AVASH Education Pack

Advanced Ventilation Approaches for Social Housing

Intelligent Energy Europe

Funded by the Intelligent Energy - Europe Programme

INTRODUCING AVASH

AVASH is a collaborative project funded by the Intelligent Energy Europe (IEE) Agency. The project partners are from the UK (University of Brighton), Denmark (Cenergia Energy Consultants, KAB Housing) and Ireland (Delap & Waller EcoCo Ltd, Cluid Housing Association). Its aim are to survey and sample social housing within the three participating countries - to assess their current performance in terms of insulation and air-tightness. Then to computer model the properties to ascertain the best ventilation and insulation upgrade strategy.

Surveying the properties entailed thermo-graphic analysis to determine the extent of their thermal insulation, and a blower door test to check the air-tightness of the building fabric.

The full report of the Sampling & Survey work can be found at the AVASH project website: http://www.brighton.ac.uk/arts/avash, along with other details about the project.

AVASH OBJECTIVES:

- To determine the best ventilation strategy for existing social housing in the UK, Ireland and Denmark, from the point of view of energy efficiency and occupant comfort.

- To propose any additional low cost measures for immediate improvement of the building's thermal performance.

AVASH METHODOLOGY:

- The project involves the assessment of a broad range of social housing stock in each of the three countries.

- Advanced sensor equipment was used to discover the state of the thermal insulation by thermal imaging.

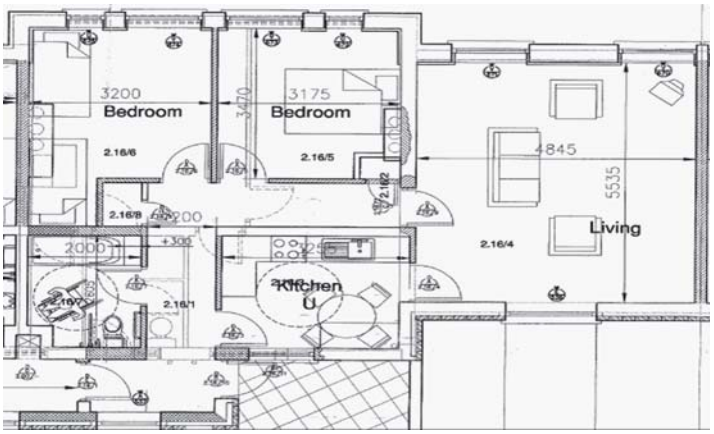

Fig. 1. A total of 30 dwellings were surveyed in Ireland including this type.

- The results are being extensively disseminated throughout the participating countries and also within Poland, which is the flagship country for new building practice within Eastern Europe.

- The data will be provided, in particular, to social housing providers who are considering upgrading their housing stock. The project will contribute to reducing fuel poverty, whilst enhancing living conditions and comfort, and reducing the cost of heating and limit carbon emissions.

- The data will be shared with other EU projects within the Intelligent Energy Europe programme.

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WHO'S DOING WHAT AND WHERE

The first phase of our work has been to isolate a representative range of dwellings from within the catchment areas of the project's participating housing providers (KAB-Denmark, Cluid-Ireland and London Borough of Camden-UK).

A consistent methodology has been used to promote detailed suggestions for appropriate ventilation solutions, to be adopted at refurbishment, in conjunction with improved insulation and other remedial measures.

SAMPLING & SURVEY PROGRAMME

A map was first produced showing the distribution of the housing stock within The London Borough of Camden's ownership, and the range of dwelling types.

They were classified typologically (detached, semi-detached, terraced etc) and by construction (materials and forms of roof, walls, windows, doors and ground floor).

Building Fabric Survey

The fabric survey was to establish the dwellings' insulation characteristics (U-values) by measurement using thermography, and by calculation from an investigation of their form of construction and specification.

Fig. 1. Comparison of a photo and thermographic image of the external surfaces of a sample flat in Ireland from which the internal temperatures and approximate insulation values of the walls and windows could be derived.

Building Infiltration Survey

The infiltration survey has established the dwellings' infiltration characteristics (in air changes per hour) by pressurisation tests, and by calculation from an outline dimensional survey of the dwellings.

Having established the format and methodology for the project similar surveys were carried out in Ireland and Denmark.

The next phase is to input the data to a computer simulation model that will establish:

i. An assessment of the feasibility of possible methods of insulation.
ii. An assessment of the probability of achieving and adequate level of air tightness.
iii. An assessment of the feasibility of remedially installing alternative advanced ventilation systems in terms of ease of installation, for example the location of clear vertical routes for ducts through the height of the building.
iv. The change in energy performance of each type after remedial insulation, sealing and installation of the different ventilation alternatives.
v. The resulting reduction in the Carbon Dioxide emissions for which each building is responsible.

Estimates will also be made of the likely costs of these measures in each country, and the projected payback periods relative to energy prices in all three countries.

The project will help to clarify the issues surrounding the choice of ventilation strategy to be made for compliance with building codes so housing authorities will know that remedial measures will give the buildings a useful life, at least for the medium term.

The arguments for and against mechanical or passive systems, under particular circumstances of building construction or climate, will be clarified by this project. Our intention is to provide the information that will ease the decision making process for housing providers.

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CONTEXT OF THE PROJECT

Across Europe, achieving adequate wintertime ventilation in houses and flats has become a problem.

For new construction thermal insulation requirements have been made more stringent so now the loss of heat due to ventilation is a large proportion of overall energy consumption. As a consequence, buildings are being constructed to be more air-tight resulting in concerns about indoor air quality.

There is also the growing need to address the vast housing energy cost which is due to the existing stock. Given the feasible rates of renewal, the majority of existing builidngs are set to be with us for many years.

Upgrading the energy performance of existing housing means improving their levels of thermal insulation and improving their air-tightness whilst safeguarding indoor air quality and comfort for the occupants.

These initiatives will help the large number of residents, particularly the elderly, who are subject to 'fuel poverty' a problem set to increase as energy costs keep rising.

These issues are highlighted in Ireland where:

- Average household energy expenditure was 1,500 euros (in 2004)
- which was 4% of disposable income ifor an average income household
- but 10% of income for those in lowest income bracket

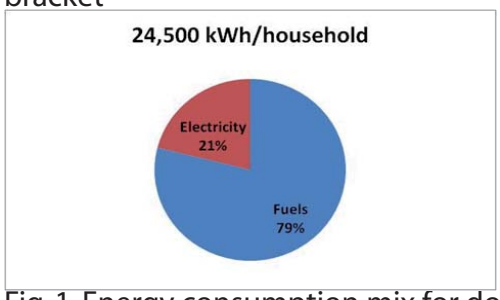

Fig. 1. Energy consumption mix for domestic buildings in Ireland.

ADVANCED VENTILATION STRATEGIES

Energy efficiency entails improving the housing stock by upgrading boilers, increasing insulation levels, reducing air infiltration, and the introduction of advanced ventilation systems incorporating heat recovery.

The most familiar method of domestic ventilation since the 1970s has been to install 'trickle' or slot ventilators over windows. Air is drawn in and out through these openings according to the direction of the wind. In the UK the size of trickle vents was doubled by a change to the building regulations in 1975 as a result of concerns about indoor air quality.

Indoor air quality (AIQ) has been cited by the US FHA as one of their top five health concerns. In the northern maritime regions of Europe IAQ is principally a matter of controlling humidity which otherwise results in condensation and mould - a cause of allergenic illness. Adequate thermal insulation is needed to raise surface temperatures, in conjunction with adequate heating, and adequate ventilation.

In addition there is the need to limit the buildup of volatile organic compounds (VOCs) that offgas from many contemporary building materials.

Advanced ventilation systems limit the amount of energy being thrown away when stale air is discharged from the building in winter. The amount of ventilation has to be geared to the occupancy of the building - not too much and not too little. In addition the spent moist air must have its heat removed, and reused, to limit heating requirements.

As a result trickle vents will soon to become an inadequate response to the problem. Their supply of air is too uncontrolled and lacks heat reclaim.

The necessary pre-requisite for all advanced ventilation strategies is that air leakage from cracks in the building fabric is limited so the ventilation system can be engineered to precise performance.

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ENERGY EFFICIENCY - OPTIONS FOR UPGRADING INSULATION

1/ EXTERNAL THERMAL INSULATION

This is the most frequent technique used in central Europe and probably the most effective. The insulation material is glued and/or mechanically fixed to the external side of the outer wall.

The most common materials are boards of EPS or hardened mineral or glass fibreboards. Protective render has to be installed to the outside, keyed to reinforcing mesh, there are requirements for it's breathability.

Material selection depends on the wall's structure and material, and is subject to a specialist's assessment of coupled heat and moisture transfer, fire resistance plays an important role as well.

Very low U-values can be achieved, depending on thickness of the applied insulation. Thermal bridging at wall junctions and around openings is readily overcome.

In some cases soft glass or mineral fibreboards are installed between battens/rails and a rainscreen is mounted in front, providing a ventilated cavity for dispersing moisture. The U-value given is affected by battens, though moisture transition can be much higher.

Pros:

- good U-values are easy to achieve without loss of floor area.
- warm wall construction couples the thermal mass of the wall with the room for heat storage.
- deals effectively with thermal bridging.
- installation has little impact on the occupants.
- the thermal mass of the interior is not reduced, thermal bridging is effectively eliminated – along with risk of condensation and mould growth,. Airtightness is usually increased. The internal living space and its finishes are not affected.

Cons:

- proprietary applications are limited (renders)
- weathering at junctions with openings is critical for durability
- thermal break detailing is required at external fixings
- changing the façade changes the the overall 'look'. On tall buildings (or on block of apartments) external insulation cannot be installed individually, all owners woud have to agree.

Suitability:

- almost for all dwellings, especially for those with solid wall construction.
- manufacturers/certified systems: RockWool 'Rainscreen Duo-slab', RockWool 'Rockshield' (triple function – weather protection, insulation, outer appearance).

Fig. 1. Process of installation.

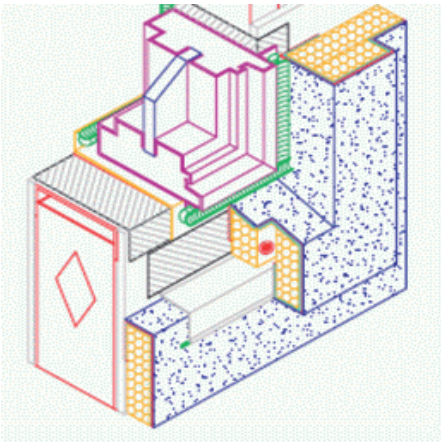

Fig. 2. Detailing around window openings.

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ENERGY EFFICIENCY - OPTIONS FOR UPGRADING INSULATION

2/ FULL FILL CAVITY INSULATION

This method is suitable only for walls with cavities (especially for traditional Irish/UK cavity wall). The insulation material is injected into the cavity under pressure and will fill the entire void. Different materials can be used – EPS substrate, cellulose fibres based on recycled paper, etc. The mix may contain glue so the material will solidify into rigid insulation in the cavity, which helps resistance to moisture.

Pros:

- water repellent, durable.
- no capillary action.
- installation from the outside or inside.
- stops 'thermal looping' in cavity (loss of heat due to convection currents).
- no need to alter or refurbish the internal or external façade, thermal bridging at partition wall junctions is solved.
- a fully-filled cavity also helps to greatly improve the airtightness of a dwelling.
- relatively clean installation, without the need to work inside.

Cons:

- limited U-value improvement - the U-value. achieved is limited by thickness of the cavity, typically for a 100mm cavity Umin=0.35W/m2K. Thermal bridging around openings is not resolved.
- Significant no. of holes in façade. The holes for injection are visible and need to be patched. Installation requires special equipment and skills.

Suitability:

- for all cavity walls, also those with previously installed partial-fill insulation.
- materials: polystyrene, mineral wool.
- manufacturers/certified systems: 'RockWool Energy Saver' (blow-in granular insulation).

