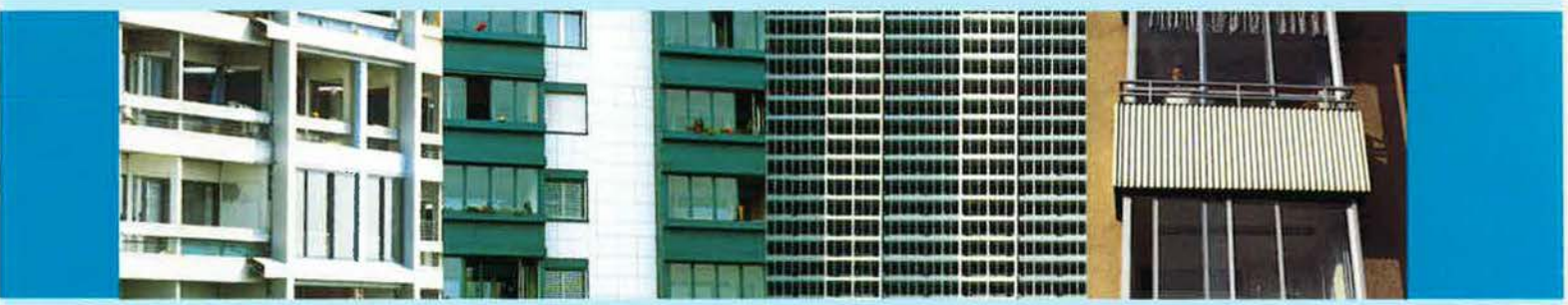
IEA SOLAR HEATING AND COOLING (SHC) PROGRAMME, TASK 20:
SOLAR ENERGY IN BUILDING RENOVATION



Glazed Balconies in Building Renovation

JAMES X JAMES

IEA
INTERNATIONAL ENERGY AGENCY
Solar Heating & Cooling Programme

Contents

International Energy Agency (IEA) Solar Heating and Cooling (SHC) Programme, Task 20: Solar Energy in Building Renovation

If the use of solar energy is to mean that significantly less fossil fuel will be consumed, solar systems must be readily adaptable to existing buildings as well as new buildings. Under the IEA SHC Programme Task 20: 'Solar Energy in Building Renovation', a number of the most promising solar concepts and systems for building renovation have been explored.

The first activity of Task 20 was the analysis of the performance of existing solar renovation projects that appear to be based on broadly applicable design concepts. Then on the basis of the information gained from these case studies, the participants investigated improved and advanced solar renovation system concepts with high potential for both energy savings and replication. Strategies for incorporating these concepts into the renovation process were developed for a number of specific projects.

The countries participating in Task 20 are: Belgium, Denmark, Germany, The Netherlands, Sweden, Switzerland and the USA.

Acknowledgements

The support of Novem (The Netherlands Organization for Energy and Environment), which has funded the leadership of the subtask on Dissemination and the work related to this brochure, is gratefully acknowledged. My thanks to all who contributed to the production of this brochure: all national experts, and my colleagues at W/E Consultants. The contents of this brochure are based on research work in Denmark, The Netherlands and Switzerland.

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Graphics: Laus vd Bliek, W/E Consultants Sustainable Building, Gouda, The Netherlands

Illustrations: Ad Oskam, Rotterdam, The Netherlands

Design and production: James & James (Science Publishers) Ltd, London, UK

Introducing Glazed Balconies

Glazing a balcony means enclosing it with a glazed facade element, while keeping a separation between the balcony and the rooms behind it. A glazed balcony should have openable glazed elements to prevent overheating in the summer. A glazed balcony is an effective measure to utilize solar energy in existing buildings.

Solar renovation

Renovation and major repair work aim at improving a dwelling to meet current building standards. In a renovation the floor plan may change, new building components may be used, the heating equipment may be replaced, the insulation value may be improved, etc. Glazed balconies can be implemented successfully and cost-effectively when other substantial building envelope improvements are being undertaken.

Glazed balconies are considered as a solar renovation option since they can be designed to maximize the capture of solar heat, as well as to reduce building heat losses.

Advantages of glazed balconies

There are many good reasons for applying glazed balconies to an existing building.

- Solar energy can preheat the ventilation air in the balcony. Glazed balconies reduce transmission and ventilation losses. Part of the heat losses can be recovered from the incoming ventilation air.
- Glazed balconies can improve the indoor climate. They create a space between the apartment and the outside - a sunspace with a comfortable climate. In winter, preheated air reduces the risk of drafts. Thermal comfort is improved in adjacent rooms. Glazed balconies may also attenuate outside traffic noise.
- Glazed balconies can help solve major building envelope problems, such as:
  - poor insulation;
  - damaged or detoriated concrete;
  - balcony slabs as thermal bridges;
  - window frame maintenance.
- Glazed balconies can protect existing facades and balconies and reduce maintenance costs for the covered elements. They can also improve the quality of the apartments.
- Glazed balconies have many other benefits. They can enhance the architectural image of the building and its dwellings. For example, they can make the building look less monotonous. The glass may give the building a more modern look. A better image can certainly have a positive effect on the surrounding area.
- Glazed balconies can increase the utility of the space. The occupants can use the balcony more often. When it is cold outside, the balcony may still be at a comfortable temperature. During the summer, a glazed balcony can be opened. The occupants can use the glazed balcony as an attractive and comfortable extra space during major parts of the year.

By taking into account some solar design principles, it is possible to create an advanced glazed balcony, one that will save more energy and improve the indoor climate, thereby increasing the lettability. This brochure explains how glazed balconies can be installed and used so as to maximize their energy performance. Included is a discussion of some of the key design considerations: glazing type, ventilation system, and solar gain control. The brochure also addresses architectural aspects of glazed balconies. Finally, information for occupants and integrated design aspects are addressed.

Advantages of glazed balconies

- **Energy is saved**
- **Ventilation air can be preheated**
- **The indoor climate is improved**
- **Maintenance problems are solved**
- **The architectural image is enhanced**
- **The utility of the space is enhanced**
- **The lettability is enhanced**

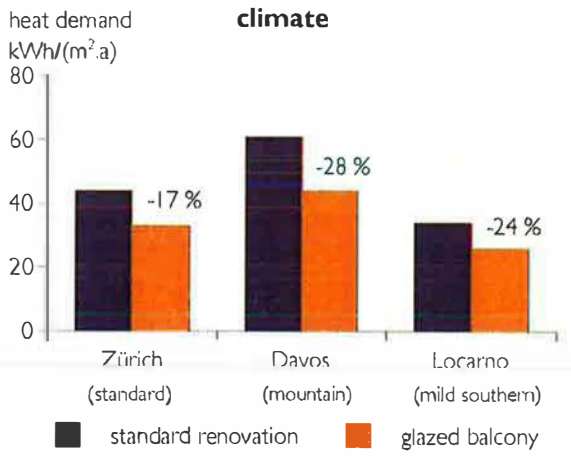
Buildings and Climate

Which types of buildings are best suited for glazed balconies? Which orientations are required for a glazed balcony? Both energy savings and indoor comfort are related to location and building parameters.

