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Guidelines for bats, insulation and lining materials

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Cover photo: Vespertilio murinus, roosting between two insulation boards.
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Introduction

Buildings are responsible for more than one third of total energy use and associated greenhouse gas emissions in society, both in developed and developing countries. Insulation to control energy loss is therefore very important; but bat colonies are under threat from insulation programmes which do not take adequate account of the presence of their roosts. Moreover, some EU-financed schemes which promote the installation of insulation are coming into conflict with policies to conserve bats, because EU members are obliged to take measures to prevent, mitigate and compensate significant damage to protected species.

Bats use networks of roosts in buildings for a variety of purposes: breeding, swarming, hibernation and as transient roosts. Large-scale insulation of buildings can cause fatalities and loss of roosts, which influences bat populations not only at local level, but can also impact on migratory bats which often use roosts in buildings. These impacts should not be underestimated.

Overground roosts should be managed in accordance with national nature conservation legislation and guidelines adopted by the EUROBATS Agreement. EUROBATS has already published guidance on the conservation and management of underground and overground bat roosts (Mitchell-Jones *et al*. 2007; Marnell & Presetnik 2010), but this is the first time that issues caused by insulation have been addressed in detail.

This document summarises accessible data from European countries and adjacent territories and suggests solutions for different insulation methods, with case studies from specific countries. Even though this publication is focused on bats and bat colonies, many recommendations can be also applied to urban populations of swifts. EUROBATS Resolution 8.9 recommends Parties and Non-Party Range States to develop appropriate national guidelines, drawing on this general guidance (see Annex 1).

1 Situation in Europe and adjacent territories – short overview

Analysis of the situation in Europe is based on results of the EUROBATS questionnaire (see Annex 2) obtained from 31 Parties and Non-Party Range States. The situation in Europe and adjacent states varies. In the north, almost all or all buildings are already insulated, whereas in some southern countries insulation is used only on new buildings, and the old ones so far remain without insulation. In former communist states, insulation mostly occurs on housing estates of panel houses (blocks of flats), whereas coastal west countries face rapid insulation of individual private houses.

In total, 20 European countries have insulation programmes. In northern countries, all houses are already insulated, whereas many Eastern European countries are so far not involved in large insulation projects and insulation is sporadic. Authorities of 26 countries do not request any pre-insulation or pre-reconstruction survey to get permission prior to renovation or insulation and only 12 countries can stop (by statutory means) the insulation process when bats are found. Ten countries use compensation measures after or during insulation; however, there are not many studies about the effectiveness of the chosen mitigation measures. Post-insulation surveys are only carried out in four countries.

The structures that are most often insulated are private houses, office buildings and blocks of flats; occasionally other buildings also undergo insulation, such as churches or monasteries. Most funding comes from private resources or local funds, but eight countries also use EU grants to finance their insulation programmes. The most affected species are pipistrelles (*Pipistrellus kuhlii, P. nathusii, P. pipistrellus, P. pygmaeus*), noctules and serotine bats. In Eastern European countries with widespread blocks of flats (also known as Plattenbau) parti-coloured bats are also significantly affected (fig. 1).

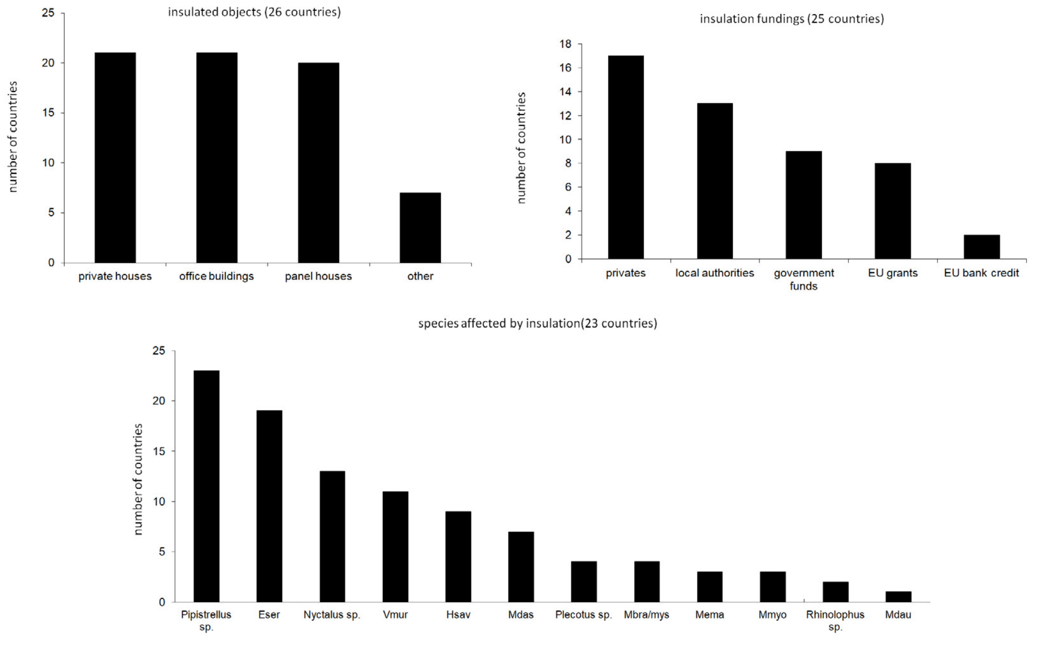


Figure 1. Bats and insulation - results from 31 questionnaires.

Only three countries have developed national guidelines detailing the survey methodology required prior to building insulation. However, seven countries raise awareness using information sheets and booklets or by publishing possible solutions on websites; four countries have held workshops and training sessions relating to bats and insulation. Cooperation among stakeholders (builders, owners, state conservancy organisations) is established in eight countries.

The problem of bats and insulation is widespread and due to the migratory behaviour of several affected species, is also transboundary – the situation in one country can influence the situation in another country. Methods used in insulation are different depending on the type of building, area of building to be insulated and the company involved, that will each have their own approach.

We hope to build understanding of how insulation impacts bats at the European level, suggest solutions and establish co-operation at an international level.

Case study

Bat population and insulation, Czech Republic, Czech Bat Conservation Society (ČESON)

It was noted that there were increasing numbers of bat records in blocks of flats after 1990 in the Czech Republic. This was presumed to be the result of a shift in the roosting strategy of some species and a response to the lack of natural roosts. In the Czech Republic there are almost 200,000 blocks of flats and since the mid 2000s there has been a boom in insulation and reconstruction programmes (about 25% of the houses reconstructed by 2007, almost 40% by 2008). Many of them were supported by EU subsidies. Insulation programmes were carried out without due regard to the presence of bats (and other species – common swifts) and their legal protection (national legislation, Council Directive 92/43/EEC, EUROBATS). This resulted in many roosts being lost and mass mortalities of bats.

Since 2008, a series of projects have been carried out to ensure the protection of bats associated with these habitats.

Project activities:

1. Mapping of bats in housing estates
2. Cooperation with other NGOs and building experts
3. Education – guidance publications and educational workshops
4. Consultancy service
5. Implementation of specific measures at model sites
6. Public awareness and motivation events

In total, six species were recorded: *N. noctula* (78%), *P. pipistrellus, E. serotinus, V. murinus, P. pygmaeus, P. nathusii*. Bats were present in most housing estates with roosting opportunities (positive records at 90% of sites) – this included a range of roost types – nursery colonies, hibernacula, autumn and spring migrations, and often year-round occupancy.

Photo courtesy of ČESON.

2 Bat life strategies and insulation

Due to the loss of natural roosts, bats have adapted to inhabit built structures, and this means that they can sometimes come into conflict with humans. Bats use a network of roosts in buildings as breeding, swarming, hibernation and transient roosts, and are endangered by insulation, renovation and demolition of buildings which can either damage roost structures or prevent access to roosts.

2.1 Life strategies

A suitably qualified bat ecologist should undertake surveys to determine the suitable period for renovation works to be carried out. This will take into account the biology and behaviour of the species that will be impacted.

The typical bat lifecycle (fig. 2) varies across Europe, but has common characteristics:

- hibernation during winter
- migration in spring
- summer colonies of females (maternity colonies) and males in some species (especially noctules and parti-coloured bats)
- migration in autumn and autumn swarming and mating.

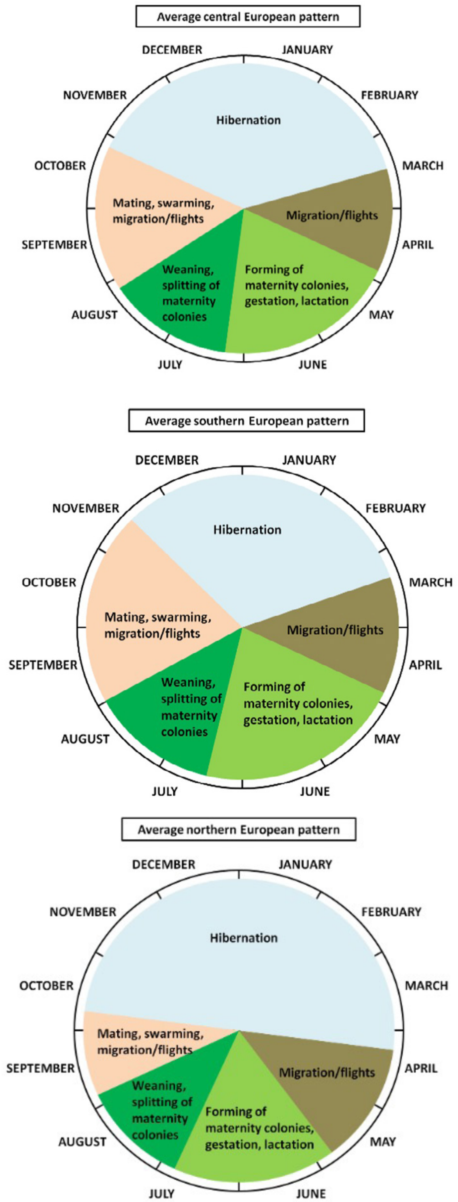


Figure 2. Life cycle of bats living in temperate zones.

2.1.1 Hibernation period (winter)

Insulation work during this period could have critical impacts on thousands of hibernating bats, especially in countries where temperatures reach below zero. Exclusion of bats from crevices or cracks is often impossible. Even large numbers of bats can be easily overlooked during winter hibernation and a visual inspection of deep cavities is not always reliable. This means that bats can be trapped in their roosts, especially when polystyrene beads or fibreglass wall insulation is used. When hibernating bats are discovered during insulation or renovation works, they cannot quickly react and advice/help from an animal rescue centre is necessary. During warmer periods in winter, bats may become more active and appear inside or outside buildings. The same behaviour has also been recorded in some roosts during a sudden decrease in the outdoor temperature. Hibernating bats can be disturbed when residents of a building increase their heating leading to a rise in the temperature inside the roost. In southern countries bats can remain active throughout most of the winter period and insulation works are not so critical as in central and northern Europe. In central Europe, there is also evidence of increased bat activity during mild winters with longer periods of warm weather. Large colonies of noctules, pipistrelles and parti-coloured bats often roost in shafts, ventilation holes, and in crevices and cracks of outer walls, and are therefore especially vulnerable to impact from insulation works when hibernating.

2.1.2 Migration period (spring and autumn)

During migration, bat presence in the roost is erratic and varies greatly between nights; some bat species can use roosts in buildings as a stopover or for swarming in late summer or early autumn. For example, in the course of such a swarming event, hundreds of pipistrelles may enter a roost during the night and stay there for one or more nights. Due to their specific behaviour response to social calls during such invasions, bats can be found trapped or entombed in various spaces inside buildings (Nusova *et al*. 2019, Vlaschenko *et al*. 2019).

2.1.3 Maternity colonies (summer)

The size of a maternity colony depends on the species, region and roost conditions, but there can sometimes be thousands of individual bats. Juvenile bats usually stay inside the roost until they are able to fly. If disturbed, mothers can leave the roost together with juveniles, but may also abandon their juveniles in a roost. Some species with thousands of individuals in a maternity colony (*e.g. Myotis myotis*) are loyal to a specific roost and the destruction of it influences the local population. Some species (*e.g.* pipistrelles) use a network of roosts and form sub-colonies. In this case, destruction of one roost does not have such a devastating effect on the local population, but insulation projects at a large scale can lead to destruction of the whole network of roosts and therefore impact the local population. Male bats can also form colonies during summer (*e.g.* noctules, parti-coloured bats, pipistrelles) or roost on their own in building roosts.