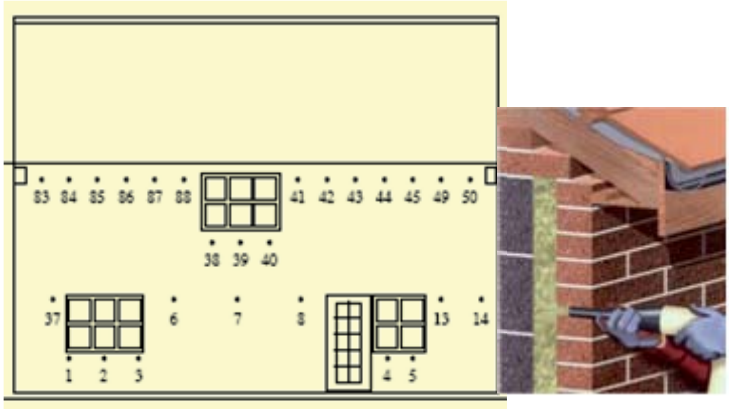

Fig. 1. Many holes are required in the facade for injection of the insulation.

Fig. 2. The whole cavity is filled without voids which overcomes problems of water tracking to the inside.

Fig. 3. Insulation is injected under pressure.

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ENERGY EFFICIENCY - OPTIONS FOR UPGRADING INSULATION

3/ INTERNAL INSULATION LINING

This method uses a variety of alternative materials, depending on the builders selection and preference. Usually insulation is installed between battens screwed to the internal side of the wall, internal plasterboard is then fixed to the battens. Crossbattens might be used, to reduce thermal bridging.
Other systems use rigid insulation bonded to plasterboard, the boards are fixed directly to wall with dabs, joints are treated as per normal plasterboard.

Pros:

- not a proprietary system.
- no alteration of the external façade.
- no extra weathering required.
- simple installation in most of the cases. It can be applied to apartments individually, depending on the occupants.

Cons:

- leaves cold bridges at junctions.
- alteration of wall fixtures and finishings is required.
- it reduces the effective thermal mass because of its cold wall construction.
- U-value is limited due to the relatively small thickness of insulation.
- the system reduces the area of living space, which could be significant in small dwellings.
- thermal bridging remains a problem, the risk of condensation and mould growth is very little reduced.
- the final U-value depends on the insulation material and its thickness.

Suitability:

- for individual apartments, where other systems could not be used.
- manufacturers/certified systems: RockWool ROCKLINER (acoustic and thermal composite dry lining system).

Fig. 1. Cross section of construction.

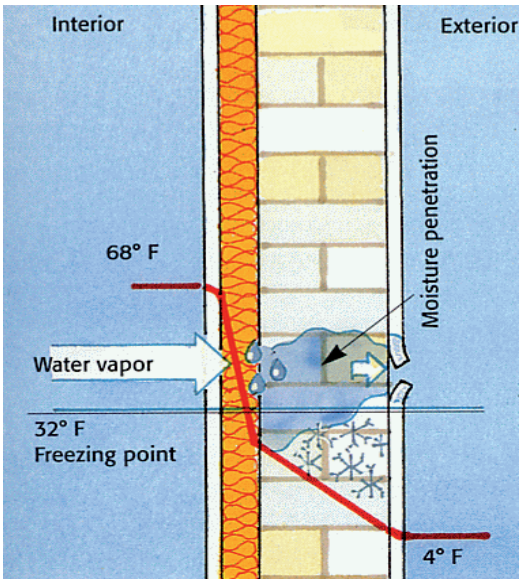

Fig. 2. Thermal gradient illustrating potential condensaton risk.

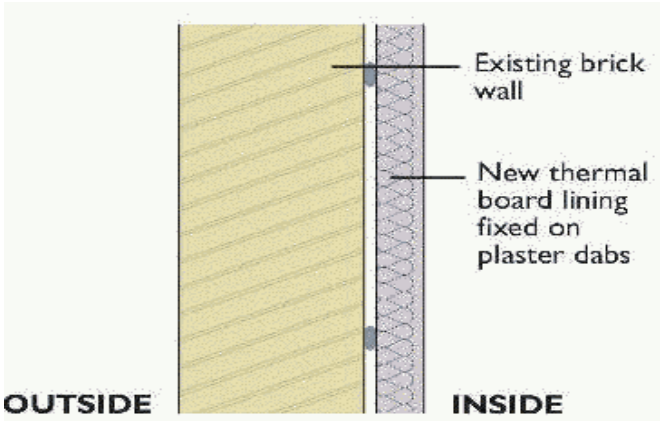

Fig. 3. Standard detail.

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AIRTIGHTNESS

For the most efficient utilisation, and in the case of advanced ventilation systems, for payback times to be of reasonable length, it is imperative that the building fabric is adequately sealed.

A programme of refurbishment entailing the insulation of dwellings whilst achieving required levels of ventilation, will require attention to the extent of ventilation heat loss, the need for an airtight building envelope, and concern for the potential problems of air quality.

This is particularly an issue in older buildings that may be subject to excessive air infiltration, not least because they may have been constructed with open fireplaces and chimneys.

Whilst air leakage can ensure good indoor air quality, its energy disbenefits, and the implications that draughts have for thermal comfort, require that a programme of improvement seeks to remedially seal the building envelope and introduce an advanced/engineered system of ventilation.

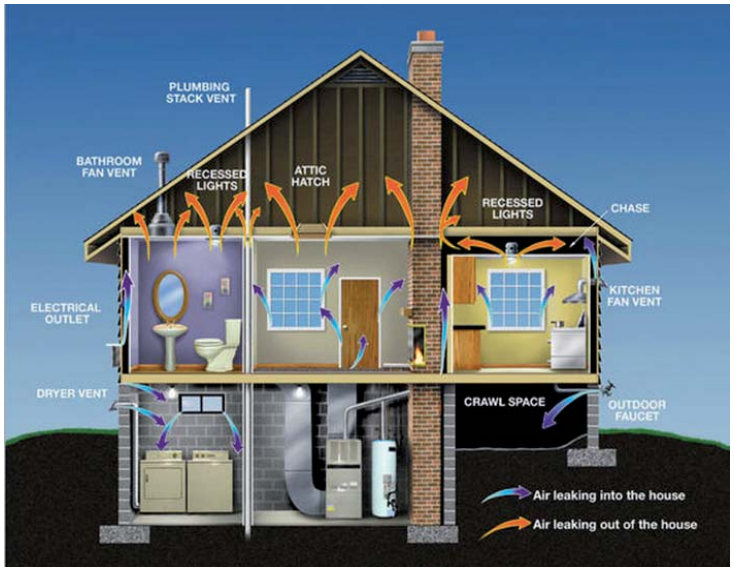

Fig. 1. Typical modes of air leakage

Fig. 2. Continuous membrane + timber frame construction.

Airtightness can reduce energy use by up to 30% and is the most cost-effective efficiency measure.

Wet air convection through gaps leads to 100 x more condensation than vapour diffusion through wall construction.

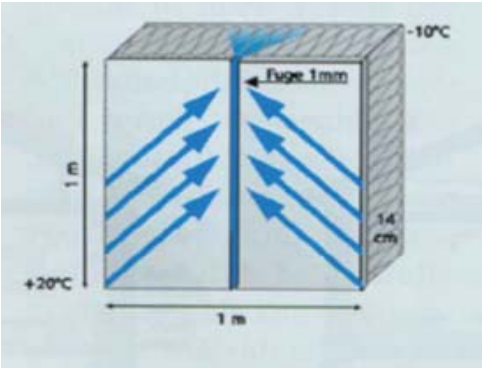

Fig. 3. A 1 m long gap 1 mm wide on 1 m2 of wall area increases the U-value of the wall area by a factor of 5.

Fig. 4. Remedial insulation and air sealing of a timber suspended ground floor.

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VENTILATION

Health and fresh air have long been associated with one another.

Problems of indoor air quality in houses were not significant in times past, formaldehyde and other volatile organic compounds are a recent introduction. Air-tight construction is a new requirement (or at least in Ireland and the UK, it has long been the norm in Denmark). Achieving healthy internal environments that are also energy efficient requires carefully engineered systems for wintertime ventilation.

Various technical solutions have been proposed in order to achieve energy efficient ventilation within better-insulated dwellings. They generally rely upon adequate sealing of the construction for their financial viability and most require the use of fans using electricity.

OPEN FIREPLACES AND CHIMNEYS

A particular problem for older construction is that open fireplaces and chimneys make it impossible for air-tightness to be achieved. There is a preference for retaining fireplaces in older houses particularly in Ireland where they are still installed as standard.

A sealed-combustion directly venting stove/fireplace is by far the more energy efficient option. They have an efficiency of combustion as high as 95%.

There is a wide range of products for replacement of open fireplaces : - fireplace inserts, stoves, russian stoves. They can be divided into categories, depending on the fuel - combi fuel (wood, coal, peat), wood burning, natural gas.

There are further options according to the way air introduced for combustion. Whether internal air (the most frequent option), or air can be brought from outside through a separate duct in the floor or in a duct around a flue (balanced flue fires).

Advantages:

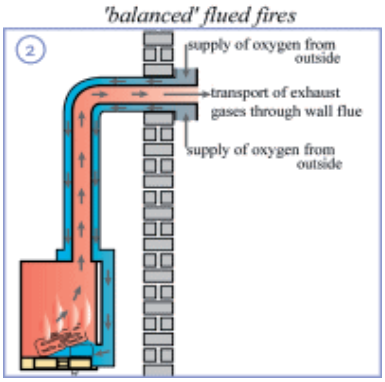
- increased efficiency from 30% to 95%, avoids cold draughts caused by flue's stack effect.
- reducing unnecessary thermal loss due to air infiltration.
- the replacement can be installed instead of an open fireplace and can use the existing flue – no additional space needed.

Disadvantages:

- if the open fireplace was necessary for ventilation, another strategy has to be proved to satisfy building regulations.

Suitability:

- for all dwellings with open fireplaces.
- manufacturers/certified systems: The Stove People, Murphy Heating, Fenton Fires, Scandinavian Homes, Heatmaster, Murphy Heating, Ideal Standards Ireland, Midwest FSG, Hearth & Home, TheGasCompany.



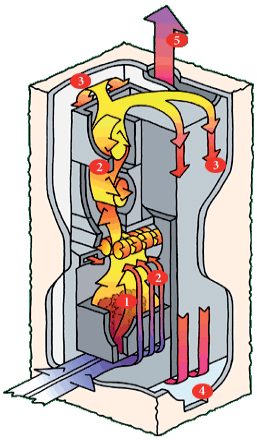


Fig. 1. Manufacturers details.

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ALTERNATIVE VENTILATION SYSTEMS: 1. MECHANICAL

Advanced ventilation strategies are:

- the key to healthier environment
- engineered solutions to suit the housing stock
- achieve lower energy use and CO2 emissions

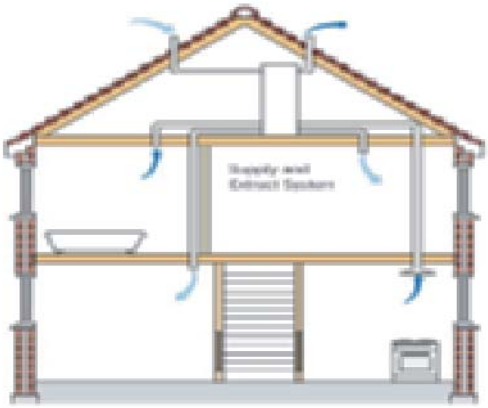

Fig. 1. Mechanical Ventilation Heat Recovery (MVHR)

MVHR is widely used in Scandinavia, the heat recovery unit in the attic uses the waste heat within air extracted from kitchens and bathrooms to pre-heat the incoming air supply to living and bedrooms.

A variety of types are available, MVHR incorporates high efficiency plate heat exchangers.

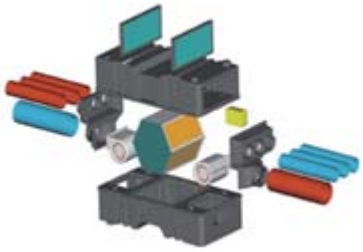

Fig. 2. Fan driven heat exchanger

But can be combined with renewable sources such as solar air collectors.

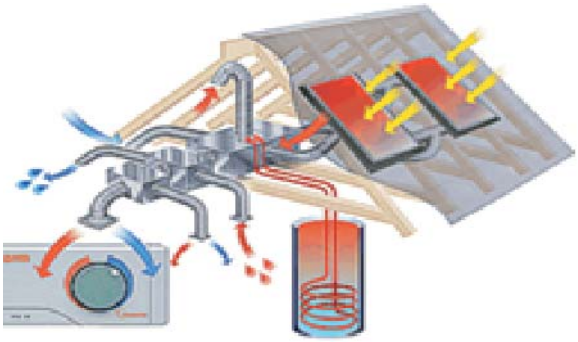

Fig. 3. MVHR combined with solar air panels.