Climatic conditions

The energy savings produced by a glazed balcony depend on the amount of solar radiation that is collected, the insulation level of the facade relative to standard renovation and the ventilation strategy. A glazed balcony will save the most energy in a sunny and cold climate. A glazed balcony will also reduce the wind pressure on the adjacent room, thereby reducing heat losses due to the infiltration of the outside air. Therefore in a windy, but cloudy, climate there can still be considerable energy savings. Typical savings in heating-dominated climates lie between 10 and 25%.

Glazed balconies can save 10-25% of heating energy requirement in climates typical of central northern Europe and similar US climates. The high end of this range is achieved in cold, sunny climates.

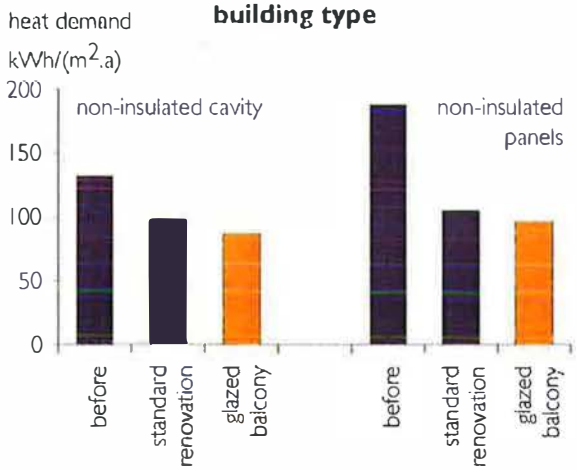


THE CALCULATED ENERGY SAVING WITH A GLAZED BALCONY IS 17% IN THE STANDARD SWISS CLIMATE (ZÜRICH), 28% IN A COLD AND SUNNY MOUNTAIN CLIMATE (DAVOS) AND 24% IN THE MILD SOUTHERN SWISS CLIMATE (LOCARNO)

Building type

The variations in energy use between non-renovated buildings can be very large because of variations in the percentage of glazing and the general level of insulation of the facade. After a standard renovation, if U=0.4 W/m²K for opaque elements, and U=3.0 W/m²K for glazed areas, the differences in energy use become smaller. When a glazed balcony is added, the covered facade is typically not renovated. The impact of the insulation level of the covered facade on the savings produced by the glazed balcony is limited. Glazed balconies can therefore be applied in all types of buildings. However, construction details can make it easier to add a glazed balcony for some building types and harder for others.

Glazed balconies can be applied in all types of buildings



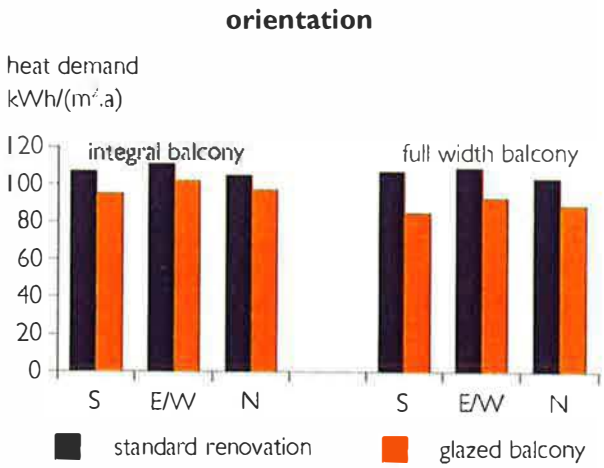
TWO TYPICAL BUILDING SYSTEMS IN THE NETHERLANDS ARE COMPARED. THE ENERGY USE BEFORE RENOVATION DIFFERS CONSIDERABLY. AS A RESULT OF THE DIFFERENT KINDS OF INSULATION USED IN THE EXISTING FACADE. AFTER RENOVATION THE ENERGY USE IS COMPARABLE

Orientation

The orientation of a building or facade influences the amount of solar radiation that is collected by a glazed balcony. However, glazed balconies also save energy by reducing transmission losses and recovering part of the losses by preheating ventilation air. Thus, energy savings can still be considerable for all orientations.

To save the most energy, glazed balconies should have an orientation between south-east and south-west. The balcony will be very light and sunny with this south orientation. However, even a north-oriented balcony will save energy, because the balcony creates a buffer zone between the dwelling and the outside.

Energy savings are highest for south-east to south-west orientations, but a north orientation will also save energy



IN THE DUTCH CLIMATE, THE ENERGY SAVINGS ARE HIGHEST FOR SOUTH ORIENTATIONS, BUT ARE STILL CONSIDERABLE FOR NORTH ORIENTATIONS. BALCONIES ORIENTATED EAST OR WEST PROVIDE ABOUT 75% OF THE SAVINGS THAT CAN BE ACHIEVED WITH SOUTH-FACING BALCONIES

Balcony type

Important characteristics of the balcony to be glazed are its width – whether it spans the full width of the dwelling or is only one room wide – and whether it is integral to or outside the building. One can distinguish four types of balconies, based on these characteristics.

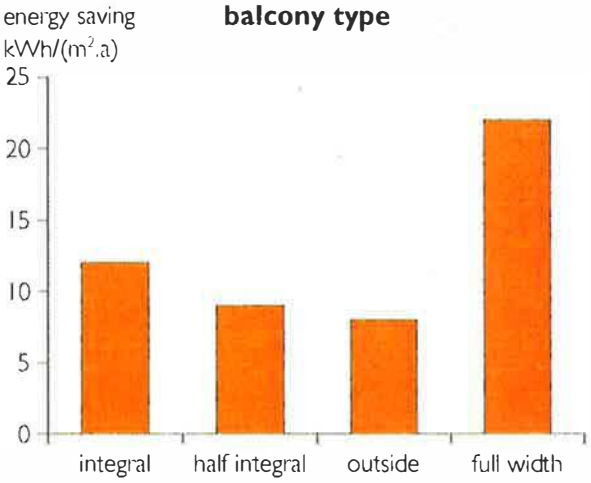
INTEGRAL *HALF INTEGRAL* *OUTSIDE* *FULL WIDTH*

The energy savings increase with balcony width. Glazing an integral balcony saves more energy than glazing an outside balcony for two reasons:

- with a glazed integral balcony the thermal envelope of the building is reduced;
- with a glazed integral balcony the shadowing effect on other balconies is small.