2.2 Types of roosts in buildings that may be affected by insulation

In many countries bat roosts are protected by law, but in some situations the exclusion of bats is allowable. It is likely that special permission or a license will be needed for this. Where this is allowable, advice from suitably qualified bat specialists or organisations will be required, and it will only be possible for certain types of roost and in particular seasons. Presence of bats in the roost can be obvious, but in some cases may go unnoticed – this depends on the season, the number of bats, and the type of roost. Signs of their presence can include droppings under the roost or stuck on facade, odour, noise, dark staining at the roost entrance, and evening or morning activity around the roost. Additionally, some types of roost act as natural traps (*e.g.* narrow vertical shafts). The smallest species of bats (*e.g.* pipistrelles) can squeeze through a fissure 5 mm on wide or 10 mm x10 mm grid.

Examples of roosts in buildings which may be affected by insulation:

Blocks of flats – fissures between panels, ventilation holes, space behind ventilation holes which lead to the space under the roof or into the pantry, ventilation shafts, crevices between layers of insulation and cladding of roof or balcony, crevices under the ledge, construction joints (fig. 3).

Other types of houses – crevices between bricks, crevices caused by mortar dropping out, crevices under the roof, crevices under the lining, any bigger holes (in grilled entrances this depends on the size of grid or presence of gaps due to incorrect installation), crevices under roofing tiles and timber, spaces between roofing tiles and old insulation or wall of built-in attic room (fig. 4).

It is important to emphasise that bats can have a network of roosts in one building which they use during the whole year, moving from one roost to another according to the season. That is why it is very important not only to protect (or appropriately replace) roosts where bats are present, but also all potential roosts, especially those features where bats are known to use similar roosting opportunities in the local area.

Figure 3. Examples of bat roosts in non-insulated blocks of flats (Czech Republic). Photo courtesy of ČESON.

Figure 4. Example of bat roost in typical UK properties. Photo courtesy of BCT/Shirley Thompson.

3 Pre-insulation survey

Ideally, prior to the approval of insulation projects by authorities, a pre-insulation survey should be carried out. Surveys should be carried out by bat specialists equipped with appropriate equipment, for example, ultrasonic bat detectors, endoscopes, thermal imaging equipment, etc. to confirm the presence of bats or presence of roosting signs (*e.g.* droppings, see fig. 5). A pre-insulation survey will ensure that bats are considered at an early stage and therefore reduce the likelihood of conflict between property owners, nature conservation agencies and construction companies. An element of pre-insulation surveys should be the assessment of roost potential in houses that are going to be insulated (presence of suitable holes, crevices, cracks, *etc*. - see section 2.2).

The process for obtaining pre-insulation surveys is different in different countries, but bat presence and the type of roosts present must always be assessed so that the correct techniques and mitigation can be applied if needed.

Ideally, a full survey should be done, covering all seasons. Unfortunately, this is not always feasible given the timing of insulation work and capacity of bat workers in some countries.

Slow and moderate rate of insulation is usually undertaken in complex buildings, where polystyrene or wall-to-wall type of insulation is used. Insulation works take more time and surveys can be undertaken across the whole year or at least in the critical periods for bats. Other types of insulation, *e.g.* fibreglass loft insulation or cavity wall insulation, can be undertaken very quickly and the work often takes only one day. In such cases, only an assessment of bat presence and bat roosts is usually undertaken.

Figure 5. Bat droppings (guano) between panels and on the ground under the bat colony. Photo courtesy of Martin Ceľuch.

3.1 Pre-insulation survey scheme – slow and medium rate of insulation (*e.g.* blocks of flats)

It is essential that all construction works are undertaken at the correct time of the year. A well timed pre-insulation survey and consultation with experts often prevents future complications during construction.

Bats may occupy roosts at different times of the year. No construction works should be carried out when a maternity colony with non-volant juveniles is present (approx. from mid-May till mid-August) or where hibernating bats are present (approx. from early November till late March).

The survey should cover all seasons. In central Europe bats often use roosts in buildings during the whole year and ideally a survey should cover periods of hibernation, migration, and breeding. To do this effectively, it is necessary to carry out repeated surveys. In northern and southern parts, the occurrence of bats in buildings tends to be more seasonal, but some species will still roost in buildings throughout the year.

The survey method is straightforward when undertaken by a suitably trained bat worker, but timing is key. An outline of the survey process is given below.

- Evaluate bat roost potential of a building (presence of holes, crevices, droppings, *etc.*).
- On a calm evening at least half an hour before sunset, the bat surveyor should stand still outside the building, watching for the emergence of bats using bat detectors and/or thermal imaging equipment. More than one surveyor may be needed for larger buildings (see below).
- Results of the survey (presence or absence), and information about the location should be noted on a form.
- Ideally, the survey should be undertaken several times throughout the year: the first survey during the end of hibernation and the start of spring migration, the second and third during the maternity season, the fourth during dispersal of maternity colonies and autumn migration, and the final one in late autumn prior to hibernation.
- The survey should include two inspections in each season. Given that many species can switch roosts, just one survey per season may result in missing their presence in a particular roost.

A surveyor will generally only be able to observe a limited part of a larger building when trying to identify entrance/exit points of maternity colonies or confirm the absence of bats. The surveyors should remain static and observe the features identified in the initial evaluation survey on their section of the building. Transects are not recommended, because smaller bat colonies can emerge inconspicuously and fly directly to a foraging area. Where bats are observed, additional data can be obtained using simple questionnaires given to residents and/or from databases (*e.g.* national records databases, animal rescue centre databases, *etc.*).

There is often not sufficient time to carry out surveys during all seasons listed above, because insulation companies are required to carry out their work quickly. Often there is only time for a single survey to assess bat presence prior to the start of insulation works. When insulation works are due to start in the cold part of the year, this survey may not be representative due to limited or no bat activity. Other techniques such as using endoscopes and close inspection of identified features from elevated access equipment should be used to gather as much information as possible, to assess the risk of bats being present and therefore potentially harmed by works. If the legislation of the country does not require a pre-insulation survey and the companies insist on continuing without a survey, the only option is to install passageway bat boxes which at least avoid possible entrapment of bats in a roost (see Chapter 4).

Case studies

Pre-insulation survey of three blocks of flats in Praha-Ruzyně by ČESON (Czech Bat Conservation Society)

2011 – an inhabitant reported the presence of noctules *Nyctalus noctula*.

2011 – 2012 pre-insulation surveys were undertaken: in the post hibernation period, in lactation period, in autumn migration period and in the period before hibernation. These were carried out using time-expansion bat detectors. The surveys started 30 minutes prior to sunset and finished at least 60 minutes after sunset on most days, so that observers could observe each wall. In all three blocks of flats, bat roosts were found in crevices between blocks on different floors. These roosts were occupied during all seasons. Roosts of noctules, pipistrelles and serotines were discovered. Nesting activity of swifts was also confirmed. The results were provided to the municipal authority, property owner and custodian.

2013 – 2014 the insulation project started. A meeting between the owner, the architect, the municipal planning authority and a member of ČESON, was organised to discuss the necessary mitigation measures before the statutory permission was granted.

The implementation phase took place in 2014 – 2016, with ČESON appointed to supervise the works.

2015 – 2016 post-construction surveys of the buildings were undertaken and noctules were observed using bat boxes set in the insulation layer as a mitigation measure.

Bats flying around the original roost (left). Bat boxes installed at the site of original roost. Under the roof boxes for swifts were also added (right).

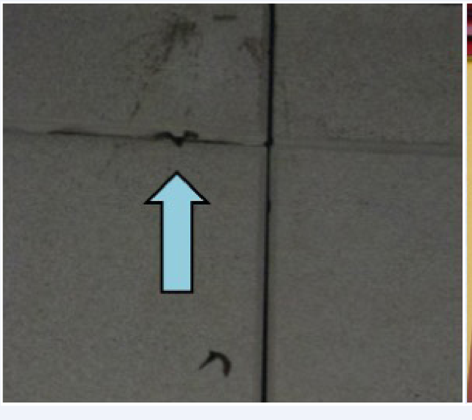


Photo courtesy of ČESON.

Pre-insulation survey, Slovakia, SON (Slovak Bat Conservation Society)

Most blocks of flats are surveyed in the planning phase. Because of costs and lack of bat worker capacity, only one visit is made in a critical period. It is important to have an experienced surveyor, who can find bat roosts or predict the likely presence of bats based on their experience of similar buildings. Endoscopes and binoculars are used to look for signs around potential roosts (*e.g.* staining at holes or crevices, guano on windows or window-sills). The surveyor also surveys the ground around the building and looks for guano or dead animals. Surveys from any flat roofs are undertaken, as well as surveys of ventilation shafts, ventilation holes and crevices under metal sheeting. When a colony of bats is confirmed, a detailed check from scaffolding is undertaken shortly prior to the start of the insulation works. Appropriate compensation measures are included in the project, usually bat boxes placed in walls without windows.

Occupied bat roost in the ventilation holes can be identified by guano.
Photo courtesy of Martin Ceľuch (SON).

4 Methods used in building insulation, main risks, technical solutions and mitigation

A bat population needs sufficient roosting opportunities close to good foraging grounds. A town or part of a city can be usually regarded as a colony's critical roosting area, and this is an important consideration for planning insulation schemes. A policy that requires sufficient roosts of sufficient quality to be provided, regardless of the type of building to be insulated, will be beneficial for bats and will not delay insulation works.

There are several different materials and methods that can be used for insulation. The method chosen will depend on the type of building and the insulation company. However, there are some basic principles that should be followed for all insulation works. All work should be undertaken before winter, as it can be hard to locate hibernacula of some species. All work should be undertaken when bats are not inside the roost to prevent injury or mortality to bats.

- Avoid working during the most 'vulnerable' periods: the maternity season and winter.
- Any modifications should maintain the quality and conditions of the roost.
- The primary purpose is to maintain the existing roosts with conditions as close to the original as possible, so that bats can continue to use the roosts after the building renovation (*e.g.* by installing 'passageway bat boxes') or even during work.
- Sometimes it is not possible to keep the roost for technical reasons, or to time the works when bats are not present in the roost (*e.g.* if a subsidy deadline has to be met). In this situation, one way exclusion devices can be put in place prior to the start of the work so bats can leave the roost but are not able to return. This process must be supervised by a suitably experienced ecologist. This is not an appropriate method where non-volant juveniles are present as they will not be able to leave the roost and the mothers will be prevented from returning, or for use during hibernation time.
- Damage to or loss of the roost should be compensated by appropriate mitigation measures guided by a suitably experienced ecologist.

4.1 Polystyrene or fibreglass boards

Where legislation and construction rules allow, polystyrene boards are used in many countries for insulation. A cheaper option is plugging of all gaps with spray foam. In older blocks of flats bats (mainly noctules, parti-coloured bats, serotines and pipistrelles) roost in a variety of different places within the building: for example, the space behind ventilation holes which lead to the space under the roof or into the pantry; fissures between panels, crevice between layers of insulation and cladding of roof and balcony; construction joints, *etc*. In many cases, bats have been found to use these roosts throughout the whole year. The size of these bat colonies can reach several hundred or even thousands of individuals.

4.1.1 Main threats to bats

Using this technique runs the risk of blocking all entrances to the roost, resulting in the bats becoming entombed inside the roost. Entrapment of bats when using polystyrene blocks can sometimes be discovered by observing unusual bat behaviour, for example, repeated landing at the freshly closed entrance trying to get in, probably responding to bat social calls. It is also possible that hibernating bats or a maternity colony will be uncovered when parts of the roof are removed at the beginning of the work. There is not only a risk of individual bats being harmed or killed during insulation works, but also that the whole roost will be under threat. The use of insulation using polystyrene or fibreglass blocks is increasing significantly across Europe (fig. 6).

Figure 6. Left: hundreds of bats entombed during renovation and insulation works. Right: winter colony discovered during insulation was put in buckets by construction workers and left to die. Photo courtesy of ČESON and ZO ČSOP Nyctalus.