Other simpler mechanical systems, with lower capital cost, include CME - continuous mechanical extract systems which are less energy efficient since they use continuously running low-wattage fans. Room extract fans ('vent-axia') which can incorporate heat recovery. Also, other controlled entry systems which can entail air coming in behind radiators so the supply is pre-heated.

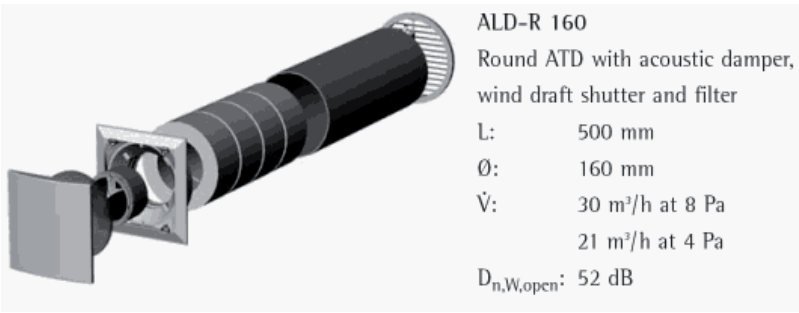

Fig. 4. Manufacturers' supply vent details.

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ALTERNATIVE VENTILATION SYSTEMS: 2. PASSIVE

The most familiar of passive solutions is trickle vents installed at the head of windows in conjunction with passive stacks (or the mechanical alternative - intermittent extract fans) in kitchens and bathrooms.

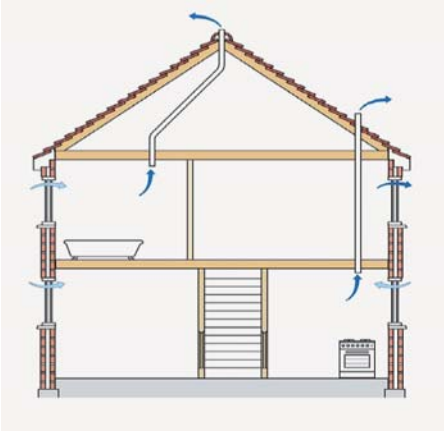

Fig. 1. Passive stacks work because warm air rises they are ducts rising from kitchens and bathrooms to extract moist air that would otherwise cause condensation.

Air extract can also be assisted by the wind passing over the roof if a specially designed cowl is used.

Fig 2. Danish 'wind catcher' cowls

Other designs are designed to turn with the wind and to provide both a point of extract and to funnel air for supply to rooms. A heat exchanger enables energy to be taken from the extract and used to pre-heat the supply air.

Fig. 3. Rotating cowl used at the UK Bedzed housing.

In existing buildings vertical routes have to be found for the passive stacks because bends and sloping sections of duct should be avoided otherwise airflow is restricted. Manufacturers include additional components such as fire dampers if the stacks are to pass through fire separations. Some catalogues also include in-line fans for sub-optimal locations such as internal bathrooms.

DWELL-VENT SYSTEM

A passive alternative is the Dwell-Vent system that combines 'supply air' windows with passive stacks.

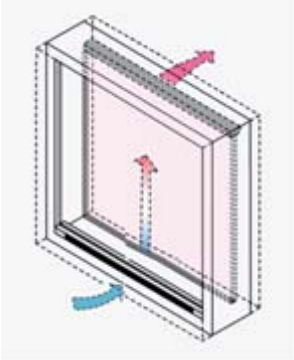

Fig. 3. The 'supply air' window and shown open for cleaning. The windows act as a heat exchanger; rather than using double glazing here the gap between the panes forms the route for air entering the building. By controlling the air flow nearly all the heat escaping can be returned to the room as pre-heated ventilation. The Dwell-Vent system is competitively priced, achieving a good level of heat reclaim without using electricity.

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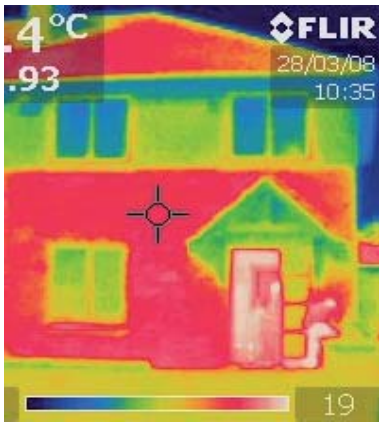
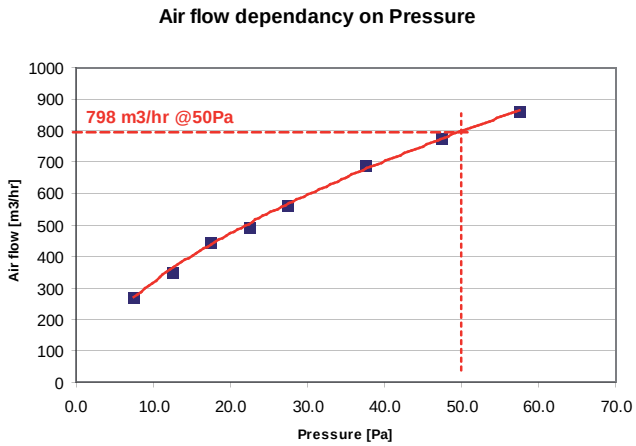
AVASH MONITORING STRATEGY

- Advanced sensor equipment was used to discover the state of the thermal insulation.

Fig. 1. Thermal imaging using a thermographic camera.

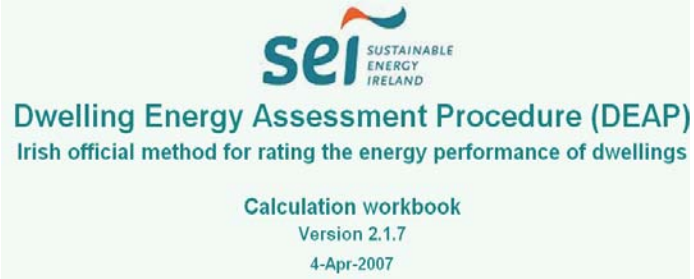


- Blower door pressure testing was used to discover the degree of airtightness.

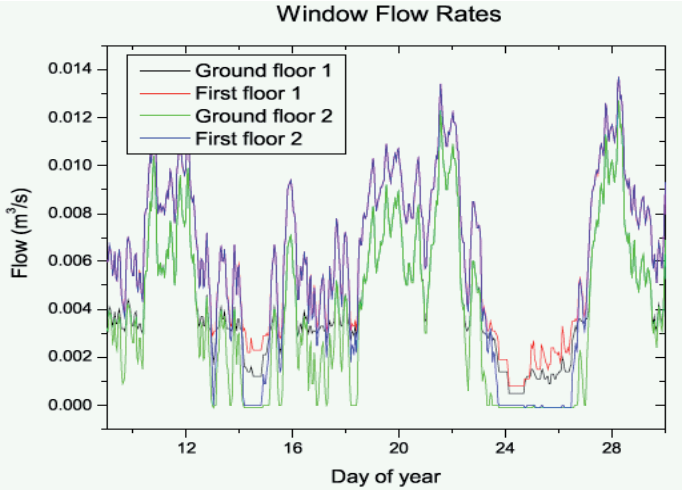


- Once the site surveys were completed, calculations and sophisticated computer simulation techniques were used to determine the best ventilation strategy for the dwellings.

1. Calculation procedures appropriate to each country, for example 'DEAP' is the method of assessing the energy performance of construction used in Ireland - similar to 'SAP' in the UK.



2. Simulation using computer modelling techniques.



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UK CASE STUDIES

18 properties of different types and ages were surveyed. The following case studies describe a range from that sample.

PROPERTY NO. 1.
Property no.1 is a duplex taking up the bottom two-storeys of a three storey block.

- The block is of in situ uninsulated concrete construction 200mm thick with uninsulated ground floor.
- Windows are original with a single-glazed, black timber frame construction and are situated in the kitchen, lounge (with single patio door) and both upstairs bedrooms.
- Dimensions are 2x1.2m for each bedroom and kitchen window and 2.0x2.0m and 0.9x2.0m for the lounge window and glazed door respectively.
- The flat is situated between two other flats, and has a single storey flat above so the flat's external surface area is quite small and consists of the front and back walls and the ground floor, totalling 61.4m2. The total volume of the flat is 134.4m3.

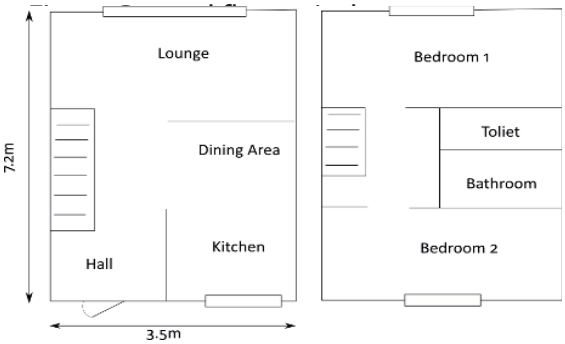

Fig. 2. building plans

Pressure Testing

For the blower door test trickle vents in the windows and mechanical extract vents in the toilet and bathroom were sealed. The results of the blower door testing for property 1 gives an air-tightness value of 7.7ACH@50Pa or 15.2m3/hr.m2. The high disparity in the figures is due to the low external surface area of the building which makes the m3/hr.m2 metric quite large whereas the ACH metric is below average for UK housing.

Major leakage points in the flat were through the back lounge door and around the windows in general where warping of the wood, and poor original fitting, led to some significant cracks between frame sections. The general construction was quite air-tight with little flow coming form the floor plates, or through service pipe access. Concrete construction of this type is often quite airtight.

Thermography

Thermographic analysis of the flats was done externally. The building inside temperature was 21.5°C, with an external temperature of 6.3°C at the time of testing.

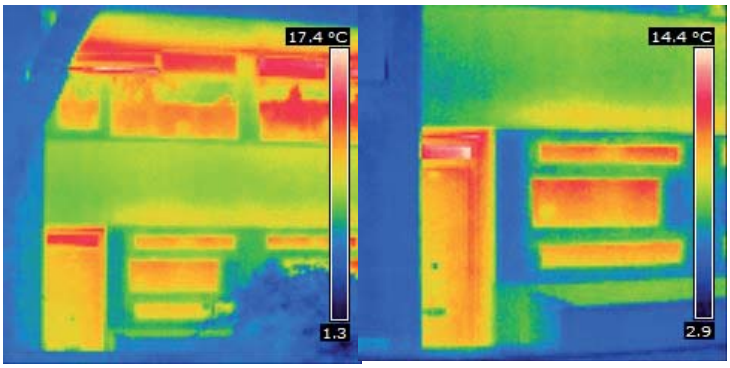

Fig. 3. Example thermographic images.

External surface temperatures, were averaged using ThermaCam QuickReport software, - resulting U-values were:
External wall 7.9°C and 2.6W/m2K
Window glazing 10.1°C and 6.3W/m2K

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UK CASE STUDIES

PROPERTY NO. 6.

Property no.6 is a two bedroom, single storey flat located on the top floor of an early Victorian terrace.

- having solid brick (225mm thick) walls, with rendered ground floor and window surrounds, timber joisted floors and floorboards.
- new plasterboard skim ceilings complete the interior finish. There is a roof space above.
- windows are the original sash windows (with brush seals added) with the exception of the bathroom window, which is a single glazed aluminium window, situated in the kitchen, lounge (front and back), main bedroom (2 at front) and second bedroom. All sash windows are 1.2x1.8m in size. The bathroom window is 1.2x1.2m.

Fig. 1. Front elevation.

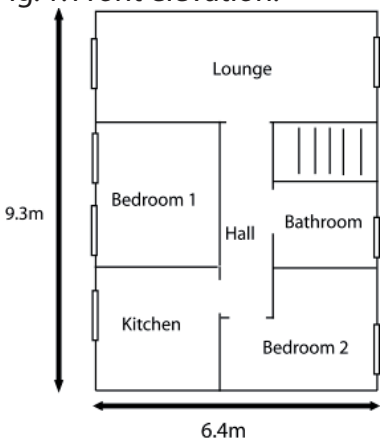

Fig. 2. Building plan.