The costs of glazing an integral balcony are less because a smaller area has to be glazed.

Glazing an integral balcony or a full-width balcony provide higher energy savings than glazing an outside or half-integral balcony



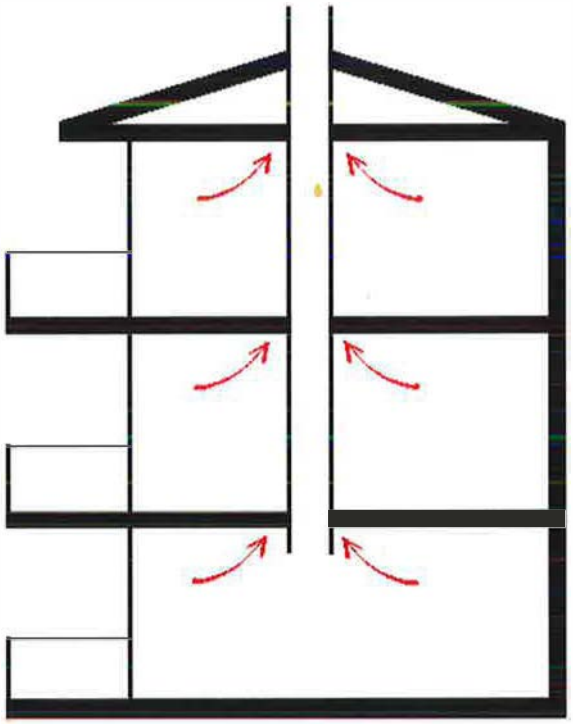
THE ENERGY SAVINGS ARE HIGHEST FOR A FULL-WIDTH BALCONY. GLAZING AN INTEGRAL BALCONY SAVES MORE ENERGY THAN GLAZING A HALF-INTEGRAL OR OUTSIDE BALCONY. ALL CALCULATIONS HAVE BEEN CARRIED OUT FOR A SOUTH ORIENTATION

Concepts

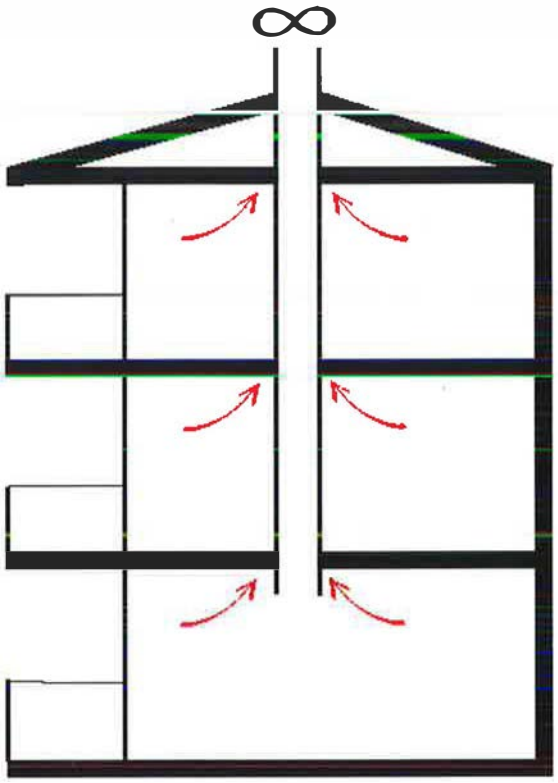
Preheated ventilation air combined with mechanical exhaust ventilation

In a glazed balcony, the ventilation air that infiltrates the dwelling will be preheated by the sun and by transmission losses. This saves energy.

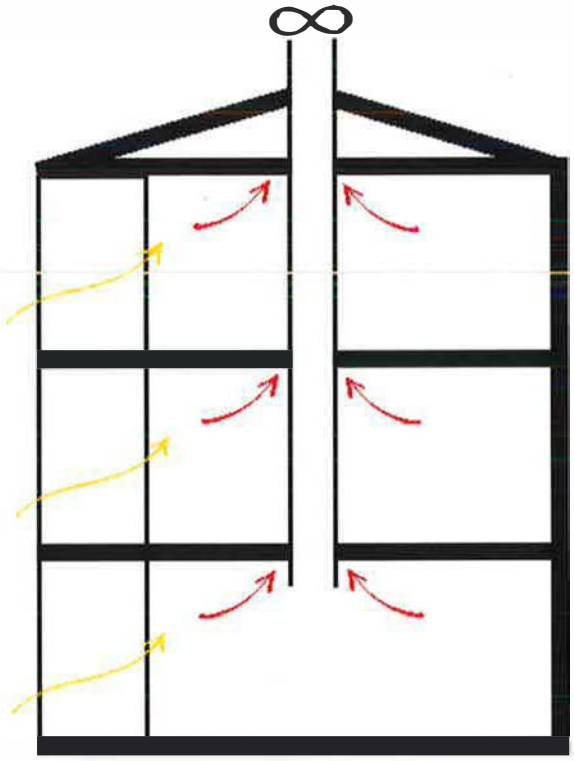
Outside air should enter the dwelling through the balcony and should be transported from there through the whole dwelling. For an optimal effect, there has to be a regulated exhaust of the ventilation air. A standard mechanical exhaust ventilation system will be sufficient for this purpose. There is no need to introduce a balanced ventilation system.



(1) *VENTILATION SYSTEM: BEFORE RENOVATION (NATURAL)*



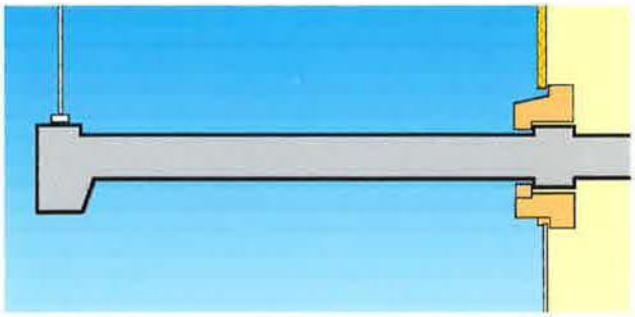
(2) *VENTILATION SYSTEM: STANDARD RENOVATION (MECHANICAL EXHAUST)*



(3) *VENTILATION SYSTEM: GLAZED BALCONY (MECHANICAL EXHAUST, PASSIVE INFILTRATION THROUGH BALCONY)*

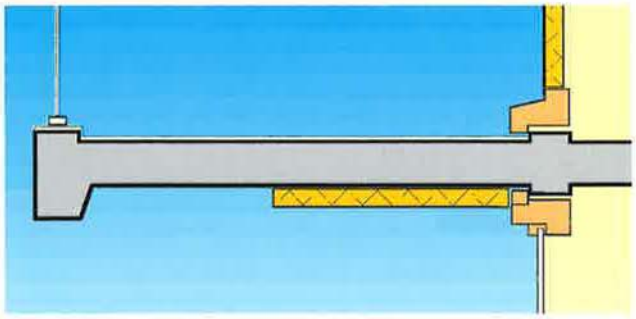
Glazing a balcony solves technical problems

Typically the balcony slab acts as a thermal bridge to the apartment floor. In addition, existing window frames need maintenance at critical corners to extend their lifetimes.