4.1.2 Technical solution

The most important consideration is the correct timing of installing insulation, considering the presence of bats and any potential bat roosts identified during pre-insulation survey. The lifecycle of bats must be considered. The priority is to retain the bat roost. Ideally the roost should remain intact or as close to its original state as possible. If this is not achievable, the negative impact on the bat colony should be mitigated. Solutions for mitigating negative impact on the bats and their roosts during insulation with polystyrene boards are relatively easy and cheap to implement. However, the methods will always depend on the specific situation and should be discussed with a bat expert to ensure that internal roost conditions such as temperature and humidity remain the same.

Crevice roosts

Crevice roosts include gaps between concrete slabs, crevices behind insulation and cladding of the roof and balcony, construction joints, etc. These crevice bat roosts are often sealed by polystyrene blocks during insulation projects.

If it is technically possible to save the roost, it is recommended that a special 'passageway' bat box is installed to act as an access point for the bats; this has entrances on both sides and enables bats to enter the original roost after insulation. There are several types of woodcrete bat boxes or polystyrene bat boxes. They are usually 8–12 cm wide and can be very easily integrated into the insulation layer. In some cases, it is necessary to underlay or cover them (ensuring that gaps are left uncovered) with insulation material to fit the smooth surface of the facade. The method of fixing them depends on the type of bat boxes; they can be glued in the same way as polystyrene blocks or they can be secured using metal plates and screws. The surface of boxes should be covered by gauze fabric and can be painted the same colour as the rest of the facade. Once the works are completed, only the entrance of the roost is visible. These types of transit bat 'access brick' boxes are used successfully in Germany, Czech Republic and Slovak Republic (fig. 7).

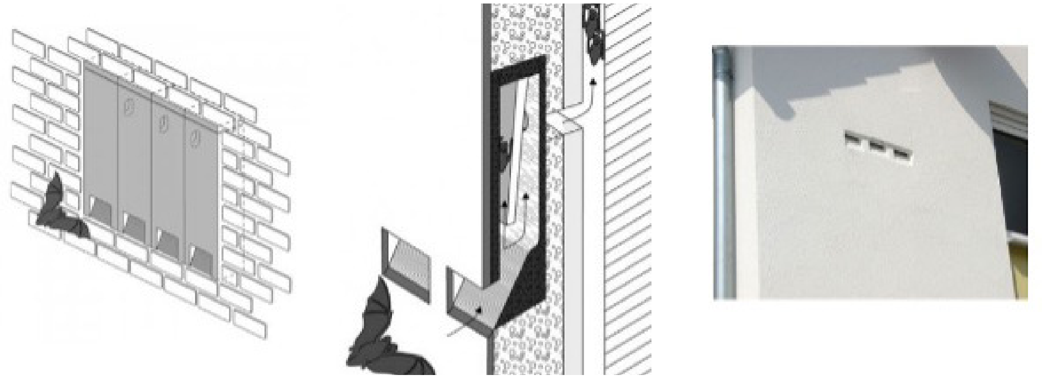


Figure 7. Installation of bat boxes, which retain the original roost after insulation. However, it should be noted that for large colonies, bat guano can accumulate in the original roost behind the insulation layer. Photo courtesy of SCHWEGLER.

If it is technically not possible to retain the roost, it is necessary to ensure that all bats leave the roost prior to blocking the entrance. This method cannot be used during the maternity season when juveniles are still present, or in the hibernation period. At least a week prior to works, a square **'exclusion flap'** made from a soft wire grid (mesh no bigger than 0.5 mm) should be placed over the entrance and fixed only at the top (fig. 8). It is also possible to use a square made from a firmer plastic. Three sides of the square remain free but should not stand away from the wall. This one-way enclosure made correctly enables bats to fly out of the roost but they cannot return. The rough facade enables bats to land on it and crawl under the mesh. It is possible when using this technique to first install sheets of hard smooth plastic around the roost and then the exclusion flap. Installing metal or plastic tubes is a more effective method where this is possible. A metal or plastic tube (length approx. 20 cm, diameter just over 4 cm but not much bigger, depending on the bat species) is fastened to the roost entrance and angled downwards. The slope, diameter and smooth surface of these tubes prevent the bats from returning. It is important to ensure that bats do not enter the roost via different entrances, *e.g.* in long fissures. The one-way enclosure should not be left there for a long time (more than a month), because wear and tear from the weather can result in reduced efficacy. Loss of the roost should be compensated by placing bat boxes close to the former roost (see section 4.6).

Figure 8. Exclusion flap allows bats to leave the roost but prevents their return. The flap is fixed at the top and it must closely cover the whole entrance and not stand away from the wall. A sloping plastic tube with at least 4 cm in diameter could be used instead of exclusion flap. The plastic cover around the tube prevents entry by bats or swifts. Photo courtesy of ČESON and Martin Ceľuch.

Cavern roosts behind ventilation holes
Bats can use cavities behind ventilation holes which lead directly to the pantry or larder in flats, or caverns which function as an extraction system of roof spaces. In these cases, to ensure bats don't become trapped in living areas, it may be necessary to use an exclusion flap as described in the previous section (fig. 8). All mitigation measures (see below) should be in place before the original roost is lost.

When bats use spaces under the roof spaces, there are three possible options:

a) the insulation plan includes only insulation of the walls of the building and not the roof. In this case it is necessary to keep all ventilation holes open. During insulation, holes must not be covered by insulation even for a short time. Circular openings in insulation are usually fitted with plastic covers to prevent rain and water coming in, but they often contain grids or horizontal plates. Where this is the case, the plastic covers must be modified to allow bats to enter the roost (*e.g.* remove the horizontal slats). The lower edge should be rasped to ensure it is sufficiently rough for bats to land and hold on. Another option could be to place a plastic tube that has a diagonal cut at the end (so the upper part forms a 'roof') at the end of the vent plastic tube. The inner part of this plastic tube must also be rasped to help bats crawl in and out. The diameter should be at least 6 cm to be suitable also for swifts, which use similar roosts and would get stuck in smaller tubes. Rectangular horizontal openings should be fitted with a 'roof' made from a metal plate fixed on the wall before the insulation material is laid. A rough plastic plate should be fixed to the lower edge of the opening. A similar approach should be taken with rectangular vertical plates. The surface of the inner part of the metal plate should also be rough, *e.g.* by spreading the layer of construction glue on the metal plate and ensuring that it has dried before the bats return (fig. 9, 10).

b) the insulation plan includes insulation of both the walls and the roof, or insulation of the roof but where the roof remains ventilated. In this case the roof is removed and rebuilt, but the ventilation holes and crevices are kept. It is crucial that work is carried out at the correct time of the year: the work must not be undertaken during the hibernation or breeding seasons, because during the work, cavities are uncovered. Other methods are similar to the previous section.

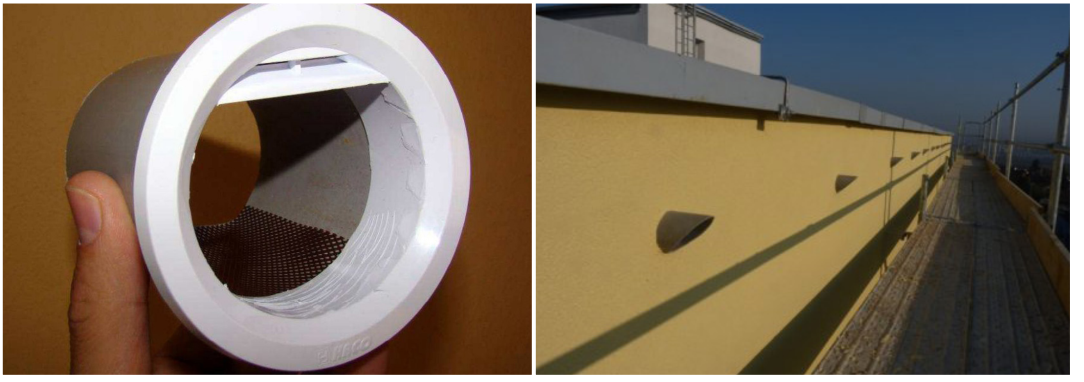


Figure 9. Covers of ventilation holes modified for bats and swifts. The minimum diameter is 6 cm. Photo courtesy of Martin Ceľuch and Lukáš Viktora.

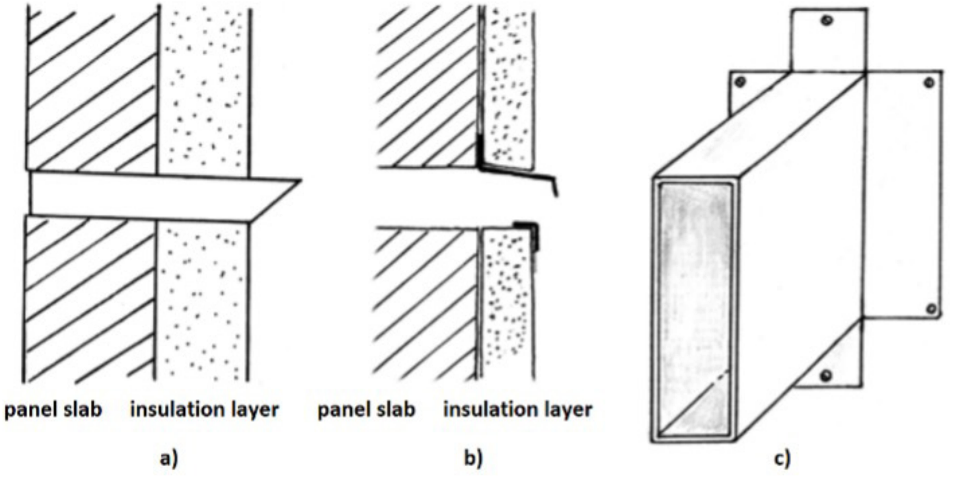


Figure 10. Variants of other methods enabling bats to use original roost a) circular openings and installation of plastic tubes, b) rectangular openings and metal roof, d) rectangular openings and metal plates. All surfaces used by bats should be roughened.

c) the insulation plan includes the insulation and reconstruction of the roof, which will change from a ventilated to an insulated roof. In this case all cavities are filled with insulation material. Works must be timed appropriately as per the previous examples, and before work is started, it must be confirmed that all bats have left the roost. The one-way exclusion method described above is used in this case. The loss of the roost needs to be compensated for by placing bat boxes close to the previous roost (see section 4.6). It is also possible to install bat boxes inside the roof wrapped in insulation material which leads to a ventilation hole, or to create new artificial cavities in the panel. These methods can only be applied in some cases, and specialist advice should be sought as works are being designed and taking place. Artificial cavities should generally be at least 30 x 15 x 15 cm with an entrance 4 x 7 cm, but the size should be adjusted according to the nature of a specific building (fig. 11)