Pressure Testing

For the blower door test air bricks in the kitchen and bathroom were sealed. No other bespoke ventilation points were built into the flat. The results from the blower door testing for property 6 gave an air-tightness value of 23.7ACH@50Pa or 34.3m3/hr.m2. The disparity in the figures is due to the low external surface area of the building and makes the m3/hr.m2 metric even larger than the ACH metric which is already well above average for UK housing.

Major leakage points in the flat were through the floorboards, sash windows, pipe entries, under the bath and under skirting boards. The general construction was poor in terms of air-tightness, which is largely due to the timber ground floor and the very leaky sash windows.

Thermography

Thermographic analysis of the flats was done externally. The building inside temperature was 21.2°C, with an external temperature of 10.6°C at the time of testing.

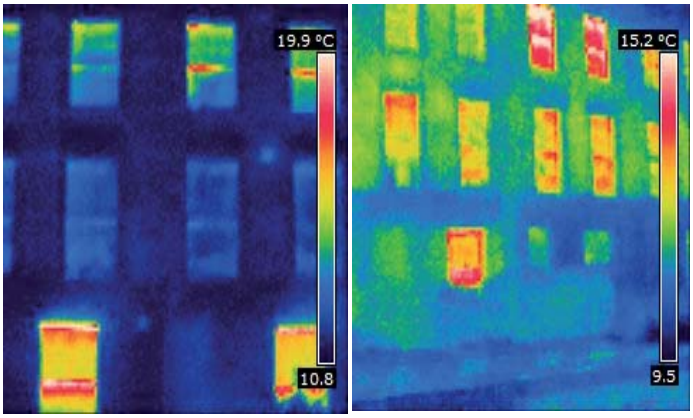

Fig. 3. Example thermographic images.

External surface temperatures, averaged using ThermaCam QuickReport software - resulting U-values were:
External wall 11.5°C and 2.1W/m2K
Window glazing 13.5°C and 6.8W/m2K

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UK CASE STUDIES

PROPERTY NO. 7.

Property no.7 is a 1920's single storey one bedroom ground floor flat in a four storey block.

- The block is constructed of solid load bearing brick 450mm thick, with a solid concrete ground floor and concrete slab ceiling. Partitions are brick, 100mm thick, and plastered throughout.
- Windows are the original timber sash windows with white painted frames in the larger rooms with timber framed single glazed casement windows in the smaller rooms. Window dimensions are 1x1.2m for the bedroom, lounge and kitchen and 0.3x1.2m for the shower room.
- The flat is situated between two other flats, and has a single storey flat above so the flat's external surface area is quite small, especially as its plan is so compact, and consists of the front and back walls and the ground floor, which totals 63.6m2. The total volume of the flat is 94.2m3.

Fig. 1. Front Elevation.

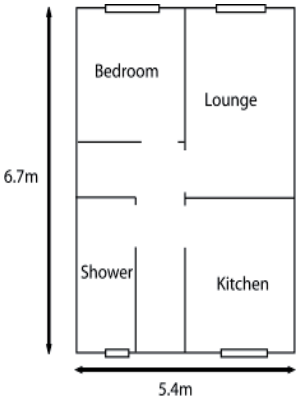

Fig.2. Building Plan

Pressure Testing

For the blower door test trickle vents at the windows in the bedroom and living room were sealed along with the bathroom extract and two wall vents in the living room. The results of the blower door testing for property 7 gives an air-tightness value of 5.2ACH@50Pa or 7.8m3/hr.m2. Both metrics are below the average for UK housing.

Thermography

Thermographic analysis of the flats was done externally. The building inside temperature was 19.7°C, with an external temperature of 7.8°C at the time of testing.

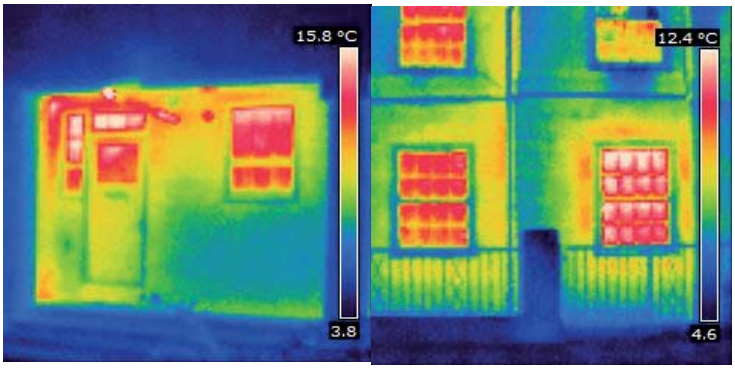

Fig. 3. Example thermographic images.

External surface temperatures, averaged using ThermaCam QuickReport software - resulting U-values were:
External wall 8.6°C and 1.7W/m2K
Window glazing 10.7°C and 6.1W/m2K

Fig. 4. Main air leakage points.

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IRISH CASE STUDIES

PROPERTY NO. 3.

Property No.1 is a single storey, one bedroom apartment in St. Josephs Mansions development on Killarney Street, Dublin.

- The apartment is located at the ground floor of a four storey block.
- The walls are refurbished 280mm brick walls (60mm insulation having been injected into the cavity) including a 100mm outer brick leaf.
- Windows are double glazed in metal frames. The frames incorporate closable trickle vents.
- Ventilation is provided by vents in windows, although some of the vents are inoperable (cannot be closed or open). There is one permanent vent in the bedroom, and two extract fans (kitchen, bathroom).
- The apartment is located on the ground floor with contiguous apartments above. The external walls are orientated to the north only, so the external surface area consists of the north external walls only, 16.4 m2 in total. Total envelope area is 148.9 m2 . The total volume of the apartment is 100.4 m3. Total floor area is 42.2m2.

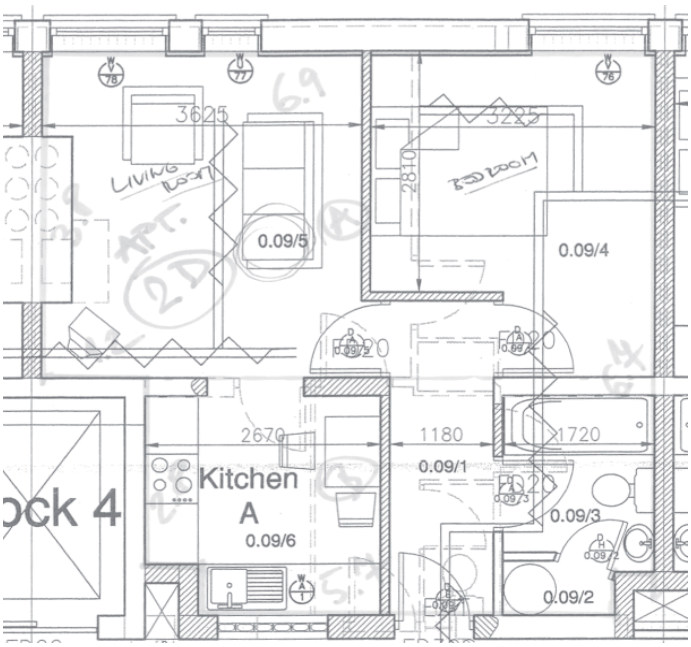

Fig.1. Floor plan.

Pressure Testing

For the blower door test permanent vent and mechanical extracts were temporarily sealed. The window vents were almost all sealed (some could not be closed), and windows were all closed. Preparation was made according to airtightness testing standards.

The results of the blower door test gives an air-tightness value of 12.2 ACH@50Pa or air permeability of 8.2m3/hr.m2 (air leakage index of 74.6 m3/hr.m2). The big disparity between the figures for permeability and leakage index was caused by ratio of external surface area against total surface area of the apartment. The air permeable internal construction (between apartments) was also a contributor.

The air permeability achieved is better than standard of 10.0 m3/hr.m2 stated as good practice in CIBSE Guide manual part A.

Thermography

Thermographic analysis of the flats was done internally. The building inside temperature was 21.6°C, with an external temperature of 8.0°C at the time of testing.

Fig. 2. Photo and thermographic image.

Internal surface temperatures, averaged using ThermaCam QuickReport software, resulting U-values were:

-	window glazing	13.0 °C	5.1W/m2K
-	window frame	12.1 °C	5.6 W/m2K
-	external wall	22.1 °C	1.6 W/m2K

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IRISH CASE STUDIES

PROPERTY NO. 18.

Property No.18 is a double storey, three bedroom mid-terrace house, in the Russell Square development, Tallaght, Dublin.

- The external walls are timberframe construction with a masonry external leaf (100mm external brickwork/blockwork, air cavity, timberframe construction sheated by plywood, service space, plasterboard).
- Internal walls are timber/steel-frame. The insulated ceiling is a structural part of the prefabricated roof joists. The floor is 150mm concrete slab on 60mm rigid insulation.
- Windows are made of engineered wood, weatherstripped, containing double glazed units, with closable trickle vents.
- Ventilation is provided by the trickle vents. There is one mechanical intermittent extract fan in the bathrooms downstairs.
- As a mid-terrace house, it shares two walls with adjacent unit. The external surface area consists of east and west external walls and exposed roof, 131.5 m2 in total. Total envelope area is 219.2 m2. The total volume of the house is 211 m3. Total usable floor area is 82.5 m2.

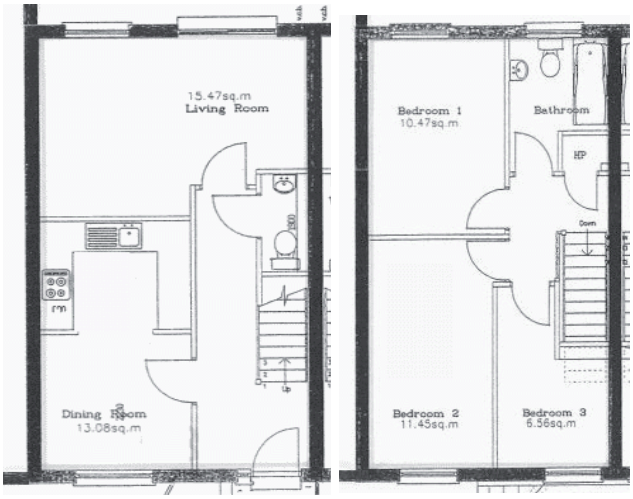

Fig. 1. Floor plans.

Pressure Testing

For the blower door test all the trickle vents were closed. The mechanical extract was temporarily sealed. Preparation was made according to airtightness testing standards.

The results of the blower door test gives an air-tightness value of 7.6 ACH@50Pa or air permeability of 7.3 m3/hr.m2 (air leakage index of 12.2 m3/hr.m2). The disparity between figures for permeability and leakage index is caused by ratio of external surface area against total surface area of the house.

The air permeability is very good compared to the standard of 10.0 m3/hr.m2 stated as good practice in CIBSE Guide manual part A.

Thermography

Thermographic analysis of the flats was done externally. The building inside temperature was 19.2 °C, with an external temperature of 7.1 °C at the time of testing.

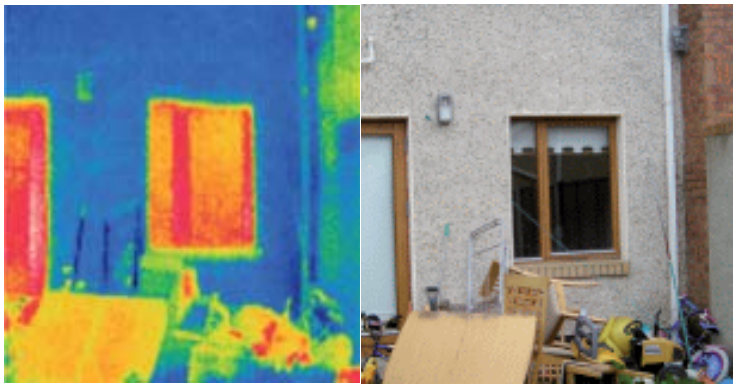

Fig. 2. Photo and thermographic image

External surface temperatures, averaged using ThermaCam QuickReport software, resulting U-values were:

-	window glazing	8.3 °C	2.5 W/m2K
-	window frame	9.4 °C	4.5 W/m2K
-	external wall	7.4 °C	0.8 W/m2K

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IRISH CASE STUDIES

PROPERTY NO. 20.