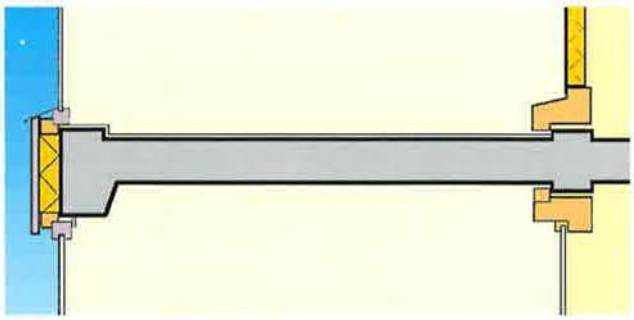
*DETAIL **(1)** – BEFORE RENOVATION*

The standard approach to renovation of balcony slabs and existing window frames is: concrete protection, thermal bridge insulation, window frame maintenance or replacement, double glazing and insulation of the parapet.



*DETAIL **(2)** – STANDARD RENOVATION*

Glazed balconies can protect existing facades and balconies. The moderated temperatures inside the glazed balcony may also solve problems related to thermal bridging. Concrete renovation measures and window maintenance can be reduced as a result of the addition of permanent weather protection.

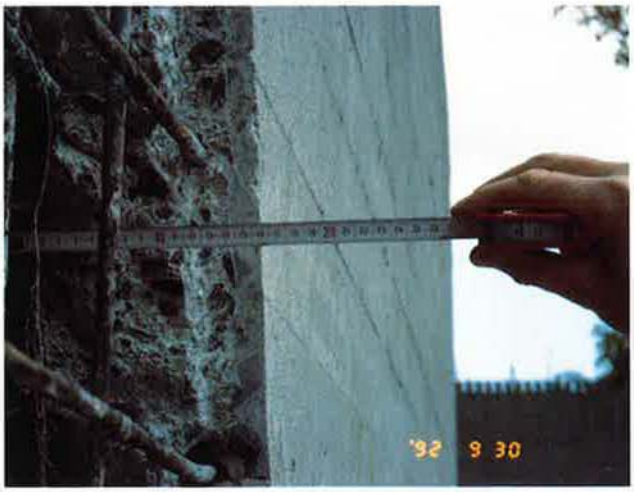


*DETAIL **(3)** – GLAZED BALCONY*

Glazed balconies are attractive for the occupants

Glazed balconies can improve the utility of the indoor environment of the apartments. The Amstenrade project (The Netherlands) has demonstrated the enhanced use of balconies by inhabitants after the glazed balcony renovation. Before the renovation, the balconies were windy and could only be used on bright summer days.

SOUTH-ELEVATION GLAZED BALCONIES AT AMSTENRADE (THE NETHERLANDS)



Example: concrete deterioration

DETERIORATED CONCRETE IN HØJE GLADSAXE, COPENHAGEN (DENMARK). ALMOST 5 CM OF EXPOSED CONCRETE HAD TO BE REPLACED TO PREVENT FURTHER DETERIORATION

Architectural Considerations

Architectural alternatives for glazed balconies

The 1964 vintage Høje Gladsaxe, Copenhagen (Denmark) project is in an area with large high- and low-rise multifamily buildings. Between 1990 and 1992 major repairs were undertaken to prevent further detoriation of the concrete facades and balconies.

Both the low-rise and high-rise buildings have been renovated in two ways. Extensive concrete renovation was carried out for the north facade and walkways, while, on the south facade, glazed balconies were installed to protect the concrete balcony slabs. This was done for the same cost as the north facade renovation.

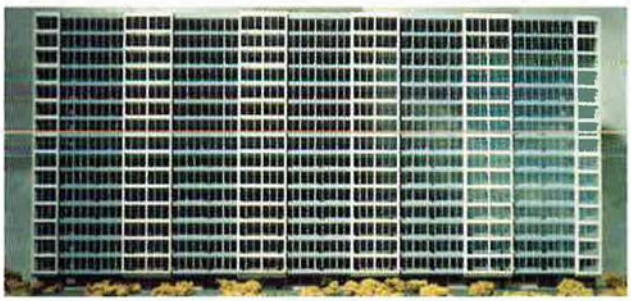
TEST MODULE OF HØJE GLADSAXE, COPENHAGEN (DENMARK)

The main architectural concern with applying glazed balconies was that it would create an unattractive flat surface. The test module demonstrates the sizes of the new glazed elements that were used.

Vertical zones of glazed balconies

One architectural design considered divides a south facade into vertical white and blue zones.

MODEL OF HIGH-RISE BUILDING WITH VERTICAL ZONES



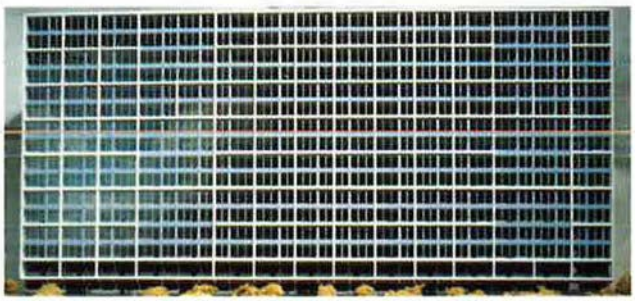
SOUTH ELEVATION OF A HIGH-RISE BUILDING WITH VERTICAL ZONES

GLAZED BALCONIES ON A LOW-RISE BUILDING WITH VERTICAL ZONES

White and blue squares of glazed balconies

The alternative that was chosen combines groups of apartments into larger groups, with a hierarchy of white and blue coloured squares.