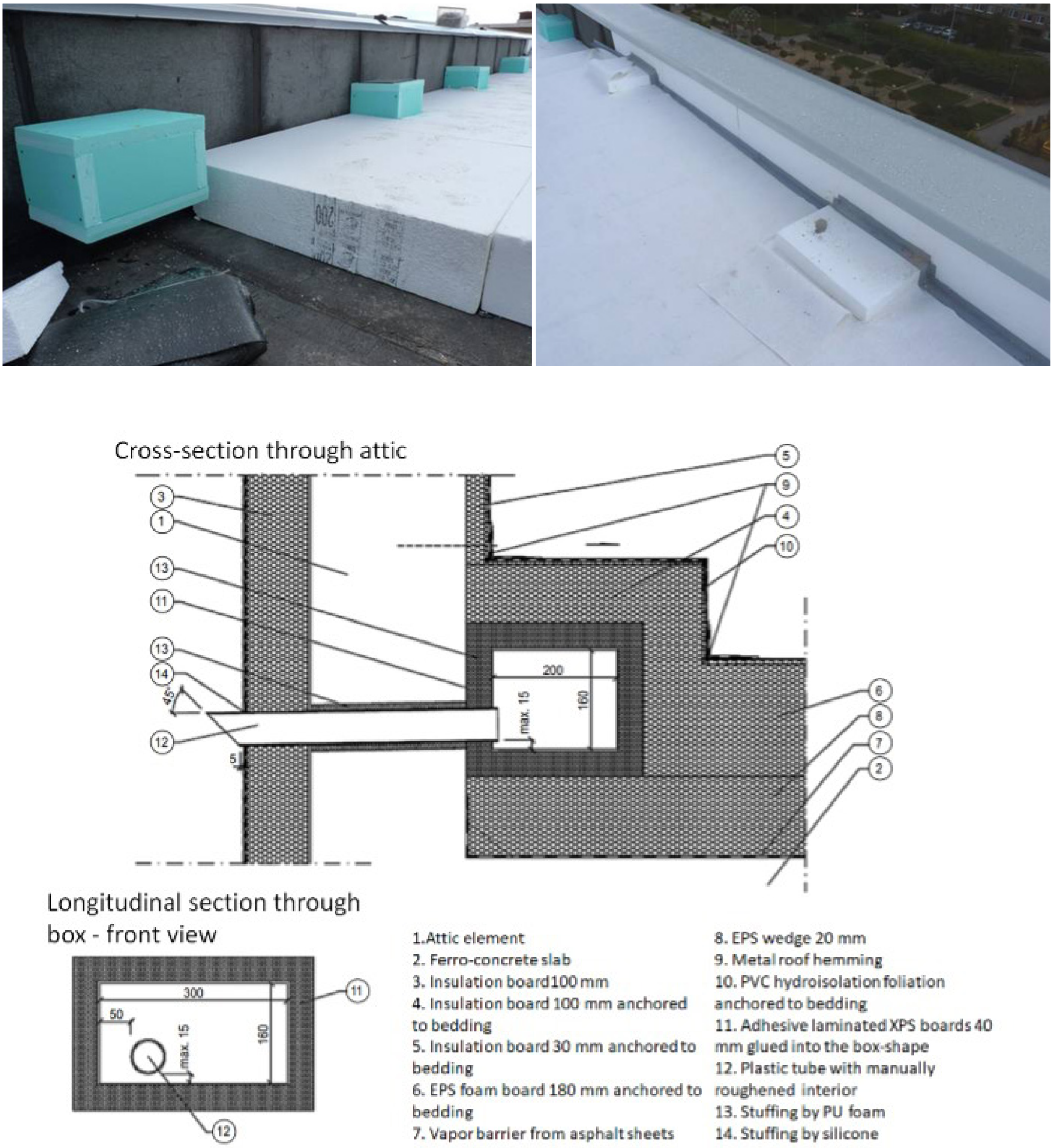


Figure 11. Insulation and reconstruction of the roof. The roof was changed from a ventilated to an insulated roof, which led to destruction of all cavities. One possibility is to make artificial cavities. Photo courtesy of Lukáš Viktora and Ivan Řehoř.

Case studies

Insulation of three blocks of flats and associated mitigation measures, Praha-Ruzyně, Czech Republic, solved by ČESON (Czech Bat Conservation Society)

After a pre-insulation survey, which revealed several noctule roosts, as well as pipistrelle, serotine and swift roosts in crevices between panels, there was a meeting between the owner, architect, municipal authority and ČESON. At the meeting the correct procedure was agreed, and statutory permission was then given to carry out the insulation works. The conditions outlined in the permission were as follows:

1. Construction works involving insulation must not be done between 15.10. and 31.3. and cannot start when bat maternity colonies and swift nests are in place, from 20.4. until 10.8.
2. Once the scaffolding had been erected, all crevices were inspected by members of ČESON (visually and with an endoscopic camera) and all possible roosts were marked with spray. One-way exclusion flaps were installed at these locations. The rest of the crevices were filled to prevent bats moving to different sites. The flaps were there for five nights. Following this, a check was undertaken by members of ČESON to confirm the roost was empty and the crevices were then filled. These works were scheduled to allow bats to use alternative roosts in another house.
3. As a mitigation measure bat boxes (woodcrete and polystyrene) were added to the insulation layer. The passageway boxes were not allowed by the architect. The three houses had 14, 13 and 15 bat boxes installed respectively. The location of bat boxes was decided based on the previous survey and with the agreement of the architect (to be as close as possible to the previous roost, but not under the windows of the individual flats).
4. Swift boxes were also added (16 in each house) on the elevator shafts along the edge of the houses.
5. ČESON supervised all construction works involving any insulation that was close to bat or swift roosts.

During and after construction, a survey was undertaken to establish the presence of bats in the new bat boxes (four surveys per year). The bats used the newly installed bat boxes in all three houses during the whole year. In the last house they started to use the bat boxes just after the works were completed and the scaffolding had been removed.

Photo courtesy of ČESON.

Insulation of a typical block of flats and associated mitigation measures in Prešov city, Slovak Republic. Resolved by members of SON (Slovak Bat Conservation Society)

During the official project phase, a survey of protected species (birds and bats) was undertaken. The building had 354 round attic openings and several hundreds of metres of crevices between panels. Openings and crevices were used by 100–130 breeding pairs of common swifts, house sparrows and several hundred common noctules. Bats were typically present from autumn to spring with most animals present in the winter during hibernation. One such building can offer hibernation roosts for hundreds or even thousands of noctules.

As the building was so large, insulation works took several months, from March till September 2014.

The attic with active nests of swifts was kept open until the last nestlings left. Nests in the crevices were located by inspection from the scaffolding, marked and free space around them was left. It was not possible to keep the attic openings or crevices between the panel open, because there would be high thermal loss. The nest and roosting spaces for birds and bats were replaced by XPS polystyrene boxes type BAT-MAN APUS-4 and BAT-MAN APUS-3. In total, 112 nest boxes were installed on three walls for swifts and sparrows. For the noctules eight double chamber boxes of type BAT-MAN Maxi-B were installed.

Most of the boxes were installed on side walls without windows, to reduce any negative impact from noise or falling bat guano. There are big concentrations of noctules in these buildings and their noise and guano can be an issue for people.

Boxes were used by bats in the winter following insulation, and the following summer by the first breeding pairs of swifts. Swifts usually take longer to adapt to new boxes than noctules. Hundreds of similar buildings were insulated in a similar way in the Slovak Republic and similar mitigation measures were implemented successfully.




Photo courtesy of SON.

4.2 'Wall on wall' insulation = Zero-on-the-counter

'Zero-on-the-counter' or 'rapid' is an insulation scheme where the cost of insulating is paid for by the reduction of the energy use. It comprises placing a completely new outer wall over the original outer wall. The new walls are created in a factory and are placed in situ in a quick process. A street of ten buildings can be completed using this method in two weeks. This kind of insulation is targeting rental houses that are poorly insulated. These buildings typically hold many bat roosts (crevice-type). The 'rapid' process also involves other technical installations, and it is regarded as an industrial process, with quick turnover times and prefabricated solutions. Full pre-insulation surveys are not done, but the presence of bat roosts of certain species is assumed.

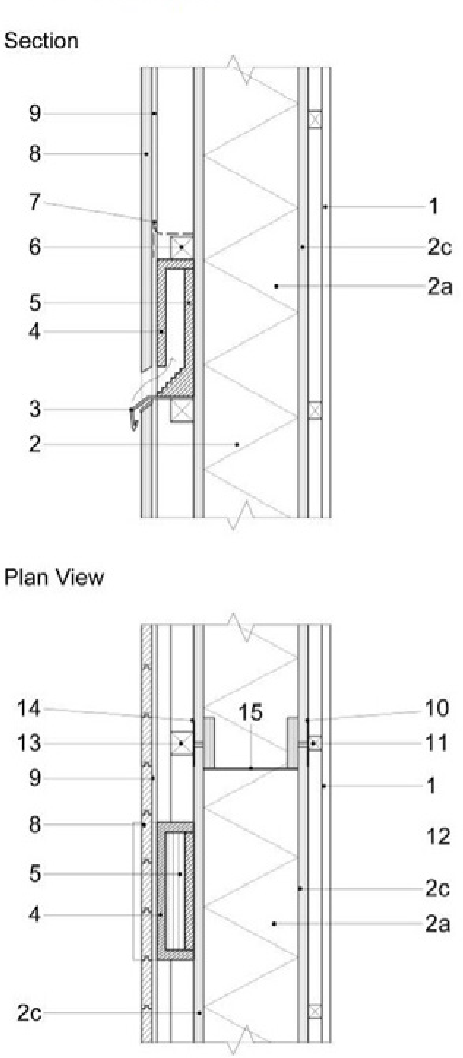
4.2.1 Main threats to bats

Original roosts are either destroyed or made inaccessible. When bats are present during the operations, they might be trapped or physically harmed. As it is done on a large scale and per block or street, the local and regional impact is high. The mitigation and compensation measures outlined below might work for common pipistrelle, but not for many other house-dwelling species such as serotine, pond bat, soprano pipistrelle, and in some areas, whiskered bat and Geoffroy's bat.

Additionally, as some birds use houses as nesting places, measures are also taken to prevent damage from birds. However, these measures might harm bats (*e.g.* putting nets up to prevent birds from using potential nesting places).

4.2.2 Technical solution

The current solution is to place a built-in bat box in the newly installed outer walls and leave small spaces in the facade to access the bat box. Work in the most vulnerable periods (maternity season and winter) is only undertaken when there is certainty that hibernacula or maternity roosts are not present. If work has to be undertaken in these two periods, prior to starting work, measures must be taken to prevent bats from using the roosts and to remove bats from roosts, under licence where applicable and under supervision of a bat specialist. Measures that could be considered are opening the original outer wall to expose the wall cavity to create an unfavourable climate for the bats. Exclusion flaps and/or filling gaps are also sometimes used, but only when non-volant juveniles are not present. The bat box installation should be discussed with the ecologist and architect involved with project (fig. 12).



1 Drylining gypsum plasterboard, 12.5 mm and 2 mm skim or flush taped and filled joints
2 Structural insulated panel
2a Non-renewable, foamed plastics insulation or laminated assembly with adhesive”
2c FSC OSB or other timber panel, both sides
3 Pressed metal drip or durable FSC hardwood sloping top and drip profile bottom, use stainless steel if acidic timber species cladding or framing
4 ‘Schwegler Bat Box 1FE 00747/6’, wood-concrete, 300 × 300 x 80 mm locate towards eaves
5 Cement-wood particle board, 12 mm roughened surface for climbing/hanging
6 Reclaimed, locally grown or FSC temperate softwood noggins, 50 x 50 mm
7 Insect resistant mesh/pertorated metall
8 Durable species hardwood or softwood UKWAS or FSC timber (avoiding preservatives) vertical weatherboarding
9 Durable species hardwood or softwood UKWAS or FSC timber (avoiding preservatives) weatherboarding battens
10 ‘Pro clima Rapidcell’ airtight jointing tape to joints
11 Reclaimed, locally grown or FSC temperate softwood pressure batten (internal), 50 x 50 mm to secure airtight seal (10 above)
12 Note, do not try to make airtight with sealant gun afterwards: little hope, unless bottomless funds and open-ended programme
13 Reclaimed, locally grown or FSC temperate softwood durable species, pressure batten, 50 x 50 mm to | secure wind-tight seal (14 below)
14 ‘Pro clima Tescon No.1’ wind-tightness tape to joints
15 SIPS panel abutment interlocking joint, with continuous runs of adhesive/sealant to achieve airtightness, or ATL & WTL strips and pressure battens inside and out.

Figure 12. Technical drawing of an integrated bat box, incorporated into the insulation layers during rapid insulation to take mitigation measures (after Gunnel et al. 2013).

4.3 Cavity wall insulation

Bats are known to roost in cavity walls during all seasons. The degree of importance for any one species in each season is difficult to discern due to the inaccessibility of the structure. A concern about the carbon footprint of housing stock has led to an emphasis on having cavity walls insulated. Cavity wall insulation is often undertaken on existing homes, as well as those that are being constructed (fig. 13).

This is often a quick process carried out by private households; however, an assessment must still take place to consider any use by bats of the cavity wall, and the works must be undertaken at a suitable time of the year and using methods that will minimise impact to bats (see below). Even if bats are thought not to use the cavity wall, contractors should be informed that bats may be found and the methods below used to ensure that bats can escape if they are present within the wall. As a precautionary measure prior to insulating the wall, contractors should closely examine all parts of the wall to be filled and listen for bats. If any evidence of bats is found, i.e. droppings or urine stains around a hole leading into the cavity wall, work should not be completed in this wall until further advice has been sought. Due to the rapid process which is often carried out on a large scale, many bat roosts or potential bat roosts are destroyed and appropriate mitigation measures should always be suggested.