Property No.20 is a single storey, two bedroom apartment, in Russell Square development, Tallaght, Dublin. It is located on ground floor of three storey building.

- The external walls are cavity construction with partial 60mm cavity insulation (100mm external brickwork, 100mm cavity with 60mm partial fill insulation, 215mm internal blockwork, air space 30mm/battens, 15mm plasterboard).
- Internal walls are studwork, structural internal walls are 215mm concrete/blockwork. The floor is 150mm concrete slab on 60mm rigid insulation.
- Windows are made of engineered wood, weatherstripped, containing double glazed units, with closable trickle vents.
- Ventilation is provided only by the trickle vents. There is one mechanical intermittent extract fan in bathroom.
- The apartment shares walls with corridors and its soffit with another apartment.
- As a result the external surface area consists of north, east and south external walls, 131.1 m2 in total. Total envelope area is 224.5 m2 . The total volume of the apartment is 174 m3. Total usable floor area is 70.8 m2.

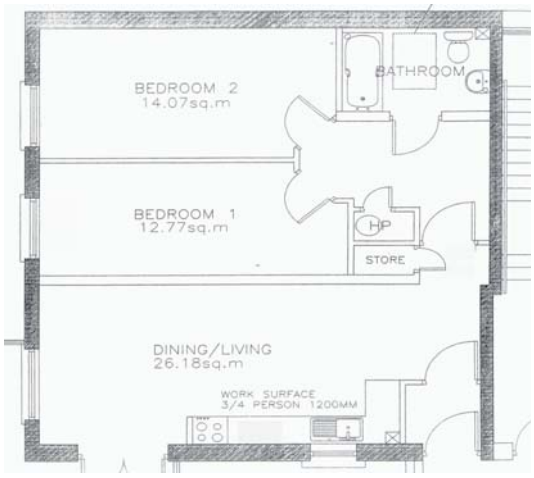

Fig. 1. Floor plan

Pressure Testing

The results of the blower door test gives an air-tightness value of 13.4 ACH@50Pa or air permeability of 10.3 m3/hr.m2 (air leakage index of 17.7 m3/hr.m2). The disparity between the figures of permeability and leakage index is caused by the ratio of external surface area against total surface area of the house.

The air permeability is very close to the standard of 10.0 m3/hr.m2 stated as good practice in CIBSE Guide manual part A.

Major leakage points were observed from behind the bottom kitchen cabinets, through cracks between the terrace door cill and plasterboard, generally around skirtings and around service pipes openings.

Thermography

Thermographic analysis of the flats was done externally. The building inside temperature was 21.5 °C, with an external temperature of 12.5°C at the time of testing.

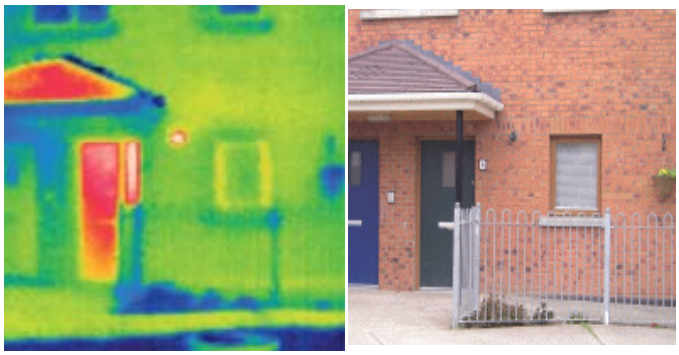

Fig. 2. Photo and thermographic image

External surface temperatures, averaged using ThermaCam QuickReport software, resulting U-values were:

-	window glazing	13.5 °C	2.6 W/m2K
-	window frame	13.7 °C	3.1 W/m2K
-	external wall	12.8 °C	0.8 W/m2K

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DANISH CASE STUDIES

18 properties were surveyed.

Properties 1-6 are from the 1950s - flats with cavity brick walls, concrete floors, and natural ventilation. Properties no 10 to 15 are of light timber frame with mechanical extract ventilation.
Properties no 16 to 18 were the newest among the tested properties constructed from prefabricated elements with MVHR ventilation.

PROPERTY NO. 5 – Solnavej 42
The property has 3 rooms on the ground floor.

Kildevænget is a social housing development of 450 housing units on three floors and a basement.

- heat is supplied from a district combined heat and power plant. The district heating is distributed to each building via a central boiler room and then to five sub-boiler rooms.
- the total consumption of district heating is monitored in the central boiler room, recording the total space heating and domestic hot water demand including losses from the internal district heating network.
- natural ventilation is supplied by trickle vents in the windows and exhaust via a duct from the bath room with an outlet above the roof.

Fig. 1. West elevation of the block.

Pressure Testing

For the blower door test the trickle vents in the windows were closed, and the air duct in the bathroom and the letter box in the entrance door were sealed. The blower door was installed in the doorway to the balcony.
The results of the blower door test was an air tightness of 0.64 l/sm2, which is very much lower than the present requirement in the Danish building regulation.

U-value

The external wall is cavity brickwork with insulation in the cavity. The U-value of the building construction has been identified from drawings:

External wall, 140 mm insulated cavity wall:	0.45W/m2K
Partition wall to staircases.	1.75 W/m2K
Basement wall below ground level	0.54 W/m2K
Basement wall above ground level	0.54 W/m2K
Floor slab between ground floor and basement	1.14 W/m2K
Floor in basement	0.56 W/m2K
Roof/sealing	0.39 W/m2K
Windows, 2 layer of glasses	2.40 W/m2K

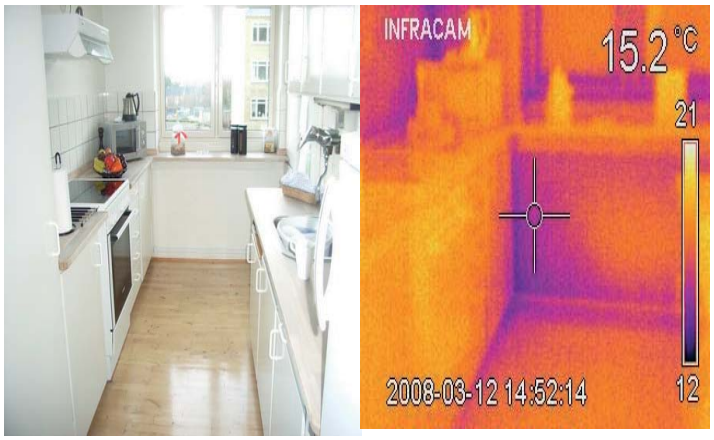

Fig. 2. The infrared photo above shows a cold area in the corner as the wall is a solid brick wall and acts as a cold bridge. Below the windows the thickness of the external wall is lower than the other parts and the thermal insulation is poor.

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DANISH CASE STUDIES

PROPERTY NO. 10 – Egebjergvang 159

This social housing development was build in 1985 in Ballerup, a suburb of Copenhagen.

- The houses are terraced and multi dwelling houses on one, two or three floors. The three storey blocks have a basement.
- The houses have heat supplied from a central heating plant with natural gas. Domestic hot water is produced by the heating plant and is distributed to the dwellings via an internal distribution network. Space heating is distributed via a separate network. In 2004 the central heating plant was renovated with a new gas furnace and new high efficiency pumps.
- All dwellings are mechanically ventilated using cooker hoods in kitchens and via dampers in bath rooms. Air inlet is through trickle vents in the windows.

Figure 1: Egebjergvang, terraced and multi dwelling houses.

Fig. 2. Property is end terraced house.

Pressure Testing

During the blower door test the trickle vents in the windows were closed, and the extract air damper in the bathroom and the cooker hood in the kitchen were sealed. The blower door was installed in the doorway to the garden.

The results of the blower door test are an air infiltration rate of 1.50 l/sm2 at 50 Pa which is the same as the requirement in the present Danish building regulation for new construction.

External wall, timber frame and brick tiles

Description	s	l	R
External heat transfer coefficient			0.17
Ventilated space			
Eternit	0.008	1.200	0.01
Insulation with timber frame	0.045	0.046	0.99
Insulation with timber frame	0.095	0.046	2.08
Gypson	0.026	1.600	0.02
			3.26
U-value			0.306

External wall light construction

Description	s	l	R
External heat transfer coefficient			0.17
Ventilated tiles			
Eternit	0.010	1.200	0.01
Insulation with timber frame	0.045	0.046	0.99
Insulation with timber frame	0.095	0.046	2.08
Gypsum	0.013	0.250	0.05
			3.30
U-value			0.303

External wall, cavety wall by concrete and brick tiles

Description	s	l	R
External heat transfer coefficient			0.17
Tiles	0.110	0.700	0.16
Insulation	0.125	0.037	3.38
Concrete	0.150	1.600	0.09
			3.80
U-værdi			0.263

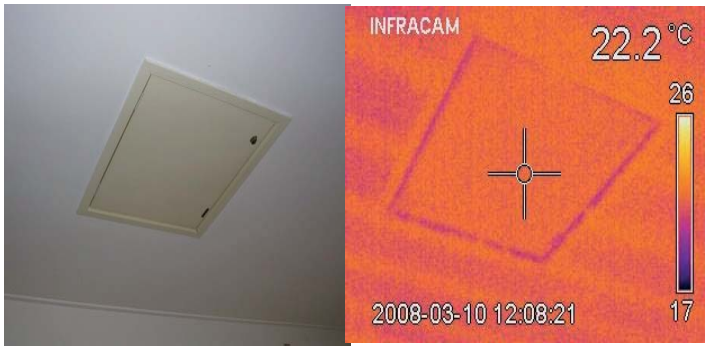

Fig. 3. The photo shows cold bridges around the hatch to the unheated attic. The timber frame construction is visible on the infrared photo indicating heat losses.

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DANISH CASE STUDIES

PROPERTY NO. 16 – Skotteparken 55

Skotteparken is a social housing development of 100 units on two floor level. The total enclosed floor area is 7150 m2 and the average size of the apartments is 71.5 m2. The whole settlement uses heat supplied from a local combined heat and power plant with natural gas as primary energy.

- Different energy savings technologies were demonstrated: super-insulation, low energy windows, mechanical ventilation with heat recovery (MVHR), solar panels for space heating and domestic hot water, and pulse operation of the district heating network.
- Skotteparken was constructed in 1992 as a demonstration project supported by the Danish Energy Agency and European Commission.
- The units were built using prefabricated structural elements of light-weight timber construction. The cladding brickwork was laid up on site. The bricks clad the lower part of the external wall, the upper section is clad in Eternit panels.
- The Skotteparken project was chosen for the survey as an example of a project using mechanical ventilation with heat recovery (MVHR) and for being a prefabricated building.

Fig. 1. Terraced house with two floor levels (house end). There is a sunspace on two sides of the house.

Pressure Testing

During the blower door test the air inlet dampers and the extract air damper in the bathroom, and the cooker hood in the kitchen, were sealed. The results of the blower door test is an air tightness of 2.56 l/sm2 - above the requirement in the present Danish building regulation for new construction.

Air leakage points were identified around sanitary installations in the kitchen. The remaining part of the building envelope was appropriately air-tight.

External wall, light construction covered by eternit

Description	s	l	R
External heat transfer coefficient			0.17
Eternit			
Ventilated space			
Gypsum	0.009	0.250	0.04
Insulation with timber frame	0.055	0.042	1.31
Insulation with timber frame	0.170	0.042	4.06
Plywood	0.150	0.180	0.83
			6.41
U-value			0.156

External wall covered by brick

Description	s	l	R
External heat transfer coefficient			0.17
Ventilated tiles			
Insulation with timber frame	0.055	0.042	1.31
Insulation with timber frame	0.170	0.042	4.06
Plywood	0.150	0.180	0.83
			6.38
U-value			0.157

Floor above ventilated crawl space

Description	s	l	R
External heat transfer coefficient			0.17
wood	0.022	0.120	0.18
Insulation	0.195	0.040	4.85
			5.20
U-værdi			0.192

Roof

Description	s	l	R
Steel plate with ventilated space			0.10
Insulation	0.250	0.036	6.94
Insulation with timber frame	0.125	0.042	2.98
Gypson	0.013	0.250	0.05
			10.08
U-value			0.099

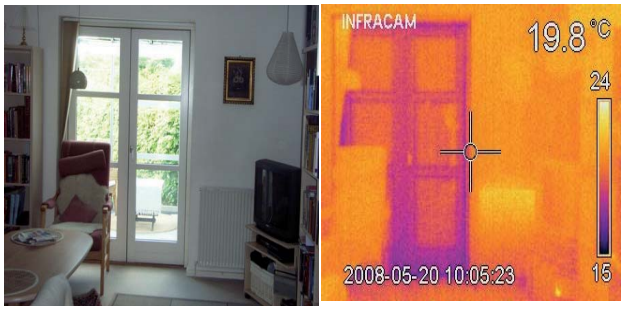

Fig. 2. shows the high temperature of the pane (low U-value) and the low temperature of the frame which implies poorly specified insulation.