MODEL OF HIGH-RISE BUILDING WITH SQUARES



SOUTH ELEVATION OF A HIGH-RISE BUILDING WITH SQUARES

GLAZED BALCONIES ON A LOW-RISE BUILDING WITH SQUARES

Design solutions

Frameless glass panes

In Finland, a prefabricated glazed balcony product is available on the market. The product consists of frameless single glass panes, each of which can be folded back, that is, opened pane by pane. The product can be applied to balconies of multifamily buildings or on an individual balcony basis. The architectural implications of such a product are fairly minimal.

Sliding windows in thin window frames

In Järnbrott, Sweden sliding windows have been mounted on existing balconies. The existing parapets of the balconies have been maintained. The glazed balcony facade is single glazed. The existing facade of the building has been insulated with triple glazing.

Sliding glazed balcony windows forming part of the integrated renovation

The Reitse Hoeve project in Tilburg, The Netherlands, shows the application of integrated solar renovation. Balconies have been glazed with sliding windows in four layers. The existing facades have been cladded with solar air collectors. The appearance of the building has been improved.

Heavy window frames as visible elements

In Glattbrug, Switzerland, glazed balconies with double glazing have been applied to high-rise multifamily buildings. The relatively heavy window frames contribute to the architectural impression made by the buildings after renovation.

A new architectural impression resulting from glazed facades

The Yellow House in Aalborg, Denmark, demonstrates the application of a solar facade 2 metres beyond the existing facade, which has small windows. Some of the apartments have glazed balconies, while others have an extended living area. Different solar options are integrated into the new facade.

Advanced Glazed Balconies

A glazed balcony saves energy by capturing solar heat, by reducing ventilation, infiltration and transmission losses and by preheating of ventilation air.

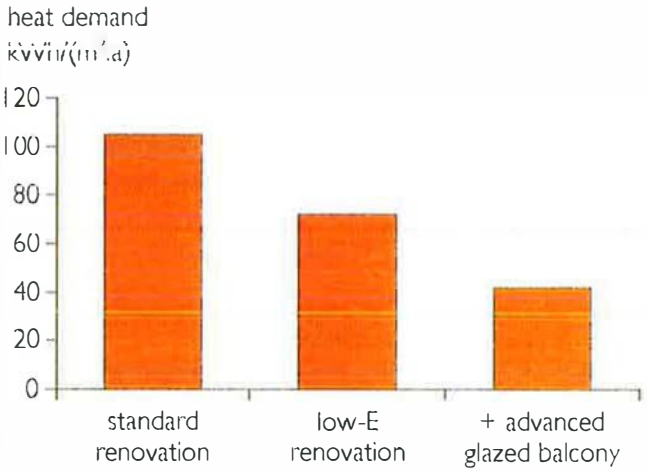
Glazing type, ventilation and degree of airtightness each have different effects on energy savings. Furthermore, the occupants have a significant influence on the savings. The influence of several of these parameters has been evaluated using calculation models.

In the creation of an advanced glazed balcony, one that will save the maximum amount of energy and, at the same time, create an optimal indoor climate, several design aspects are important. A renovated dwelling with an advanced glazed balcony will have an annual heat demand for space heating of 35–55 kWh/m² of apartment area, according to Danish, Dutch and Swiss calculations.

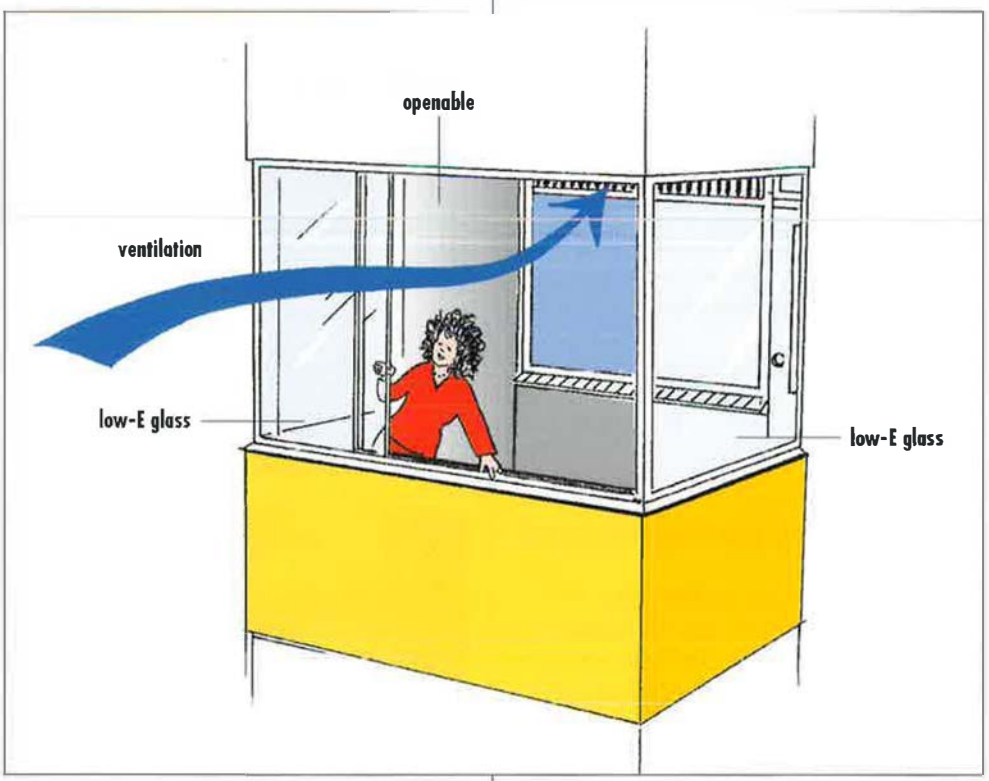
Design principles

- **Low-E glass should be used in either the inner or the balcony facade**
- **Windows should be openable in summer (1.2–1.5 m²)**
- **The ventilation air should be preheated using the exhaust ventilation system**
- **The facade elements must be made strategically more airtight**
- **Provision of adequate shading devices**

effect of advanced glazed balcony



IF ALL PARAMETERS ARE OPTIMIZED, MAJOR SAVINGS CAN BE ACHIEVED. FOR AN ANNUAL ENERGY DEMAND OF 105 KWH/M² FOR A STANDARD RENOVATION, THE ADVANCED APPROACH MAY ACHIEVE 35–55 KWH/(M².A). SOME 30–40 KWH/M² OF THE ANNUAL REDUCTION CAN BE ATTRIBUTED TO LOW-E GLAZING IN THE APARTMENT AND 30 KWH/M² TO THE GLAZED BALCONY AND PREHEATING OF VENTILATION AIR



System Design

Glazing type and position

In general, the energy savings are higher when better insulating glass (lower U-value) is used. Whether heat-reflecting glazing (low-E) is applied in the inner or the outer (balcony) facade makes hardly any difference to the energy savings.