Types of injectable insulation:

- Blown mineral wool (glass or rock wool). It consists of mechanically granulated spun glass or rock wool, treated with a binder or water repellent during manufacture.
- UF Foam. Urea Formaldehyde Foam is injected into the cavity in a wet foam state 90–95% pre-expanded through 19 mm holes. It completes its expansion by moulding itself to unusual shapes within the cavity and sets to form a rigid insulant.
- EPS beads. The expanded polystyrene beads used for cavity wall insulation are in the form of virgin pre-formed beads which are usually combined with a binding agent or adhesive at the time of injection. Polystyrene beads are produced to a specified size and density which remains unaltered during the installation process.

Figure 13. Example of filling up cavity wall and a bat victim of polyurethan (PUR).

4.3.1 Main threats to bats

The micro-beads, fibre glass or foam can physically trap bats and also block the roost entrance / exit points, entombing bats within the cavity wall and resulting in the destruction of the roost. This is a particular issue during the hibernation period as bats cannot react in time to escape and during the summer maternity period as babies may get left behind.

4.3.2 Technical solution

To avoid entombing bats in cavity walls it is advised that works are undertaken only when outside temperatures are 10°C or above and that insulation should start from the bottom of the cavity wall and work upwards, thus giving any bats still remaining in the wall a chance to wake and escape. If the roof void is left as a cold space then the insulation fill stops at the eaves line and a gap at the top of the cavity wall is naturally left for bats. If any evidence of bats using the cavity walls is found, then expert advice must be sought on the best way to retain a roosting site and ensure the building is insulated properly. Often, external bat boxes are used in such cases.

Expanded Polystyrene (EPS) beads allow this to be done through the filling process and machinery monitoring the fill levels in the wall. In the UK, this may only be undertaken with EPS blown-in since use of an alternative material is unlikely to be given a guarantee by the insulation contractor (fig. 14). The BBA (British Board of Agrément) permits partial filling of the gable apex (*i.e.* limiting the fill to several brickwork courses above ceiling level) provided the top of the wall is protected by the roof and the roof void is not an occupied space and where the loft insulation is at ceiling level.

However the method must always be checked with the installer to see if it is appropriate; it may be that the type of filling, wall in question or building construction means that this is not possible.

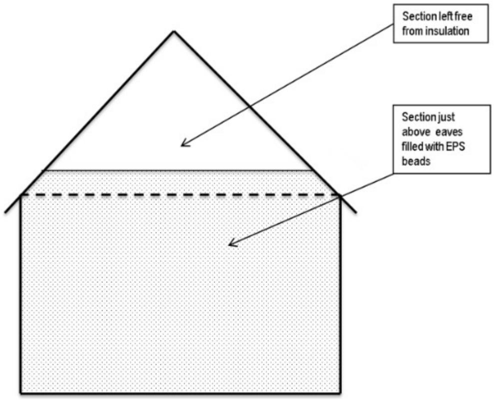


Figure 14. Retaining a section free from insulating material. Picture courtesy of BCT.

Case study

Estimation of number of cavity wall insulated houses, Netherlands

Stimulated by a government programme to reduce energy consumption, private households are insulating their cavity walls. Cavity walls are filled with pellets, mineral wool or PUR. Typically, walls are filled up in half a day. The cost is low, less than 1,000 EUR.

Based on `Feiten en Fabels na-isoleren van spouwmuren. Milieu Centraal, 2015` several tens of thousands of houses are being insulated.

Number of houses insulated via cavity wall filling in the Netherlands

Year	Number of houses (estimation)
2010	20,000
2011	50,000
2012	40,000
2013	45,000

4.4 Other types of roof and wall insulation

4.4.1 Fibreglass loft insulation

Bats are threatened by entombing. This type of insulation is used mainly for roof insulation. The sheets of this material are usually laid on the floor of the attic or on the sides. The addition of insulation on the underside of the roof may entomb bats by blocking entrance and exit holes into the roof void. Additionally, if bats are present, they can be disturbed by workers accessing the roosting site in the loft. If the roost is retained, there will be a change in the conditions (for example, temperature, humidity) which may mean the roost is no longer suitable for the original species.

For ensuring safe bat roost preservation during insulation work, these are the key points:

1. **Pre-Work Inspection**: A qualified ecologist should inspect the roof void prior to starting any work to locate access points and confirm the absence of bats during the process.
2. **Retain Access Points**: Keep bat entry points to roosts intact when adding insulation.
3. **Insulation Adjustment**: Trim insulation back at least 10 cm from the eaves to preserve ventilation, or insulate only the loft floor, leaving the roof as a cold space.
4. **Provide Alternative Clinging Surfaces**: Bats need materials like rough sawn timbers at the ridge to cling onto once they return after insulation installation.

This approach protects bat habitats while maintaining building insulation efficiency. It is important to make sure that bats have other types of material to cling onto when they return after the insulation has been added *e.g.* rough sawn timbers at the ridge.

Case study

Fibreglass loft insulation, Romania

Bats have been observed roosting in fibreglass insulation in Romania in multiple situations. A team of bat researchers and rehabilitators from the Visul Luanei Wildlife Rescue and Rehabilitation Centre and Wilderness Research and Conservation Association from Bucharest is usually called in to mitigate human-bat interactions. Bats often find shelter in the residential buildings, built in the communist era, which are made of concrete slabs that offer generous spaces for bat roosts. However, in the city suburbs or in rural areas, where optimal summer roosts are not abundant, the animals can choose sub-optimal roosts, such as fibreglass insulation.

Several species have been observed roosting and raising pups in such roosts, for example, *Pipistrellus pipistrellus, P. kuhlii, P. pygmaeus*. In some cases, even hibernation roosts have been found in such insulation, containing *Nyctalus noctula, N. leisleri* or isolated individuals of *Eptesicus serotinus*.

Where house renovations have meant that bats needed to be relocated, in the case of some hibernation colonies, the animals were brought to the wildlife centre and put into artificial hibernation. Before this, a medical screening of the colony was performed, and veterinarians observed small cuts on the patagium and the fur littered with small pieces of fibreglass. Such roosts are potentially dangerous to bats. The fine particles which are generated when they move in the fiberglass can be inhaled and cause serious damage.

Bats usually roost in places where fibreglass has not been correctly installed or where it has been compacted by repairs to the house, forming small spaces in which sections of the colonies can roost. They access the pockets from the exterior, where the insulation is not properly installed, i.e. with small openings, and usually move in the fibreglass through the joints of two insulation layers, where material tends to be thinner or entirely absent. In these cases, the best option is to use plastic flaps in order to exclude the bats from the roosts, but only outside of the maternity or hibernation periods. Multiple hibernation and summer roosting artificial bat roosts (woodcrete) should be placed near the openings of the old roost, to offer alternative solutions for the bats which will return.

4.4.2 Spray foam insulation

This method is used as a replacement for fibre glass loft insulation in the UK. This insulation foam solidifies when sprayed directly to the inside of the roof therefore completely sealing it from the outside. The spray foam is prepared using two liquid components mixed within the nozzle of a spray gun during the spraying process. It is applied to various substrates and built up in layers not exceeding 20 mm in thickness.

Bats are threatened by entombing. The spray on foam insulation may entomb bats themselves or by blocking entrance and exit holes into the roof void. Additionally, bats that are present can be disturbed by accessing the roosting site in the loft. The foam and fumes may be toxic to bats. If the roost is retained, there could be a change in conditions (such as temperature) that would make it unsuitable for the original species.

The roof void should be inspected by a suitably qualified ecologist prior to work taking place, to ensure access points are located and there are no bats around when the work is being done. When installing insulation it is important to retain the bat access points to the roost. It is advised to pare back the insulation a minimum of 10 cm from the eaves (this also helps to maintain building ventilation). This may be difficult with the way spray foam insulation is applied. If not viable, then a different method should be used.

It should be noted that in the UK, this insulation method has been highlighted as trapping moisture against the wooden roof timbers and advice has been provided for surveyors to alert householders to the problem to get the foam removed; this impacts the availability of finances such as mortgages being available for these properties.

4.4.3 Sheep's wool insulation

This method is being used in modern eco-homes as a sustainable natural roofing and wall insulation material. It is not yet known how widespread this practice is in Europe

Bats are threatened by entanglement. The wool strands become loose and become tangled around a bat's feet and wings, resulting in bats becoming immobilised and eventually dying (fig. 15). Bats present can also be disturbed by accessing the roosting site in the loft.

The roof void should be inspected by a suitably qualified ecologist prior to works taking place, to ensure no access points are blocked and no bats are around when the work is being done. Sheep's wool could be packaged loosely in some sort of pillowcase to stop the spreading at the eaves and the bats coming into contact with this. Disturbance to the roost should be avoided by working when bats are not present and any wool should be covered by fabric with entrances and exits remaining clear of material to retain access. No material should block roosting areas at roof apex or on roof surface; these should be retained or reinstated with the addition of rough wooden boards.

Figure 15. Sheep's wool insulation wrapped around a serotine pup. There were a total of three deceased pups tangled in the insulation fibres. The roost is monitored each summer and the max. count is around 25–30 bats; in winter the roost is cleaned to minimise the droppings for the roost owner and gives an opportunity to check there are no further issues with the insulation. The insulation is now covered with dust sheets to prevent bats getting tangled and there have not been any further problems since doing this (Credit – Pers.com. Sally-Anne Hurry, Mountfield Ecology).

4.5 Non-bitumen coated roofing membranes (NBCRMs)

NBCRMs are installed in many buildings. The breathable versions (BRMs) allow the roof to breathe so that less traditional ventilation is required, and the non-breathable versions are lighter and easier to manage than traditional bitumen, and so are preferred. However, bitumen is still fine to use with adequate ventilation. Research (Waring 2014) showed that at the time of this study all non-bitumen coated roofing membranes, produced using spun-bond filaments, pose a serious threat to bats as a result of entanglement. In addition, the functionality of the membranes was studied when coming into contact with bat urine; this was shown to degrade it.

4.5.1 Main threats for bats

Bat claws tease spun-bond filaments loose from the surface of non-woven membranes forming a 'fluffed up' appearance on the surface. These loose filaments can become entangled around a bat's feet and wings, resulting in bats becoming immobilised and eventually dying. This risk of entanglement extends to all NBCRMs currently on the market that have not been certified as passing entanglement testing as per the peer reviewed published independent testing methodology (Essah *et al*. 2020). There are also modern types of bitumen felt that contain polypropylene filaments (for example type 5U). These membranes, despite being called bitumen, still pose a risk of entanglement to bats.

Findings from the research indicate that the functionality and longevity of the membranes can be affected in those parts altered by the presence of bats. The research also found that the microclimatic conditions of the roof voids varied between different types of membranes.

4.5.2 Technical solution

Any roofing underlay that has been independently tested and passed the required entanglement test (Essah *et al*. 2020) for NBCRMs should then be individually assessed by the relevant countries statutory nature conservation organisation (SNCO) to ensure it is otherwise appropriate for use in buildings where bats are present.

Bitumen 1F felt that is a non-woven short fibred construction does not need to be subjected to entanglement testing or be assessed by the SNCOs for its safety for use in bat roosts.

4.6 Roost compensation – commercial bat boxes

Roost compensation for insulation is usually undertaken by placing suitable bat boxes on/in the building. There are many types of bat boxes and their use and placement need to be discussed and agreed with the architect and/or the owner of the house. They can be either almost invisible or they can be used as an interesting feature of the insulated building, for example, if they are painted with bat motifs. However, advice from a bat specialist is needed ahead of installation to ensure that the correct type of box is used, considering the specific species and the roost type, *e.g.* maternity, hibernation, all year, *etc.* It is also important that the specialist checks that installation has been done correctly and placed at a suitable location on the building (*e.g.* avoiding placing bat boxes just above the windows of flats). It is also possible to suggest to owners of insulated new homes that they could install decorative, but functional bat boxes to balance the loss of roosts.

4.6.1 Preconditions and recommendations for installing new bat boxes

The design, temperature and size of the boxes needed differ according to the species and the requirements (*e.g.* seasonal bat boxes, whole-year bat boxes). The correct temperature and humidity inside the bat box are a precondition to them being used as effective compensation; they should suit both the bats and the insulation requirements. When bat boxes are used as roost compensation for roosts affected by insulation, the measurements should be taken by the company installing the insulation, and the conditions (and therefore likely effectiveness) of the bat box should be based on evidence; their thermal characteristics should be tested if possible. The ideal scenario is to place a ‘passageway bat box’ at the entrance of the original roost. These boxes are used when the original roost can be retained or where there is another cavity that can be used by the bats instead of their original roost. Bats crawl through the passageway bat box to the original cavity or they can roost in the new box. One issue with these boxes is that after several years, if there is a large colony, a large amount of bat guano can accumulate.