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UK RESULTS

Camden Council has a total of 33,872 properties on its books.

constructed:

1945-64	1-2 Bedrooms	82
1945-64	3+ Bedrooms	58
1965-74		435
1975	+	442
All Non Trad Houses & Bungalows		24
High Rise		10795
Hostel Flats		859
Medium Rise		19943
Post 1944 Low Rise		364
Pre 1945 1-2 Bedrooms		173
Pre 1945 3+ Bedrooms		328
Pre 1945 Low Rise		369
Grand Total		33872

Due to the huge majority of flats compared to houses in Camden's stock, flats were the preferred option for testing. The properties surveyed include all the main types of housing provided by Camden in terms of age of construction and bedroom number/type.

Fig. 1. London test locations

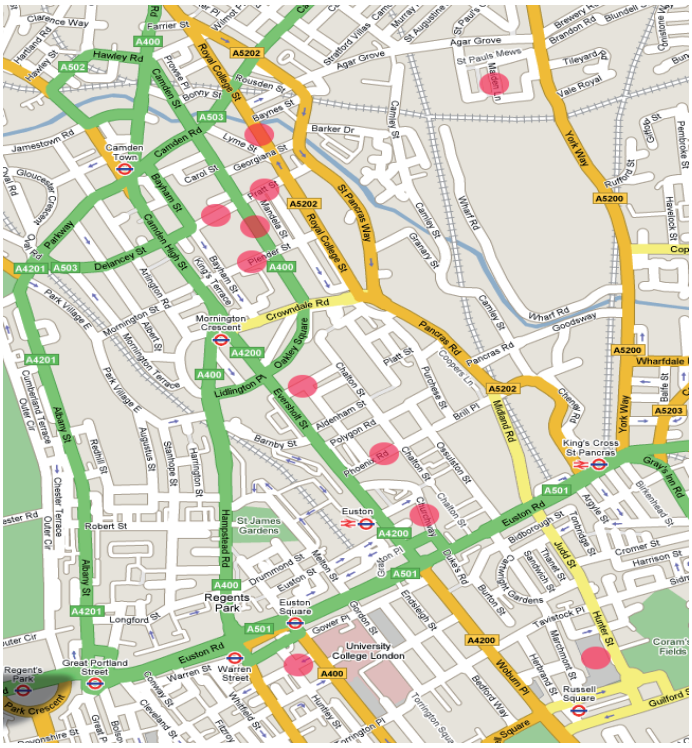
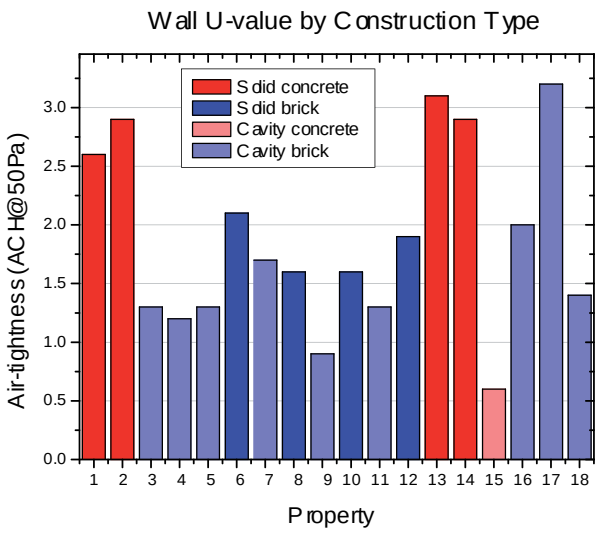
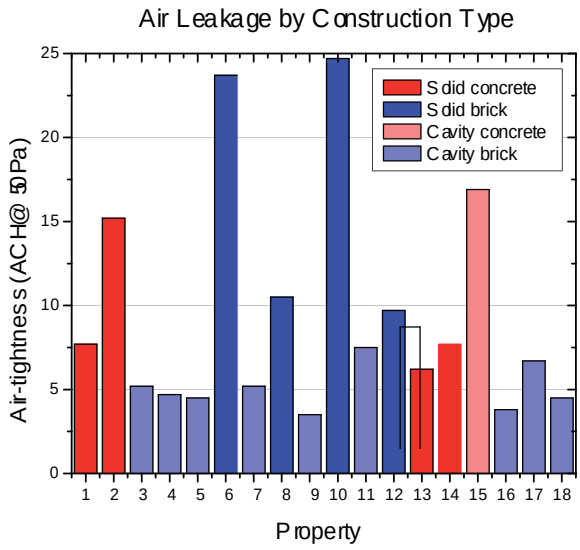


Fig. 2. Survey results for air leakage and wall U-value by construction type





Properties constructed before WW1 with uninsulated solid brick walls also had suspended timber ground floors that were responsible for a large proportion of the air leakage.

Flats constructed in the 1960s and 70s had plastered walls and solid concrete ground and upper floors and were relatively air-tight. In some cases they had been refurbished with new windows so air leakage was restricted to service entry points. The overall energy performance was however generally poor.

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IRISH RESULTS

32 properties have been surveyed in Dublin, a sample relatively typical of housing in Ireland. Mostly all of the types have been built in last 12-14 years.

All of the CLUID stock is relatively new. The internal finishing of walls is a critical consideration, recent dry construction was found to give very poor results whereas wet plastered walls were relatively airtight.

For that reason properties from the 1950s were better than newer constructions despite the older buildings tending to have windows that were less airtight.

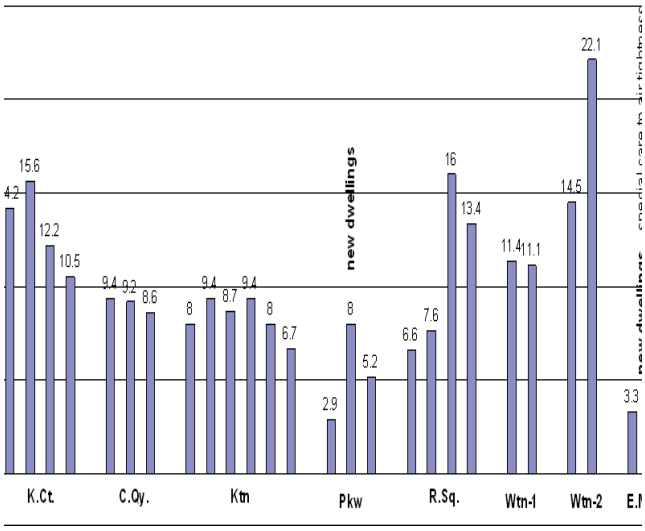

Fig. 1. Sample Irish air-tightness test results.

- the sample represents mainly recently built units, with different construction, size and ventilation strategies. Both houses and apartments were tested.

- From an overall primary energy consumption houses did better than flats because they tend be run on gas rather than electricity, despite the smaller unit size of flats.

- The internal finishing of walls is a critical consideration, drylining was found to give very poor results whereas wet plastered walls were relatively airtight. So older properties were air-tight but not energy efficient due to their lack of insulation.

DANISH RESULTS

The older Danish buildings showed a good and consistent level of airtightness but there was a larger spread of results for newer construction.

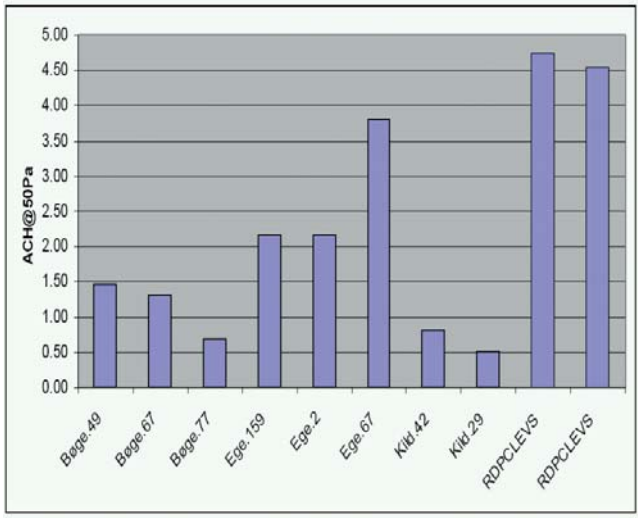

Fig. 2. Danish air-tightness results.

KAB manages approximately 50,000 housing units exclusively in Greater Copenhagen.

70 % of KAB's stock is multi-storey housing and 3.5 % are row houses, the remainder being a mix of different types.

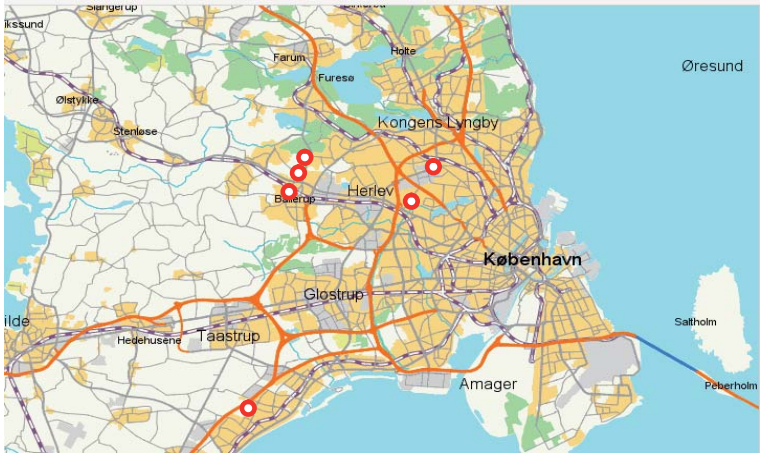

Fig. 3. Location of test sites in Copenhagen. Types include flats, detached and terraced houses with a variety of ventilation systems - passive, mechanical and heat reclaim.

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CONSEQUENCES FOR REFURBISHMENT

REMEDIAL AIR-TIGHTENING

The essential requirement for installation of advanced ventilation strategies is that the building is made adequately air-tight.

Fig. 1. Masonry built houses at Easton Mews near Dublin, air-tight construction incorporating the Dwell-Vent system.

Fig. 2. Achieving air-tightness in existing construction by installation of an impermeable and continuous membrane sealed around doors and windows.

Fig. 3. At more extensive reconstruction attention to these details can incorporate insulation to eliminate cold bridges.

Fig. 4. Suspended ground floors should have their floor boards removed and a membrane and insulation installed beneath, all to proprietary details. This eliminates one of the principal sources of leakage found in the UK housing sample.

Fig. 5. A blower door test is a necessary check on the standard of workmanship achieved.

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CONSEQUENCES FOR REFURBISHMENT

REMEDIAL AIR-TIGHTENING CONTINUED

CHECK AND REPAIR WINDOW HINGES AND LOCKS

This is a relatively simple technique to reduce air leakage through windows. In a majority of cases in the sample buildings a gap was visible between the window frame and the sash.

It will probably be necessary to adjust the hinges and the lock mechanism as well – the precise adjustment required depends on type of hardware used. Usually simple tools are sufficient (Phillips screw driver, hexagonal keys, wrench). Some of the parts might require to be changed.

Advantages: Simple, no cost measure, very effective.

Disadvantages: Can become complicated when special tools are needed.

Suitability: for all dwellings.

WINDOW REPLACEMENT

Old windows are replaced by new ones. Usually the jamb and sill are upgraded to eliminate thermal bridging and the risk of condensation. New units should be certified for the thermal bridging of the frame and for overall U-value. Double glazing with a low E coating should be a minimum requirement.

Triple glazed units with thermally broken frame are available to reach passivhaus standard (U=0.8-0.9 W/m2K).

Alternatively, cheaper supply air windows can be used having dynamic U-value as low as 0.7 W/m2K (an air extract system, e.g. passive stacks, is required to be installed in this case as well).

Certified windows are airtight compared to old ones, having more efficient and multi weather-stripping and all-perimeter locking mechanisms.