For example, in Swiss apartment buildings glazing of the (inner) facade is typically double glazing. If the glazing used to enclose the balcony is double low-E glazing, the savings are 24%, while, with double (non-low-E) glazing or single low-E glazing, the savings are 15%. Finally, with single glazing (non-low-E), the savings are negligible.

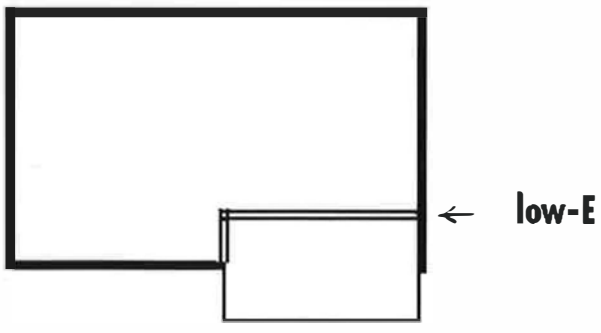
Low-E glass in inner or outer facade?

If the entire dwelling is well insulated and has low-E glass in all external windows, there are two options for choosing glazing types for the balcony. Low-E glazing can be applied in the inner (existing) facade and single glazing in the outer (balcony) facade. Alternatively, low-E glazing can be applied in the outer (balcony) facade and single glazing in the inner facade. In many cases, the latter means that the inner facade can be left untreated. In the case of Dutch multifamily buildings with half-integral balconies, the savings are comparable: 20% with low-E outer glazing and 18% with low-E inner glazing.

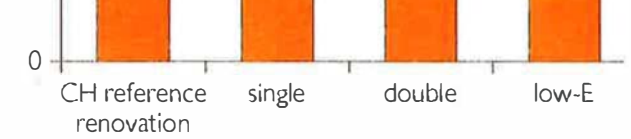
Furthermore, Danish calculations show that there is only a small difference, 2 kWh/m² per annum, between applying low-E glazing in the inner facade and in the outer (balcony) facade. Low-E glazing saves 2 or 3 kWh/m² per annum more than double glazing.

For fully integral balconies, the energy benefits of low-E balcony glazing are greater. For outside balconies it may be advantageous to apply low-E inner glazing.

With low-E glazing applied in the inner (existing) facade or the outer (balcony) facade, the savings are comparable

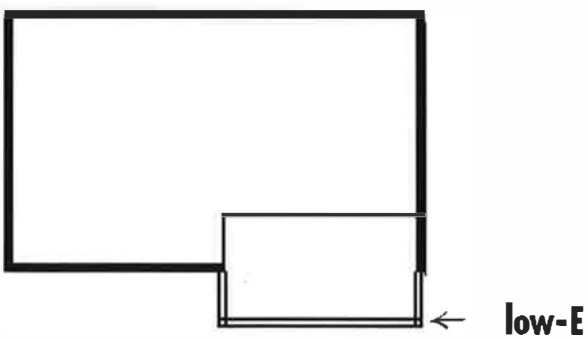


LOW-E IN INNER FACADE



THE EFFECT ON THE HEAT DEMAND OF THE GLAZING TYPE USED IN THE GLAZED BALCONY (SWITZERLAND)

THE EFFECT ON THE HEAT DEMAND OF DOUBLE GLAZING AND LOW-E GLAZING IN THE INNER (EXISTING) FACADE OR THE OUTER (BALCONY) FACADE OF A HALF-INTEGRAL BALCONY (THE NETHERLANDS)



LOW-E IN BALCONY FACADE

Airtightness

To save the most energy one should make optimal use of the preheated ventilation air. If more fresh air is taken from the glazed balcony and less directly from the outside, the advantages of preheating in the balcony are greater.

Strategic improvement of the airtightenness of facade elements

A strategic distribution of incoming fresh air can be influenced by improving the airtightness of the building envelope, excluding the facades of the balconies, to a leakage area of 50–75 cm². The inner facade (balcony-apartment) should have a leakage area of around 25–50 cm². This is frequently the existing leakage area due to cracks, so no changes to the inner facade adjacent to the balcony have to be made. However, it may be advantegeous to incorporate properly sized and positioned openings in the balcony so as to control ventilation airflow rates.

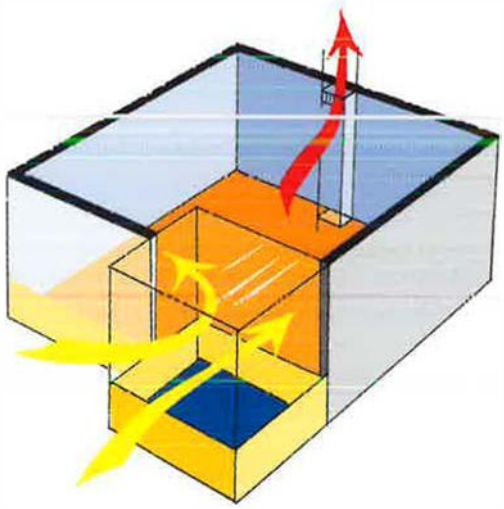
In the case of an integral or a half-integral balcony, for an optimal distribution of the preheated ventilation air it may be necessary to make a vent of 25 cm² in the wall between the balcony and a neighbouring room. To avoid draughts, the position of the vent has to be chosen so that incoming air can be heated by existing radiators or by some other means in the dwelling.

Indoor climate

To create a high quality indoor environment, good ventilation is required. Enough ventilation air has to enter the dwelling, while carbon dioxide, water vapour, unpleasant odours and dust have to be extracted.

With a well designed glazed balcony, most of the incoming air enters the dwelling through the balcony, not directly from the outside and thus the inner facade and balcony facade should contain vents of sufficient size. More precisely, if the vents and leakage area in the glazed balcony facade have an area of 150–250 cm², the quality of the air that enters the dwelling is comparable to the quality of the outside air.

