="list-style-type: none"> • New possibilities for active spending of leisure time for students and general public are open thanks to the new sport facilities • Overall improvement of people's perception of the building and surroundings
Koniklecova	<ul style="list-style-type: none"> • Improved user comfort of the tenants as new equipment, windows, doors, etc. are easier to use and maintain than original ones. 	<ul style="list-style-type: none"> • Aesthetic perception of the building and its surroundings has improved • Renovation of the building was related to other works - renovation of surrounding pavements, playgrounds, etc. – which also had positive impact on the living conditions
Skodsborgvej, Virum	<ul style="list-style-type: none"> • The family can place furniture etc. close to the wall without risking damages (mould) and draught • This investment ensures that the family can afford other investments in the future 	<ul style="list-style-type: none"> • The roof-construction has been checked, and it is clear that it is a good construction which will last for the next 20 – 30 years • The useable space (first floor) has increased, i.e. the family will use the rooms upstairs far more
Traneparken, Hvalsø	<ul style="list-style-type: none"> • improved indoor climate. 	<ul style="list-style-type: none"> • New green surroundings. New balconies

Designation	Co-benefits from energy related measures	Benefits from non-energy related measures
Sems Have, Roskilde	<ul style="list-style-type: none"> • Improved architecture • Improved indoor climate • New lighting in the staircases • New sewer system, new- cold and hot-water system and new electrical system 	<ul style="list-style-type: none"> • Up-to-date affordable apartments which can be rented out • New kitchens and bathrooms • Improved surroundings • Prestige: nominated to a renovation award • Elevator to apartments in block A • Balconies for some apartments
Ca' S. Orsola, Treviso	<ul style="list-style-type: none"> • Radical renovation that transformed a historic building in a prestigious and comfortable residence • Better living conditions with more qualified living spaces • Reached acoustic first class according to national standard 	<ul style="list-style-type: none"> • Aesthetical improvement returning the identity of the original building and increasing the market value • Improved structural conditions in an uninhabited and listed building by implementing a seismic consolidation
Via Trento, Ranica	<ul style="list-style-type: none"> • Improved mean radiant temperature, due to the radiant floor and the highly insulated envelope • Improved acoustic features • Improved IAQ due to the mechanical ventilation system • Improved control of light and of comfort mitigation in summer due to the new shading devices 	<ul style="list-style-type: none"> • Addition of a floor providing a professional office for the owner • Achieved water savings due to the installation of a rainwater recovery system for garden irrigation
Wijk van Morgen, Kerkrade	<ul style="list-style-type: none"> • Reduced exposure to energy price fluctuation • The housing association has considerably enlarged the economic and technical “life time” of the housing complex 	<ul style="list-style-type: none"> • Overall status of the area has improved
Pontes Country House, Melgaco	<ul style="list-style-type: none"> • The renovation measures returned the building living conditions, with levels of thermal and acoustic comfort and air quality consistent with current requirements; • The focus on energy consumption minimization and usage of low embodied environmental impact materials is to be used for marketing purposes, as a sign of pride, prestige and reputation. 	<ul style="list-style-type: none"> • Reuse of an abandoned traditional building, with preservation of its architectural value; • Development, in an economically depressed region, of tourism activities with sustainability principles

Designation	Co-benefits from energy related measures	Benefits from non-energy related measures
Rainha Dona Leonor, Porto	<ul style="list-style-type: none"> Improved thermal comfort conditions with users now able to heat indoor spaces and keep the interior environment within healthy and comfortable temperatures; Improved natural lighting with larger glazing areas in living room. 	<ul style="list-style-type: none"> Aesthetical improvement, returning the dignity and identity of the neighborhood, reducing the social housing stigma; Better living conditions with more space and more qualified living spaces.
Montarrioio, Coimbra	<ul style="list-style-type: none"> Material benefits - seismic safety, energy performance and more area increase the value of the building and potential rent value Alternative renovation processes allow for new insights on collective energy efficiency 	<ul style="list-style-type: none"> By renovating towards nZEB goals, the neighbouring owners can realize the potential of their buildings, and be engaged in their renovation By fostering maintenance practices, local jobs are encouraged
Corazón de María, Bilbao	<ul style="list-style-type: none"> Renovation makes delivering affordable warmth to the poor households easier, and it reduces the risk of energy poverty and cold homes 	<ul style="list-style-type: none"> Development in a depressed area of the city Building accessibility is significantly improved
Backa röd AB, Gothenburg	<ul style="list-style-type: none"> Repaired façade Water and sewage systems replaced, hot water circulation installed 	<ul style="list-style-type: none"> New electrical installation; New bathrooms and kitchens; Change to parquet floor in living rooms and bedrooms; New surface finish in the apartments; Safety doors for the apartments. New extended balconies
Brogården, Alingsås	<ul style="list-style-type: none"> Better indoor climate New water and sewage system 	<ul style="list-style-type: none"> Improved accessibility (ground floor) New electrical installation New bathrooms and kitchens New surface finish in the apartments New balconies Larger living rooms
Maratonvägen, Halmstad	<ul style="list-style-type: none"> Better indoor climate Glazing of balconies The old entrance doors to the apartments were replaced with new safety entrance doors 	<ul style="list-style-type: none"> New burglar proof storerooms New common laundry rooms Improved surroundings Improved status of the area
Les Charpentiers, Morges	<ul style="list-style-type: none"> Better comfort (noise, thermal); To avoid thermal bridges, the new thermal envelope wraps balconies. So the living floor area increases. 	<ul style="list-style-type: none"> Renewing the apartments, new sanitary and kitchen facilities.

CONCLUSIONS

A “one size fits all” approach is unviable for “Cost Effective Energy and Carbon Emissions Optimization in Building Renovation”.

The Shining Examples show that the implemented RUE/RES measures were a consequence of local opportunities and constraints, ownership and local laws, and not only a design option.

The Shining Examples may be characterised as forerunners initiated by “first movers”.

The shining examples demonstrate the potential of the renovation measures. As a whole they state that this potential can be harnessed in all buildings renovations, from single family to multi-family buildings.

Barriers were overcome and the renovations have led to many significant co-benefits!

Thank you for your attention!

Questions?