Materials used during installation provide airtight solutions as well, therefore infiltration is greatly reduced.

The work is done from interior, takes approximately 1-2 days for an average apartment.

Advantages: Reduces a large portion of thermal loss through transparent elements. Minimises air leakage and therefore eliminates infiltration loss. Solves thermal bridging and reduces or possibly avoids condensation at and around window. Improved security and fire protection.

Disadvantages: Works are done from inside. Initial costs.

Suitability: For dwellings with old, single glazed, metal or very leaky windows.

Manufacturers/Certified systems: Dwell-Vent (supply air windows), NorDan Vinduer, and many others.

CHECK / SEAL OPENINGS FOR SERVICE PIPES & WIRES

All openings for service pipes should be sealed, from internal spaces to the external environment.
The most common technique is to use silicone, if the gap is small. Polyurethane foam is more appropriate for larger gaps. Sometimes service openings are not easily accessible, so the main part of work is in uncovering the holes to carry out the work.

Advantages: simple effective option

Disadvantages: might become too complicated if the pipe run is not accessible.

Suitability: everywhere where holes occur.

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CONSEQUENCES FOR REFURBISHMENT

REMEDIAL AIR-TIGHTENING CONTD - SEALING THE BUILDING ENVELOPE

Check and seal joints between new and old structure (if possible).

If the dwelling has any additions (extensions) or has been refurbished, there is usually a risk of cracking between the old and newer structures.

If the cracks are visible or possible to investigate, it is appropriate to seal them to limit air leakage.

The most frequent is to use acrylic sealant, which remains plastic after hardening so is possible to be painted over, and appropriate for interior use. It is applied by caulk gun into the crack (following the procedure recommended by manufacturer).

From the exterior silicone (which is elastic after hardening) sealants are used as they are weather resistant.

If the cracks are bigger, it may be suitable to fill them with polyurethane foam and cover them with mortar/plaster.

Advantages: simple, effective.

Disadvantages: may be difficult to investigate particularly if dry-lining has been installed.

Suitability: for all structures with cracks.

SEAL GAPS BEHIND PLASTERBOARD AT SKIRTINGS

Usually internal plasterboard is not brought down to the ground concrete slab or the structural floor at upper floors. Approximately a 2-5 cm gap can occur behind skirting board.s

These gaps are especially problematic because they create connections between service spaces behind the plasterboard, ceiling spaces and other service spaces (at ground floor and other higher floors).

Stack effect multiplies the extent of infiltration, which can be later observed at all openings in the plasterboard (outlets, lights, etc).

It will be necessary to dismantle the skirting board and seal the space between the wall and plasterboard. Polyurethane foam is usually used.

Advantages: this is a principal cause of infiltration.

Disadvantages: the skirting board can not be readily dismantled in many cases, if it was installed prior to the floor finishes.

Suitability: for leaky houses with evident leakage from behind plasterboard.

SEAL CRACKS AROUND WINDOWS (INSIDE, OUTSIDE)

In many cases cracks were observed around windows, at the junction of the window frame and plasterboard (or plaster), sill board and plasterboard.

Acrylic sealant is most frequently used - it remains plastic after hardening and can be painted over. It is applied by caulk gun into the crack following the procedure recommended by the manufacturer.

In some cases Silicone (elastic after hardening) or Silicone-Acrylic (solid hard after hardening) sealants are used. Silicone is used for most external situations.

Advantages: simple, low cost, effective. Also to visually improve the internal space.

Disadvantages: none.

Suitability: for all cracks.

Manufacturers/certified systems: wide range.

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CONSEQUENCES FOR REFURBISHMENT

REMEDIAL AIR-TIGHTENING CONTD - REFURBISHMENT OF LOFT HATCH (weatherstripping, lock mechanism, additional insulation).

As a loft hatch separates the internal environment from the exterior, similarly to a window or door, attention should be paid to this as well. Most commonly a loft hatch is not insulated and has no weather-stripping.

The extent of improvement varies and is highly dependent on the individual situation.

However, in most cases EPS board cut to size can be glued to the loft hatch to provide thermal insulation. Highly compressive weather-stripping (silicone rubber based, or soft rubber) should be fitted to the hatch.

In order to keep the strips compressed, the lock mechanism should be adjusted, or mounted where none exists.

Hatch openings can be completely refurbished using manufactured folding loft ladders (insulated) as well. These systems are usually provided by roof windows manufacturers, their procedure should be followed during installation.

Fig. 1. Manufacturers' loft ladder details.

Advantages: a simple and effective measure, only simple tools are needed.

Disadvantages: initial costs and fitting a manufactured replacement into the available opening.

Suitability: for all loft hatches.

Manufacturers/Certified systems: LTK Thermo (Fakro), LWS Smart (Fakro), Dolle Extra (Dachstar), Dolle Termo+ (Dachstar)

CHECK AND REPAIR (INSTALL) WEATHER-STRIPPING.

The most frequent problem for older windows is poor or no weather-stripping which results in air leakage.

Usually old strips (if any) do not have to be removed. The area where the new weather-stripping is to be applied has to be cleaned of dust and dirt.

New self adhesive strips are applied, to the sash.

The function of the lock mechanism has to be verified and sometimes adjusted to achieve correct compression.

There is wide range of weather-stripping available. The most appropriate are silicone based "D" shaped self-adhesive tubes, which can be easily compressed from 6mm to 0.7mm.

Hard rubber or flat strips are not suitable, as they can not be compressed. If some improvement to a door with no threshold is required, special profiles are availabl for screwing into the door are used (rubber + metal).

Advantages: Easy to install, low cost, very effective

Disadvantages: difficult when improving sash windows - brush seals are not as air-tight.

Suitability: for all older windows.

Manufacturers/Certified systems: Too many to mention (usually available in different shapes, materials and colour in hardware stores).

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CONSEQUENCES FOR REFURBISHMENT

REMEDIAL THERMAL EFFICIENCY - LOFT INSULATION

This is a relatively easy way to improve insulation above a heated space, as the loft is usually accessible. Ideally the final thickness of the insulation should be approximately 200mm to give a U-value 0.19 W/m2K.

Usually mineral or glass fibre insulation is used, either in rolls or blown form. It is appropriate, and sometimes necessary, to install a wind barrier (breathable membrane) on the top of the insulation, to avoid possible thermal looping (loss of heat due to convection currents). OSB or chipboards can be used as an alternative.

Additional counter battens should be used to eliminate thermal bridging, and to achieve the required thickness of insulation.

Advantages: accessible space means relatively easy installation, also obviating thermal bridging.

Disadvantages: difficult to deal with the detail at the perimeter of the loft. It may be necessary to dismantle a section of the roof to bring the insulation inside and provide sufficient ventilation during the work.

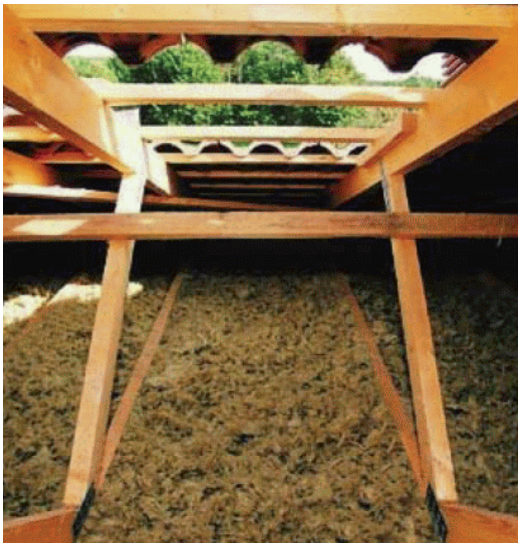

Fig. 1. Installation at loft perimeter.

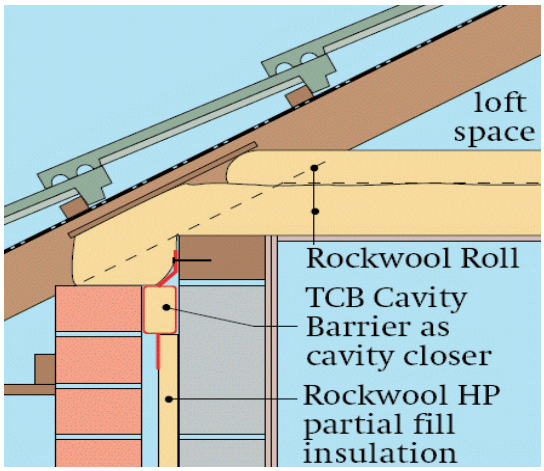

Fig. 2. Continuously insulated envelope with ventilation provided to the loft space.

Suitability: for all dwellings with low or poorly installed insulation at ceiling level.

Manufacturers/Certified systems: Rockwool 'Rockprime' (blown loft insulation) – other soft roll insulation, products from Rockwool, Isover etc.

ERADICATION OF COLD BRIDGES

Could be done to avoid condensation (mould growth) and eliminate cold bridging. This is particularly appropriate when replacing windows and doors. Additional insulation and plasterboard is mounted to the side of openings (jambs and head) to eliminate thermal bridges. Also as shown in fig. 2.

The "moulding" shape is created around openings. The old plasterboard (or other layers) can be removed for better performance and possible improved sealing of the window frame.

Advantages: simple installation, occurring locally at the relevant windows or other junctions.

Disadvantages: overall thermal performance of the dwelling is not greatly improved.

Suitability: for dwellings with significant mould growth around openings. or junctions.

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CONSEQUENCES FOR REFURBISHMENT

REMEDIAL THERMAL EFFICIENCY CONTD

FLOOR INSULATION

Additional floor insulation may be fitted. As there are limitations to thickness, in most cases it would consist of a limited thickness of rigid insulation below the floor finish.

Sometimes if there is enough space, the insulation is laid down between the battens with the flooring fixed to the battens.

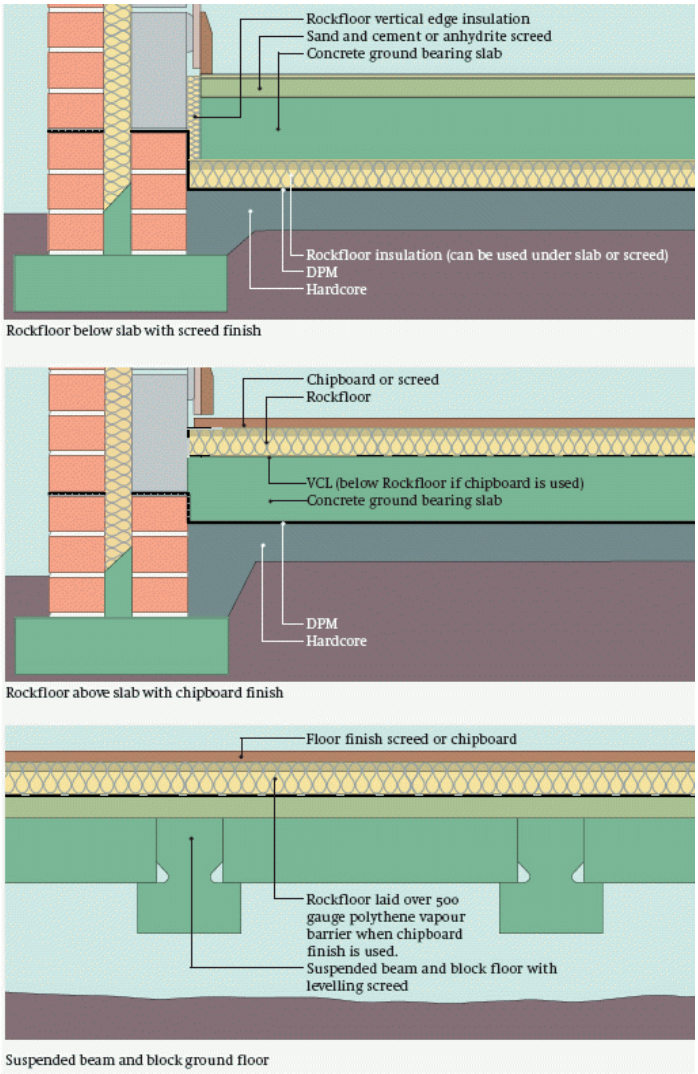

Fig. 1. Typical manufacturers' details.

Advantages: There is no need to remove old layers unless otherwise required.