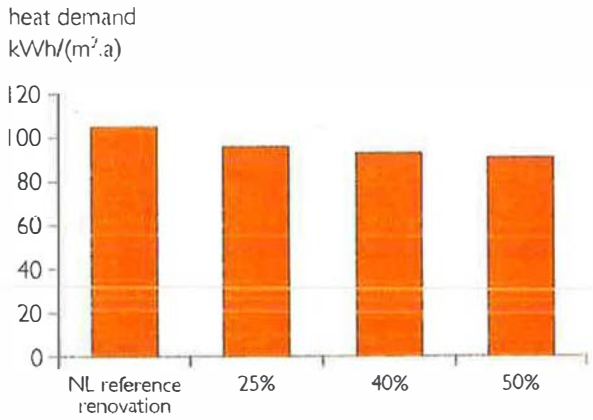
Energy can be saved by an optimal use of the preheated air, while the entire building should have a high airtightness. The ventilation air supply is sufficient if the vents in the balcony facade have an area of 150–250 cm²



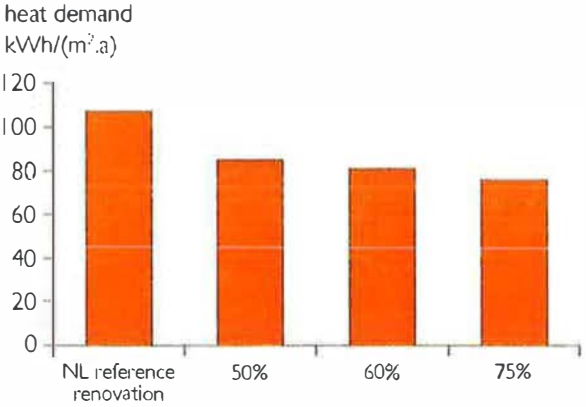
VENT BETWEEN BALCONY AND ADJACENT ROOM

The effect of three different ventilation patterns on the heat demand is calculated for a Dutch multifamily building for two balcony types. In all cases, the ventilation is 240 m³/h. The percentages indicate the share of ventilation air entering through the glazed balcony. For example, if 75% instead of 50% of all air enters through the glazed balcony, the annual energy saving is 9 kWh/m²

ventilation (half integrated balcony)



ventilation (full width balcony)



Thermal comfort

A glazed balcony has several positive effects on the comfort level of a dwelling. In autumn, winter and spring, when it is cold outside, the balcony is sunny and light, a comfortable place to be. In the heating season the average temperature in the balcony will be between 5 and 10°C higher than outside, because of the solar energy and recovered transmission losses.

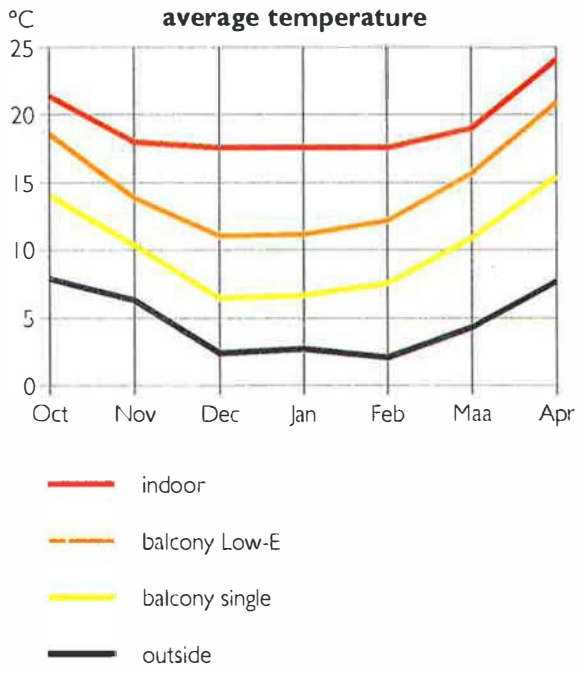
Openable windows in summer

In summer it is necessary to avoid overheating. Therefore, the balcony facade has to be openable. The occupants should be able to create a space with the same climate as the old open balcony. An openable area can be achieved with a sliding door or with large windows. In The Netherlands an open area of 1.5 m² has proved to be sufficient, while in Denmark 1.2 m² has been found to be an appropriate size. Ventilation efficiency is highest when there are openable areas near the floor and near the ceiling.

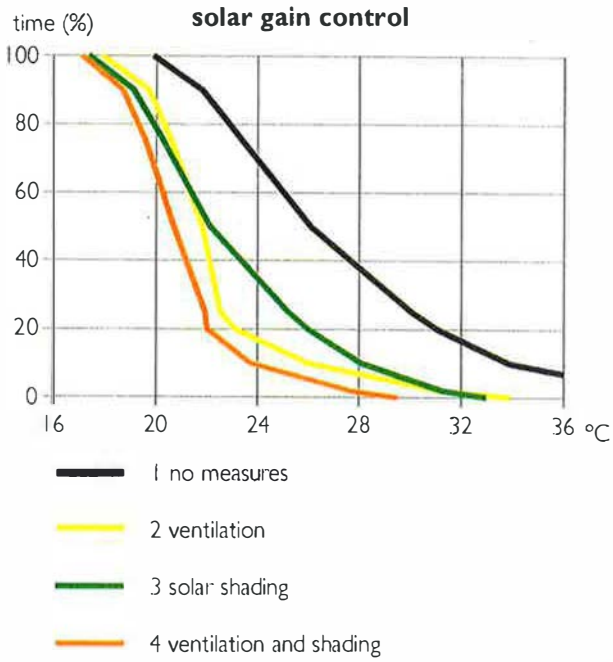
Shading opportunities

Occupants should also have shading devices available if they wish to avoid the direct sunlight. This is not a problem that is unique to glazed balconies; people may also want shading in open balconies. Simple sunshading devices are venetian blinds and roller blinds.

In a glazed balcony on average it will be 5–10°C warmer than outside. In summer, there should be no overheating if proper shading and ventilation measures are used



CALCULATED TEMPERATURES IN THE BALCONY IN THE HEATING SEASON (THE NETHERLANDS): AVERAGE EXTERNAL TEMPERATURE 4.8°C; SINGLE GLASS IN EXTERNAL FACADE 10.2°C; LOW-E GLASS IN EXTERNAL FACADE 14.8°C



TEMPERATURE DISTRIBUTION CURVE FOR A GLAZED BALCONY. THE DIAGRAM SHOWS THE PERCENTAGE OF TIME DURING WHICH THE TEMPERATURES IN THE BALCONY IN SUMMER (JULY, THE NETHERLANDS) ARE BELOW A CERTAIN VALUE, TOGETHER WITH THE EFFECT OF SOLAR GAIN CONTROL MEASURES

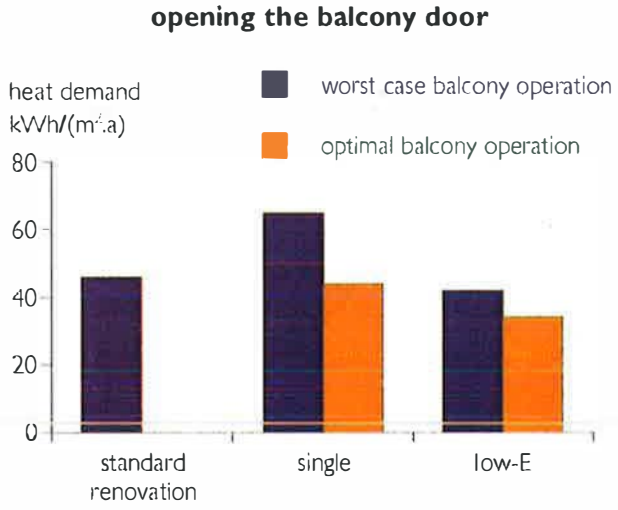
Occupant and User Information

One can design an energy-efficient glazed balcony, but the real energy savings, of course, do not depend only on the technical solution. They also depend significantly on occupant behaviour. If occupants leave the door from the dwelling to the balcony open for extended periods during the heating season or if they use the balcony as an extra room and heat it, the energy demand may actually rise.