Sometimes this option is not possible, and bat boxes have to be placed as close as possible to the original roost. The probability of bats accepting the new bat box decreases the further away it is from the original roost (for noctules even 50 cm can be a problem). A bat specialist should identify the correct location, and advise on height and orientation (north, south, west, east). Factors influencing placement will be the country, the design of the house and surrounding objects. It is recommended that new bat boxes are not installed above windows because of potential issues with bat droppings and bats accidentally entering the flat during the morning swarm. If a bat box does need to be placed above a window, it is suggested that a narrow metal deflector board (shelf) is installed above the windows to prevent droppings falling. It is also recommended that residents put insect mesh across their windows to prevent bats from flying through the open window into the flat.

It is better to place more than one box on a wall near the destroyed roost to let bats choose the box with the most suitable microclimatic conditions. In cases where the roost has not been destroyed, one passageway bat box placed at the original bat roost entrance is often enough. Where the original roost has been lost, it is recommended that four potential new roosts are provided for each roost lost. If possible, the internal width of the box should be aligned with the internal width of the original roosting cavity. The number of bat boxes should be sufficient to compensate for the loss of the original roosts. As bat boxes are not always effective and some bat boxes will not be used, overcompensation is necessary. Results from post installation monitoring surveys provide evidence that this is a good starting assumption.

Case study

Effectiveness of mitigation measures including bat boxes in the United Kingdom, a study carried out by the Bat Conservation Trust (BCT)

A study in the UK (BCT 2020) into the implementation and effectiveness of a range of mitigation measures, including bat boxes, recorded that bat boxes were the most frequently deployed roosting provision, being installed at 64% (n = 71) of sites as a compensation or enhancement measure. Box frequencies ranged from 1 to 41 at sites where they were installed, with an average of 6.6 boxes per site (n = 270). Bats, or evidence of bats, were recorded in 20% of these.

Bat boxes mounted externally on buildings showed the highest occupation rate regardless of species. Common pipistrelle showed a preference for these over tree mounted boxes; the opposite was true for soprano pipistrelle.

For the four most popular bat box models used by consultants in the study (all Schwegler), bat presence was highest in the 1FF (32%, n = 53) and lowest for birds (8%). The tree mounted 2F and wall-integrated 1FR/2FR models both demonstrated similar bat presence rates of 23% (n = 43) and 25% (n = 32) respectively. The 2FN tree-mounted model showed the lowest presence rate for bats (11%, n = 19) and the highest for birds (58%). There were also 26 timber bat boxes, none of which were used by bats. No evidence of birds was found in bat box designs where access point apertures were ≤17 mm. Similarly, box models with the highest bird presence featured access apertures at least 25 mm wide. Ninety-two percent of 1FF boxes with bats placed boxes on external walls were occupied by common pipistrelles, compared to just 8% occupied by soprano pipistrelle. Only one tree-mounted 1FF box was occupied at a single site, and this was by soprano pipistrelle.

Furthermore, despite soprano pipistrelles being recorded at three sites where alternative tree-mounted models had been installed alongside the 1FF design, this species was only recorded once in the 1FF model. Although this may suggest a difference in bat box preferences between common pipistrelle and soprano pipistrelle, it must be noted that both were recorded using the 2F and 1FR / 2FR designs in equal proportions.

Average bat box heights above ground level were 4.6 m; tree-mounted boxes were slightly lower at 3.8 m and wall-mounted / integrated boxes were slightly higher at 5.4 m. The lowest occupied box was at 1.8 m and the highest at 11 m. However, fitting height did not have a statistically significant impact on either bat presence or on counts. Likewise, there were no significant differences between boxes on different orientations. There were insufficient bat count data to assess the relationship between bat counts and orientation using this method. Only five heated bat boxes were surveyed, and no evidence of bats was found. Despite close examination and discussions with site personnel, it was not possible to confirm whether the heating elements were functioning.

4.6.2 Types of bat boxes available

There are several types of bat boxes which are used in/on insulated buildings. The bat boxes can differ according to the material (woodcrete, polystyrene, wooden), function (passageway bat boxes, which lead to the original roost, bat boxes installed into the insulation, bat boxes installed on facade), size and design. A suitably experienced bat ecologist should choose the most suitable type of bat box for the situation, taking into account the target species and the purpose of the original roost (for example, summer bat boxes, whole-year bat boxes, use for maternity colony, use for hibernation).

Polystyrene and plastic bat boxes (fig. 16)
This type is made from XPS polystyrene; they are lightweight, relatively cheap and easily integrated into the insulation layer. They contain a thin inner layer of concrete which enables bats a better grip and protects the box from being worn. In the winter they use residual heat from the building to keep thermal conditions stable at around 6°C. They are successful for hibernating noctules, for example, the type Maxi-B for 50–100 noctules. If they are heavily used by noctules, staining could develop under the box from bat guano and urine.

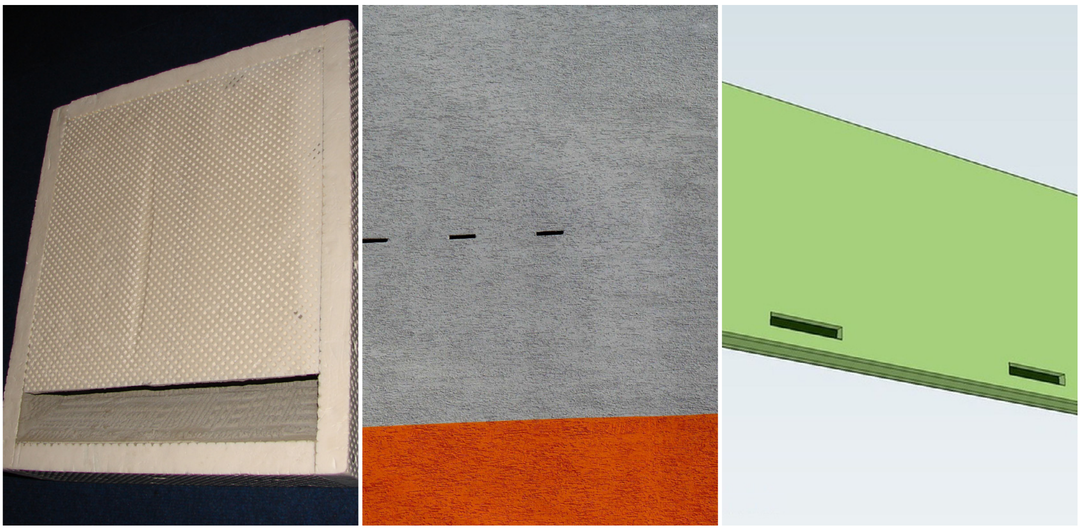


Figure 16. Example of polystyrene bat boxes to the insulation layer (JIZECO, CZ and BAT-MAN, SK).

Woodcrete boxes (figs. 17, 18, 19)

Bat boxes made from wooden-concrete mixture are durable, permeable, and are used successfully by a number of bat species in several countries. They are usually heavier and more expensive, but are readily available with plenty of designs. It is necessary to consider what species the box will be used for. In some types the inside width would be too wide for small species. Ideally, the inside width of the box should be similar to the inside width of the original roost site. They can be both placed into the insulation layer (as a non-passageway box or as a passageway box) or placed on the facade where they can serve both as a functional bat roost and a design feature. They can also be used as an engagement tool to educate the public.

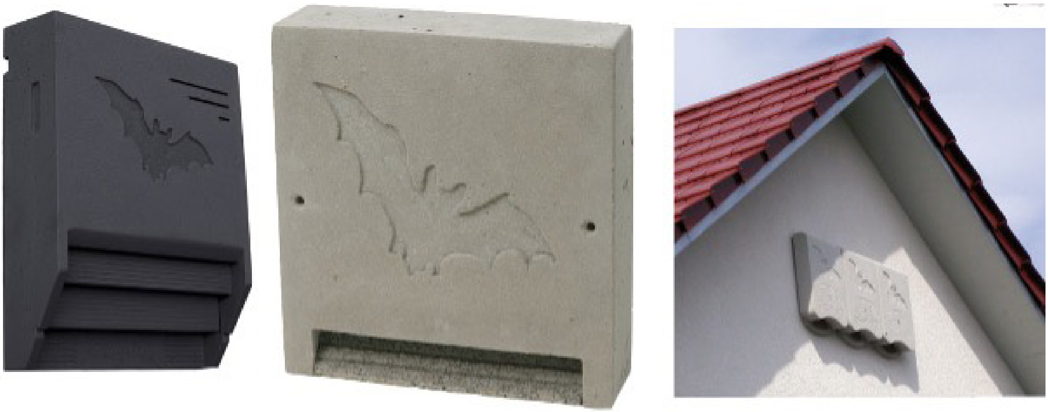


Figure 17. Different types and design of non-passageway box. Photo courtesy of SCHWEGLER.

Figure 18. Left: built-in bat box. Photo courtesy of SCHWEGLER. Right: Green & Blue's Bat Block being fitted.

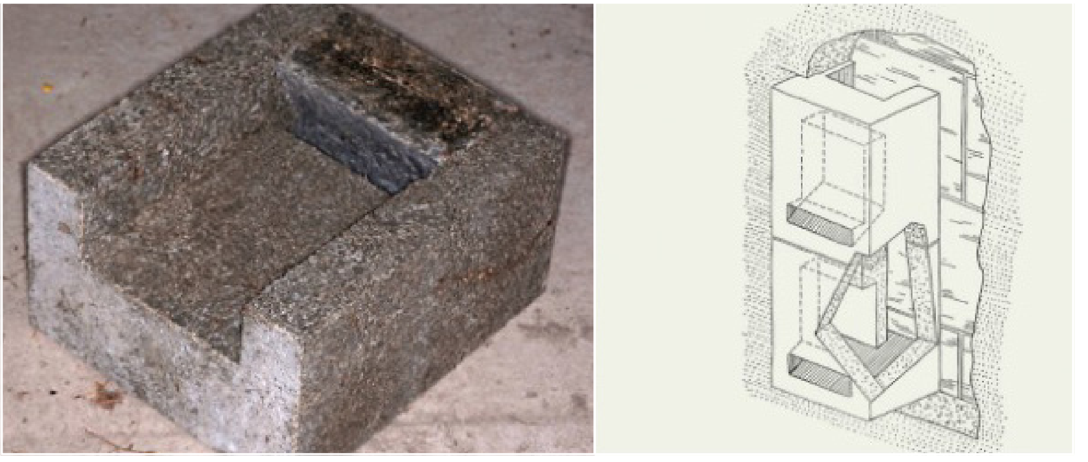


Figure 19. Passageway bat box. Photo courtesy of Naturschutzbedarf Strobel.

Figure 20. Use of the wooden boxes in the facade of the newly insulated school. Photo courtesy of Evžen Tošenovský.

4.6.3 Custom made artificial bat roosts

If it is possible to make an artificial bat roost which resembles the original roost in both design and physical conditions (temperature, humidity), it should be done with the guidance of a bat ecologist. New types of artificial roosts on buildings, including the more unusual solutions, should be recorded as case studies where possible so that others can learn from them. All surfaces in a bat box, including the entrance, must be rough to enable bats to crawl inside. They must not include toxic or entangling materials (fig. 21).

4.6.4 Potential issues to address after bat box installation

Bat boxes should not be placed above windows and balconies, because bats can occasionally accidentally enter the human living space. The falling guano can also stick to windows, fall on the balcony surface or on the window ledge, and the noise of bats can lead to complaints from the house inhabitants. To mitigate some of these issues, installation of insect mesh to the nearest windows is recommended, as well as installation of a deflector board (shelf) under the roost to prevent most of the bat droppings from falling.

Another potential issue can be discolouration of the facade caused by bat urine, as well as growth of green algae under the bat boxes. The extent of the issue will depend on the size of the colony, type of the bat box and the colour of the facade. Façades can easily be cleaned when bats are not present if advice is sought from a specialist bat worker or organisation.