Disadvantages: The U-value provided is limited, thermal bridging at junction of the floor and external wall is not solved – the risk of condensation and mould growth remains.

The finished floor level is raised, making it difficult to deal with door height and at the first step of a staircase.

Suitability: For dwellings with no floor insulation.

Manufacturers/Certified systems: Rockwool Rockfloor.

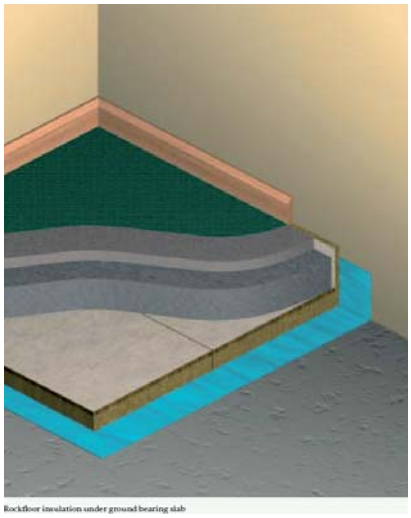

Fig. 2. Typical build-up of floor insulation.

REFURBISHMENT OF SERVICE OUTLETS (TO PASSIVHAUS STANDARD)

Existing outlets are replaced to comply with passivhaus standards (rubber seal required around cables).

Advantages: lowering air infiltration.

Disadvantages: initial cost, work must be performed by specialised electrician.

Suitability: for houses where the infiltration through outlets is noticeable.

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CONSEQUENCES FOR REFURBISHMENT

REMEDIAL VENTILATION PROVISION - INSTALLATION OF EXTRACT FANS WHERE THERE ARE NONE (when only permanent or trickle vents are present in wet rooms) nb. this is irrelevant if passive stacks or MVHR are installed.

Unless there is ventilation system installed (MVHR, SAWs + passive stacks, controlled ventilation) it will be necessary to install extract fans in order to remove moisture at the point of generation (wet rooms - kitchen).

This is especially important if there is a condensation problem on poorly insulated thermal bridges and windows, as there will be an increased risk of mould growth – encouraging the occupants to overly ventilate in the vain hope of removing the mould.

Having permanent or trickle vents in these rooms is absolutely unsatisfactory, as there is no control over the air flow since it depends mostly on wind direction. As a result the air is often (or permanently) flowing into the wet room, picking up moisture and redistributing it into the dwelling, causing dampness.

The extract fan can be installed into the window, a refurbished opening previously occupied by a permanent vent, or directly into the wall. Ducting is sometimes necessary.

It is important the extract fan has damper and at least 5 min. "overrun" time. Some may be set to maintain a certain level of humidity (using a humidistat).

Advantages: removes dampness and odours from the dwelling, lowers the incidence of condensation and risk of mould growth. Encourages the air to flow in the opposite direction (dampers need to be installed).

Disadvantages: extracts and ducting need to be installed, cost of installation.

Suitability: for all wet rooms and kitchen hoods.

without extract.

Manufacturers/Certified systems: Vortice, Xpelair, Multiwing SA.

Fig. 1. Manufactured examples.

INSTALLATION OF PASSIVE STACKS INSTEAD OF FANS

Note: only if the ventilation strategy is designed as whole house extract ventilation.

The concept is to replace existing old extract fans by passive stacks which use stack effect and wind energy to ventilate the house, therefore saving electricity.

There have to be designed openings for air intake into the room (permanent or trickle vents, retrofit 'supply air' windows).

The work basically consists of running plastic pipes Φ 100-150mm from wet rooms to above the roof.

There is a wind cowl attached to the exterior side of the pipe to catch wind energy, a grille is usual at the inlet to the passive stack.

Advantages: saving electric energy otherwise needed for running the extract fans, no other work on vents or interior. No maintenance. Silent operation.

Disadvantages: initial costs, work done from interior, generally long payback period. Not having boost option when using wet room.

Suitability: for dwellings with whole house extract ventilation strategy, mainly houses.

Manufacturers/Certified systems: Passivent, Ubbink, + 'supply air' windows: Dwell Vent system.

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CONSEQUENCES FOR REFURBISHMENT

REMEDIAL VENTILATION - INSTALLATION OF CONTROLLED VENTILATION SYSTEM (INNOVENTUS etc)

Controlled ventilation systems utilize small units to supply fresh air into rooms. The exhaust air is then collected at extract/passive stacks inlets, commonly in wet rooms, and expelled.

The actuating units can be mounted behind radiators so the incoming air is heated and cold draughts are avoided.

The other units can be mounted on the side of a window with an inlet in a jamb to visually hide the grilles; there is usually a 4-way diffuser from the interior side.

All units can be operated by independent control, based on temperature, occupancy, humidity, CO2 etc, depending on specific system. They could include a low-speed and low-noise fan with optional filters for cleaner air (against pollen, dust etc).

The system requires exhaust, usually satisfied by extract fans or passive stacks.

Extract fans can provide additional boost, they cannot have dampers. The fans have to run all the time, or their control has to be connected to the actuating unit – this is fairly sensitive situation and requires special istdesign skills.

Passive stacks do not have boost option, but are much simpler. In addition they create stack effect, helping the actuating units to run on lower speeds and consuming less electricity, while maintaining sufficient air flow.

The installation depends on the particular manufacturer. Generally, new inlet openings are created, radiators might be refurbished, actuating units are installed, and doors undercut. An existing extract system can be utilised and upgraded, or passive stacks could be installed.

Design and installation has to be done by specialists, actuating units have to be wired to power and control.

Advantages: installed in individual rooms, therefore individual independent control is provided (based on humidity, CO2 level, etc). Cold draughts are avoided. Electricity consumption is low when combined with passive stacks. Relatively simple installation of actuating units (no ductwork needed). Possibility of using an existing extract system.

Disadvantages: High electricity consumption when combined with extract fans. Initial costs of advanced sophisticated systems. Problem of accommodating vertical ducting for passive stacks.

Suitability: for all dwellings where SAWs+passive stacks, or MVHR is not suitable.

Manufacturers/Certified systems: Sonair (Innosource), Innoventus (Innosource).

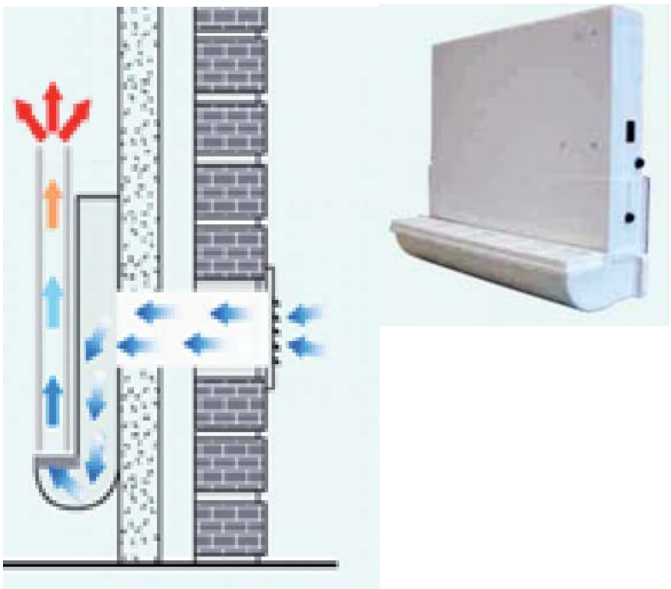

Fig. 1. Fan units with air being pre-heated to avoid draughts in winter.

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VENTILATION contd.

DWELL-VENT SYSTEM INSTALLATION

Upgrading of windows to Supply Air windows (also requires passive stacks or continuous mechanical extract - CME).

The system is engineered and provides windows with U-values as low as 0.7 W/m2K. The flow-regulating vents are mounted on the window. This is a whole house system, the passive stack or CME draws air through the windows to the outlets in the wet rooms, it is then exhausted at the cowl on roof.

The measure requires old windows to be replaced by Supply Air windows, all interior doors to be undercut by approximately 30mm for free air flow.

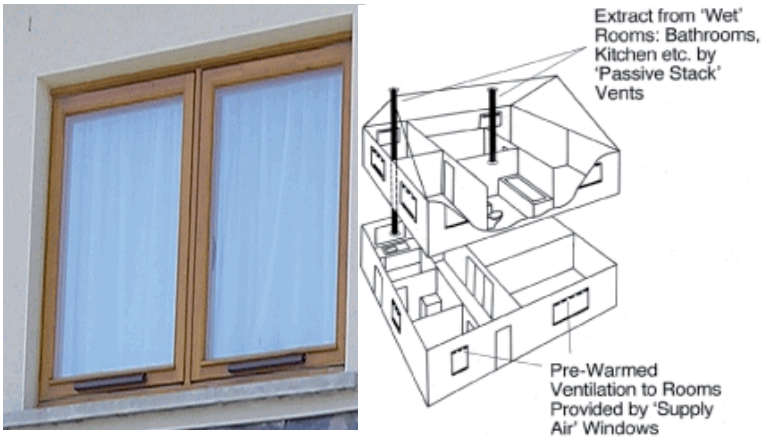

Fig. 1. Supply Air windows with inlet vent at base of window and Dwell-Vent system concept

Advantages: significantly reduced heat loss through windows. Engineered balanced ventilation. Thermal bridging at openings usually solved during refurbishment.
low cost of windows (only approximately 15% more than regular double glazed units); low cost of passive stacks (plastic pipes).
no additional energy (electricity) needed during entire operation, no maintenance. Silent during operation. System will last the life of building.
low initial costs.

Disadvantages: refurbishment work carried out from the inside of the house, some restrictions to apartments/apartment blocks may apply.

Suitability: almost for all dwellings with windows worse than standard double glazed units, and with poor/uncertain ventilation strategy

Manufacturers/certified systems: Dwell Vent system

INSTALLATION OF MECHANICAL VENTILATION WITH HEAT RECOVERY (MVHR - different systems)

MVHR with high efficiency fan motors provides pre-heated continuous fresh air. Permanent vents in walls and trickle vents in windows are not required and must be blocked.

Installation includes mounting duct work, control panel/panels, the MVHR unit, inlet and extract grilles. The work is done from inside , there may be difficulty in accommodating the ducts.

Operation can be set depending on time, humidity, temperature etc. Design and installation has to be done by specialists.

Advantages: good indoor air quality.

Disadvantages: Electricity required for running the fans increases carbon emissions (three times more than natural gas) which can outweigh the benefits. The initial cost of installation, running costs, ongoing maintenance liability. Danger of bacteria growth in poorly designed and installed systems, noisy operation.

Suitability: for dwellings where Supply Air Windows and Passive Stacks would not work or would be too difficult to install.

Manufacturers/Certified systems: Vortice, Xpelair, Quality HRV, Proair, Ireland, Aervent, Control Aer, Vectaire Ltd, Villavent Limited, MTD Solutions, Nuaire

AVASH - YET TO COME

We are in the process of making an overall assessment of the Sampling and Survey studies in the UK, Ireland and Denmark.

Based on the completed surveys and their analysis for each dwelling type in each country:

An assessment of the feasibility of possible methods of insulation.

An assessment of the probability of achieving and adequate level of air tightness for Advanced Ventilation Strategies.

An assessment of the feasibility of remedially installing alternative advanced ventilation systems in terms of ease of installation, for example the location of clear vertical routes for ducts through the height of the building.

Through use of computer model simulations constructed within the Sampling and Survey Report, estimates will be made of:

The change in energy performance of each type after remedial insulation, sealing and installation of the different ventilation alternatives.

The resulting reduction in the Carbon Dioxide emissions for which each building type is responsible.

Estimates will also be made of the likely costs of these measures in each country, and the projected payback periods relative to energy prices in all three countries.

Benefits

By way of conclusion we will then be able to derive:

- A range of feasibility for application of insulation, sealing and installation of an appropriate ventilation system relative to the range of dwelling types for the study areas in all three countries.
- An estimated total applicability for the stock as a whole within the study areas in all three countries.
- The estimated total energy savings that would result.
- The estimated total reduction in CO2 emissions that would result.
- The estimated total cost of these measures.

The database that will be contained in the Assessment Report will be a uniquely valuable addition to the available resources of housing providers, policy makers and housing professionals within the three countries with much broader application and interest throughout Europe. A dissemination programme will follow.

For further details about the project either see our website or contact the Project-Coordinator

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Cenergia Energy Consultants

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