Use of the balcony and glazing type

If low-E glazing is applied in the balcony facade, user behaviour will have a smaller effect. In this case, the balcony may have the character of an inside space, which the occupants are likely to use as an extra living room. If occupants heat such a balcony, some energy savings will still be achieved through insulation, but not through preheating of ventilation air.

If low-E glazing is applied in the inner facade and single glazing in the balcony facade, the balcony behaves more like an outside (intermediate) space. It is not likely to be used as a living room, since it will feel colder. In this case, occupants should not leave the balcony door open or heat the balcony.



THE EFFECT ON HEAT DEMAND OF OPENING THE BALCONY DOOR. FOR SINGLE-GLAZED BALCONIES AT A SWISS APARTMENT BUILDING, THE USE OF ENERGY MAY EVEN RISE IN THE HYPOTHETICAL CASE THAT OCCUPANTS ALWAYS LEAVE THE BALCONY DOOR OPEN

Occupant information

It is important that the occupants understand the effect on energy savings of how they use the balcony. The building owner should explain the principles of the glazed balcony. Written instructions should be provided on how to use the balcony in an energy efficient way and how to use the ventilation provisions. Occupants should:

- Understand why their behaviour is important.
- Know how to control the energy use and the ventilation rate. Be able to carry out the most important operations.
- Know where to find extra information.

The occupants have to be informed that:

- The glazed balcony can save energy, because solar energy is used to preheat the ventilation air and the glazing helps reduce heat losses.
- The balcony can be used as an extra room in spring, summer and autumn. In winter the balcony should not be used as an extra room.
- The balcony should not be actively heated or the balcony door opened too often.
- Solar gains can be controlled in the summer by use of the ventilation devices and solar shading.
- The ventilation devices can be used to provide sufficient ventilation, to prevent draughts and to save energy.
- The vents in the inner facade should always be left open and the mechanical exhaust ventilation should never be switched off.
- The glazed balcony will only provide good-quality ventilation air if the balcony is used in a 'normal' way. For example, garbage should not be stored on the balcony.

Creation and distribution of instructions should be part of the renovation process. Written instructions should contain easy to understand language, clear illustrations and not be too technical. They must be tailored for the specific building. Written instructions should always be combined with individual verbal explanations and demonstrations.

Utilization

Available products on the market

There are several available products that will match the requirements of existing balconies reasonably well. For single glazing, standard window frames or metal frames such as those designed for greenhouses in horticulture may be used. When double glazing or low-E glazing is used in the outer facade, heavier frames may be needed. In addition, standard sliding and hinged windows and doors are available. Most standard products are of good quality. The installation quality depends on the skill of the workers. Weak points are where the frames are sealed to the existing walls.

In most countries new, complete integral products are also being developed.

Costs and investments

The price of a glazed balcony depends on the building type, the size of the area that has to be glazed and specific features, i.e. type of glass, frame etc. A glazed balcony also saves operational and maintenance costs, because some maintenance tasks have been made unnecessary. The cost of a standard renovation can therefore be higher or lower than a solar renovation with a glazed balcony.

In general, a glazed balcony is not cost-effective if it is considered only as a means to save energy and reduce maintenance. Normally, there are other motives too: improvement of image, ease of renting, occupant comfort etc. It is very difficult to estimate the monetary value of these positive aspects of glazed balconies.

It may be possible to recover additional capital costs by increasing the rent. Some building owners increase the rent significantly, because the desirability of the building and of the dwellings has increased. Evaluations demonstrate that tenants are willing to pay more because of the improved comfort and increased utility of the space.

Design team

There are many important aspects in designing a glazed balcony. Architecture, construction details, and heating and ventilation techniques have to be integrated. The design team should therefore consist of people with different specialties. The architect develops the construction and design details; the heating and ventilation consultant develops the installation specifications; and an energy consultant or a consultant in building physics gives suggestions for energy aspects. Of course, the building owner has to decide on the final design. It may also be useful to add other contracting parties to the design team, for example a manufacturer or an installer of one of the products. Sometimes it may be useful to involve the local authorities and the fire department early in the process, so as to prevent unexpected and possibly expensive changes that are necessary to meet the regulations. Finally, the occupants should be asked about their desire for glazed balconies. Their acceptance is essential for a successful result.

Conclusions

Glazed balconies can successfully be applied in different countries and in different situations. They save energy, improve indoor climate, reduce maintenance costs and enhance a building's image and its amenity value. With modest design improvements, it is possible to create an advanced glazed balcony that both saves a large amount of energy and provides an optimal indoor climate.

Successful implementation requires that architectural, construction and heating and ventilation aspects are integrated. Finally, it is important that the occupants are involved. They are critical to realizing the energy benefits of glazed balconies.

Literature and Addresses

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IEA SHC Programme Task 20 publications

IEA SHC Programme Task 20 Brochures

- Solar Energy in Building Renovation
- Solar Collectors in Building Renovation
- Glazed Balconies in Building Renovation
- Transparent Insulation in Building Renovation

Developed under the Subtask on Dissemination, led by Chiel Boonstra, W/E Consultants Sustainable Building, The Netherlands.

Published by and available from:
James & James (Science Publishers) Ltd, 35-37 William Road, London NW1 3ER, UK, 1997
Email: james@jxj.com

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Subtask A: Evaluation of Existing Building Applications. 'Solar Energy in Building Renovation', Jan-Olof Dalenbäck, Building Services Engineering, Chalmers University of Technology, Göteborg, Sweden. Summary article published in Energy and Buildings 24 (1996) 39-50.

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Subtask C: Solar Renovation Demonstration Projects. Solar Renovation Demonstration Projects. Design of Solar Renovation Projects, edited by Olaf Bruun Jørgensen, Esbensen Consulting Engineers, Copenhagen, Denmark, 1997

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