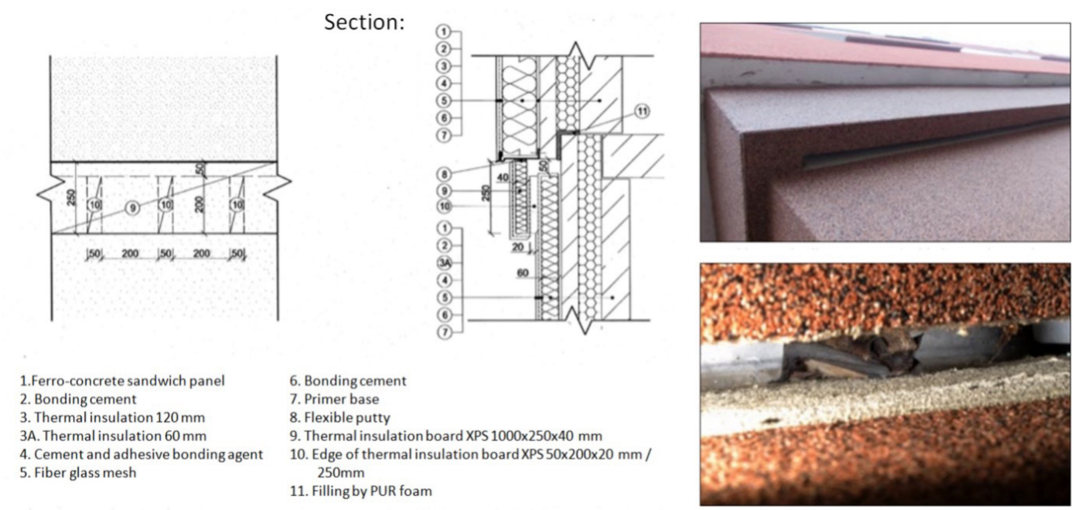


Figure 21. Example of a custom made artificial bat roost in an insulated house that imitates a fissure roost. Photo courtesy of ČESON.

5 Post-insulation survey and results of mitigation measures

To assess the impact of insulation on bat populations and the effectiveness of mitigation measures, a post-insulation survey is needed. Lack of time should not be a factor influencing the method of survey (as it can be with pre-insulation surveys), so a post-insulation survey should be done thoroughly, covering all the seasons. The survey should cover hibernation, spring and autumn migration and the maternity season, and if possible, include two independent surveys in each season. Given that many species can switch roosts, just one survey per season may result in missing their presence in a particular roost.

Using bat detectors and undertaking emergence counts from the roost is often effective, but takes a lot of time and volunteer capacity. It may be possible to include the general public in such monitoring in some countries, but positive records would need to be verified by bat specialists. Thermal imaging can prove effective for surveying building roosts. This method can be used to provide accurate and reliable data relating to dusk emergence and dawn re-entry examination of a range of built structures (Williams & BCT 2021).

Endoscopic cameras can also be a useful tool to survey for bat presence during the day, if the roost is easily accessible for the bat specialist. Some types of bat boxes (vertical with an entrance at the bottom) attached to the facade of the building allow the presence of bats to be confirmed during the day with a strong torch.

The presence of bats in a supplementary roost, compensatory roost or modified old roost can also be confirmed by the presence of bat droppings or discolouration of the facade close to the entrances of the bat box.

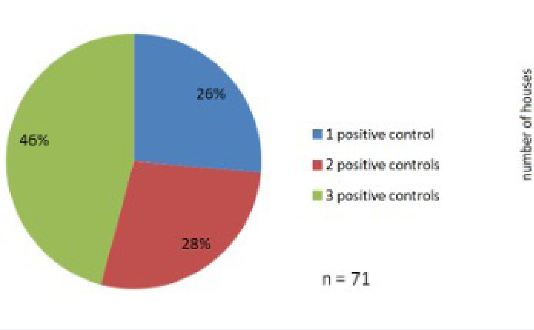
Case studies

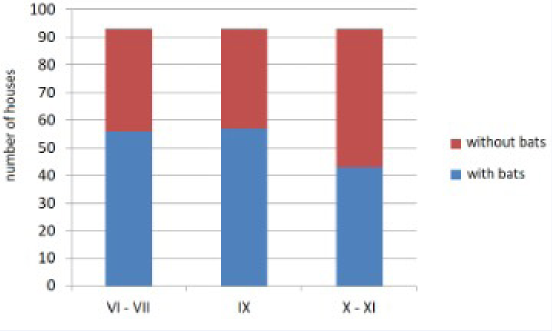
Post-insulation survey and bat boxes efficacy, Czech Republic

During 2015 and 2016 the efficacy of mitigation measures used during building insulation was evaluated. The presence of bats was found in all buildings during pre-insulation surveys and boxes were installed as a mitigation measure. New bat boxes were monitored through evening surveys (30 minutes before sunset till 60 minutes after sunset) during three periods (lactation period from June till begining of July; migration period in September; beginning of hibernation in November) on 93 buildings in 15 towns. Thirty-five volunteers from the Czech Bat Conservation Society used bat detectors to observe emergence behaviour, as well as checking for presence of social calls and faeces.

Use of the bat boxes during at least one time period was recorded in 76% of surveyed buildings. The most frequently recorded species were *Nyctalus noctula* and *Pipistrellus pipistrellus*, with *Vespertilio murinus*, *Eptesicus serotinus* and *Hypsugo savii* also being recorded, either as individuals or colonies (100–150 individuals). In 46% of the buildings, the presence of bats was recorded during all three time periods, which suggests that these boxes are inhabited during the whole year. The number of inhabited buildings with bat boxes was a little higher in the autumn migration period which is in line with the trend observed in non-insulated buildings.

No clear pattern was observed in relation to south-north or east-west orientation of boxes. The longer the roost (newly installed bat box) had been in place, the higher the chance of it being used by bats. No difference was found between the use of polystyrene or woodcrete bat boxes in the insulation layer.





Joined system of roosts in noctule bats in Waldkreiburg, Bayern, Germany

Buildings in Bayern are very important noctule bat hibernacula in winter, but individual bats roost in crevices and under the cladding of walls and roof throughout the whole year. There is so far no evidence of maternity colonies during early summer, but bats use hibernacula at many other times of the year, and guano can accumulate under the colony inside the building.

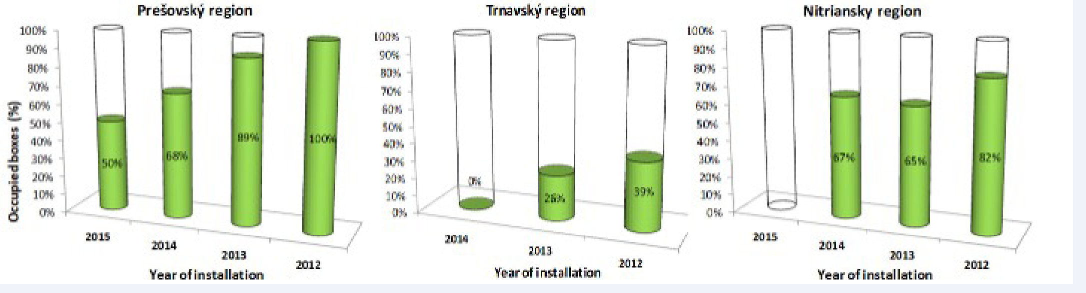
There were known roosts in 12 buildings which were relatively close to each other and formed one joined network of roosts. During insulation works, roosts on 11 of the buildings were destroyed. As a mitigation measure, 31 bat boxes or substitute roosts were provided. Half of these had their entrance at the same place as the original roost. In the first phase of construction works bats only inhabited the unaffected roosts, but after losing 70% of roosts they started to settle in new bat boxes on the facade or inside the insulation. About one third of roosts were inhabited during the following three months. Post mitigation observations showed that noctule bats have difficulties in finding the opening entrance of the new bat box and difficulties increase the further the entrance is from the original roost. The bat box should be installed as close as possible to the original roost.

Post-insulation survey and bat boxes efficiency, Slovak Republic

The use by bats of boxes installed during the renovation of building in years 2012–2015 was surveyed in the year 2015 (Ceľuch *et al*. 2016). Altogether 526 bat boxes were checked at 90 locations in three regions in Slovakia. In the survey, four different types of bat boxes were used – polystyrene Maxi-B, Hibernation box (insulated box from OSB board and polystyrene insulation), UNI-XL and woodcrete box Strobel Nr. 128. The hibernation box and woodcrete boxes were installed on the insulation, and the polystyrene boxes into the insulation layer.

Boxes were counted as occupied if bats were found by using inspection cameras, if they were seen emerging from the box, if guano was found under the box or sounds from the box were identified as noctule social calls. Typical staining from bats under the box was also used as sign of occupancy by bats. It was not possible to undertake emergence observations from all boxes due to the high number of boxes and the large region. Boxes were found to be mostly occupied from autumn to spring. Emergence could be at different times depending on the season, and there was activity during the winter only if the temperature rose to +5°C or higher. The temperatures inside the boxes was also measured at one location in January and February 2016.

During the year, 53% of 526 installed boxes were occupied by bats, mostly noctules. Polystyrene boxes installed into the insulation layer were used for hibernation, whereas woodcrete boxes were only used in autumn and spring because they freeze in the winter. The hibernation boxes were also used in winter. Occupancy was high – 100% after 3 years from installation in Prešovský region and 39% in Trnavský region. In this region (Western Slovakia) there is lower occurrence of noctule bats. In some locations boxes installed for swifts were also used by noctules, mostly in Prešovsky region. They have a round opening and bigger chamber – so they are are attractive during swarming and mating time for noctules.



The temperatures in the boxes were different. Outside temperature during January–February 2016 ranged from +11°C to -15.5°C, mean temperature was 0.1°C. Mean temperature in the hibernation box was 1.9°C, but ranged from 12°C to -8°C. Mean temperature in polystyrene box Maxi-B inside the insulation was 5.8°C, extremes were 12°C to 0.4°C. Interestingly, when the temperature dropped under -15°C, bats woke up in both types and actively heated the box. The polystyrene bat box Maxi-B is more stable and more suitable for hibernation.

Use of bat boxes, France

French buildings are mostly used by *Nyctalus noctula, Pipistrellus* spp. and, in southern France, by *Tadarida teniotis*. Buildings may be used all year round as maternity or hibernation roosts. In 2016 the subject of renovating buildings with bat roosts was discussed for the first time during the 16th National Bat Meeting held in Bourges. Experimental research then slowly began during the year 2017. The challenge is huge, as 500,000 thermal building renovations are planned annually in the country.

The work avoids the destruction of bats and offers new accessible roosts after renovation. The first step is for specialists to assess whether or not the building is occupied by bats. The second step is installing hidden bat boxes within the insulation, without altering the thermal quality.

Two French case studies are outlined below:

1) Thermal renovation of a building occupied by 70 noctules and pipistrelles spread over 17 locations in the upper floors. The work took more than one year. A total of 34 days was necessary for the follow-up. Before the renovation program, bats were excluded by bat specialists using exclusion anti-return devices. To recreate the original conditions of the roosts, bat boxes were placed on each of the six facades. A few weeks after the work was carried out, bats took up all of the new roosting opportunities. Around 40 noctules occupied the six bat boxes during the winter 2020–2021. The boxes are equipped with thermal sensors showing a gradient of 6.5°C, offering the animals a variety of seasonal conditions. Text and photos by Laurent Arthur.

2) Installation of eight bat boxes during the renovation of eight buildings (most of) which were not occupied by bats. Each building was equipped with one bat box on the top floor, inside the insulation, and located away from doors and balconies. In order to offer a variety of conditions two bat boxes were also placed on each side: North, East, West and South. A public awareness campaign with the owners "Val de Berry" and the residents followed the bat box installation. The first bat, a pipistrelle, was recorded three months after the end of the work, in September 2020. All these bat boxes are self-cleaning and made of rot-proof wood. They do not require any maintenance and can be installed on flat walls as well as on individual houses, in all types of insulation, or under any cladding made of wood or concrete. These bat boxes can be removed whenever it becomes necessary to work on the building. Text and photos by Laurent Arthur.

6 Communication with public and industry

Raising public awareness is crucial for nature conservation. Information relating to bats and insulation can be communicated at a number of different levels, ranging from running specialist workshops for bat experts, planning authorities and architects, to education of the general public.

For communication to be most effective, it is important to have a network of experienced bat workers and volunteers who can run specialist workshops for stakeholders, companies and officials. It is crucial for architects and bat consultants to work closely to find a method that is suitable for both people and bats. It can also be beneficial to collaborate both with ornithologists (who often face similar insulation-related problems with swiftlets) and with bat rehabilitation centres which rescue hundreds or thousands of bats (often from buildings). They can provide useful data when bat presence needs to be assessed prior to prior to installing insulation.

The general public can be reached through specific bat events, for example, International Bat Night (IBN) and bat walks, which are very popular across Europe. On IBN, a number of methods can be used to engage the public, for example, presentations, leaflets, quizzes or games for children. At a local level, exhibitions or travelling exhibitions can be set up, providing information about bat ecology and how insulation can impact bats. Other ideas for engagement include educational programmes for schools and literary or art competitions.

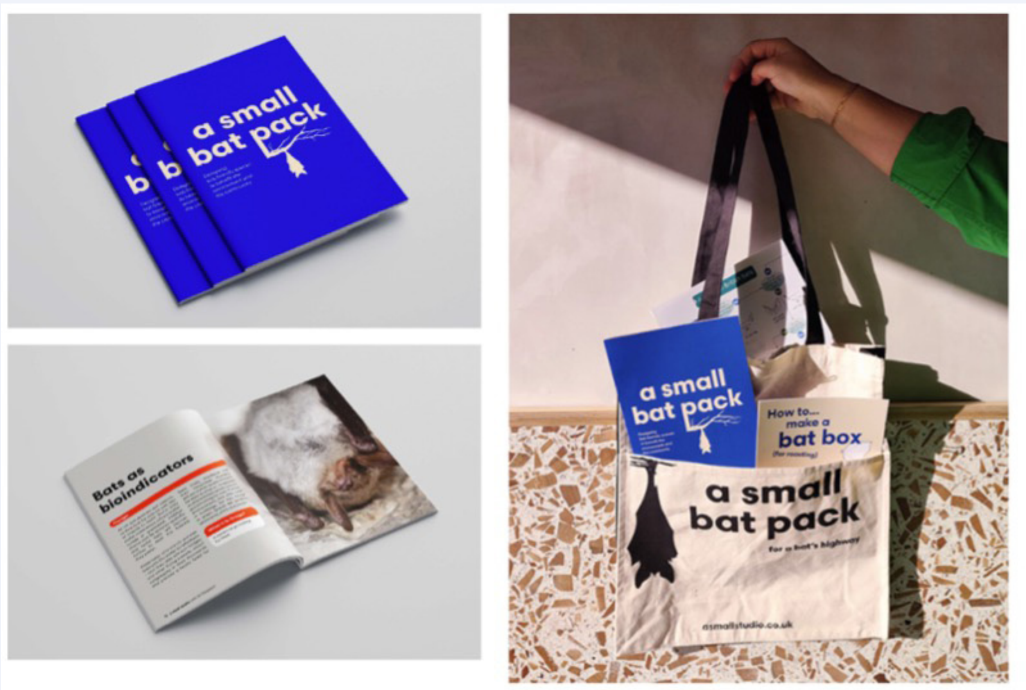
The system is not effective if the public do not receive a response from bat workers. It is important to have in place web pages giving appropriate information, including relevant contacts, to set up a hot line for people to report bats at risk from insulation projects, and to establish a database of bats recorded in buildings that is easily accessible and convenient for officials.

If the law is violated by companies, the media (TV, local newspapers, web, social networks) should be contacted to draw public attention to particular cases.

Case studies

Engaging communities and businesses to improve habitats to support bats in urban areas

In the UK, BCT's Built Environment Manager worked with a local Business Improvement District member and architect firm A Small Studio in a highly urban area of south London to produce 'A Small Bat Pack' for members of the community and businesses locally to encourage small interventions such as bat boxes and planting for bats to create ‚Bat Highways' through towns and cities and improve local environments: https://asmallstudio.co.uk/project/a-small-bat-pack/




Colony found during building insulation works and cooperation among NGOs and authorities, Czech Republic

On February 24, 2009, a hibernating colony of noctule bats was discovered during insulation works. The workers of the company put the bats in buckets covered by tarpaulin and left. The following day, a passer-by heard the bats and uncovered the buckets. The workers of the NGO ZO ČSOP Nyctalus were contacted. They found 670 individuals, only 328 of which were alive. Those individuals that were not injured were placed in a hibernation cellar, but many of these individuals were stressed and refused to hibernate. Injured animals were euthanised. 244 bats survived and in spring were fed with the help of volunteers. The case was delegated to NGO ČESON (Czech Bat Conservation Society) which resolved this case with lawyers and the Czech Environmental Inspectorate. The case was publicised through the media, which generated public interest and highlighted the potential conflict between insulation works and the conservation of protected species. Based on Resolution 7.11 Bats and Insulation, it was stated by the Ministry of Environment in 2015 that every company which plans to insulate buildings and asks for governmental financial support must include in their application the results from a basic pre-insulation survey for bats. Since 2010, ČESON has run a series of projects relating to buildings and insulation: more than 30 seminars have been delivered in different regions, a booklet about bats, birds and insulation was published, new specialised webpages were created and a helpline about bats and buildings was established. Collaboration with the designers and project engineers continues.


Photo courtesy of ZO ČSOP Nyctalus.

7 List of websites dealing with bats and insulation

Czech Republic
http://ceson.org/ukryty.php
http://www.sousednetopyr.cz/?page_id=20
http://www.ceson.org/document/brozura_Netopyri_2015_final.pdf

Germany
https://www.nabu.de/tiere-und-pflanzen/saeugetiere/fledermaeuse/aktiv-fuer-fledermaeuse/13998.html

https://www.fledermaus-bayern.de/files/upload/Downloads/schutz_und_pflege_von_fledermaeusen/leitfaden_zur_sanierung_von_fledermausquartieren.pdf

https://publikationen.sachsen.de/bdb/artikel/22958/documents/54809

Netherlands
https://bouwnatuurinclusief.nl/blogs/toegankelijke-muurspouw

https://www.vleermuis.net/meer-weten/nieuws-archief/746-na-isolatie-en-vleermuizen-een-tragedie-in-de-spouw

Romania
General guidelines about impact assessment involving bats and conservation of building dwelling colonies (both in Romanian):

https://lilieci.ro/wp-content/uploads/2016/11/ghid_APLR_adaposturi_antropice.pdf

https://lilieci.ro/wp-content/uploads/2017/05/ghid_APLR_impact.pdf
http://www.wildernessrc.ro/resurse/ghid2018/

Switzerland
http://fledermausschutz.ch/Ratgeber/Sanierungen.html

http://fledermausschutz.ch/Ratgeber/Holzschutzmittel.html

http://www.ville-ge.ch/mhng/cco/proteger/service-batiments/

United Kingdom
http://www.bats.org.uk/pages/bats_and_buildings.html

https://www.bats.org.uk/our-work/buildings-planning-and-development/existing-buildings/cavity-wall-insulation

https://www.bats.org.uk/resources/guidance-for-professionals/designing-for-biodiversity-a-technical-guide-for-new-and-existing-buildings

https://www.bats.org.uk/events/bats-for-building-professionals-online

8 Links to companies offering bat boxes

There are several companies producing different types of commercial bat boxes. Bat boxes are traditionally used as a mitigation measure, but there is a lack of knowledge about their effectiveness. Custom-made bat boxes are often installed with knowledge of internal design of the roost and bat species and thus can prove more effective. We are now at a stage of collecting evidence of effectiveness, and proper monitoring of both custom-made and commercial bat boxes used as mitigation measures is needed.

Czech Republic
JIZECO (former part of Ecoplastics)
https://www.jizeco.cz

Zelená domácnost (offers bat boxes from Fa Schwegler, Germany, and also make their own)
https://www.zelenadomacnost.com/k/budky-pro-netopyry

Germany
Hasselfeldt
https://www.nistkasten-hasselfeldt.de/fledermauskaesten.html

Schwegler
http://www.schwegler-natur.de/fledermaus/

Strobel, Fa. Pröhl
http://naturschutzbedarf-strobel.de/fledermausquartiere/

Slovakia
BAT-MAN Ltd.
www.bat-man.sk

United Kingdom
Roost Partnership scheme: https://www.bats.org.uk/our-work/buildings-planning-and-development/roost-replacement-and-enhancement/partnerships

BCT's bat box information pages: https://www.bats.org.uk/our-work/buildings-planning-and-development/bat-boxes/external-ready-made-bat-boxes-integrated-bat-boxes

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Bat Conservation Trust. (2015). Bats and Buildings leaflet. https://cdn.bats.org.uk/pdf/Bats_and_Buildings.pdf?mtime=20181101151310&focal=none

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Mitchell-Jones A.J., Bihari Z., Masing M. & Rodrigues L. (2007). Protecting and managing underground sites for bats. EUROBATS Publication Series No. 2 (English version). UNEP/EUROBATS Secretariat, Bonn, Germany, 38 pp.

Schnitzerová, P., Cepáková, E., & Viktora, L. (2015). Netopýři v budovách: rekonstrukce a řešení problémů (Bats in buildings: reconstruction and problem solution). ČESON, 2nd edition. http://www.ceson.org/document/brozura_Netopyri_2015_final.pdf

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Annex 1 - Resolution 8.9 Bats, Insulation and Lining Materials

8th Session of the Meeting of the Parties, Monte Carlo, Monaco, 2018

The Meeting of the Parties to the Agreement on the Conservation of Populations of European Bats (hereafter "the Agreement"),

Recalling Article III of the Agreement, especially paragraphs 1 and 2;

Noting that bats use a network of roosts in buildings as breeding, swarming, hibernation and transient roosts;

Further noting that bat colonies roosting in buildings are seriously endangered by insulation programmes which do not take adequate account of the presence of bat roosts and that some EU-financed schemes to promote the installation of insulation are in conflict with policies to conserve bats;

Recalling Resolution 5.7 on Guidelines for the Protection of Overground Roosts, with particular reference to roosts in buildings of cultural heritage importance, which recommends to ensure that overground roosts are managed in accordance with national nature conservation legislation and taking note of any guidelines adopted by the EUROBATS Agreement;

Recalling Resolution 8.3 on Monitoring of Daily and Seasonal Movements of Bats with regard to ensuring effective protection of migratory species and their habitats and surveying breeding and hibernation areas, migration routes and stopover sites, because species threatened by insulation include distance migratory species;

Recalling Resolution 8.5 on Conservation and Management of Important Overground Sites for Bats with regard to the EUROBATS list of important overground roosts;

Recalling previous decisions of the Convention on Migratory Species which also include the protection of migratory bats, their roosts and foraging sites;

Recalling that the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions "Roadmap to a Resource Efficient Europe" (COM/2011/0571) recommends strengthening policies and activities for promoting energy efficiency in buildings, with consideration of the wide range of environmental impacts of buildings;

Recalling Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings promoting the improvement of the energy performance of buildings within the Union, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and costeffectiveness, especially the obligation to set and apply minimum requirements for new and existing buildings;

Recalling the EU Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage, which obliges EU members to take measures to prevent, mitigate and compensate significant damages to protected species;

Recalling the Kyoto Protocol to reduce CO2 emissions in context of combatting climate change, that buildings are responsible for more than one third of total energy use and associated greenhouse gas emissions in society, both in developed and developing countries (http://www.unep.org/sbci/pdfs/BuildingsandCDMreporteversion.pdf) hence insulation is important;

Recognising that insulation of buildings can cause bat fatalities and loss of roosts, which can negatively impact bat populations;

Recommends Parties and Non-Party Range States to:

1. Ensure that insulation projects are undertaken in compliance with national legislation regarding bat protection and conservation by implementing appropriate pre-insulation surveys and assessments, mitigation and compensation to avoid roost loss and bat mortality.
2. Put in place mechanisms for post-insulation monitoring to ensure mitigation and compensation has been implemented, and to assess the efficacy of mitigation measures.
3. Where mitigation and compensation measures are not effective, encourage the development of new approaches.
4. Take into account, when assessing the importance of individual losses, that the cumulative impact of fatalities and loss of bat roosts in buildings can lead to detrimental effects on bat populations.
5. Resolve any possible conflict between insulation regulations and bat conservation.
6. Include bats in the impact assessment of insulation programs at a strategic level.
7. Recommend appropriate awareness-raising campaigns, training and information materials for public and stakeholders involved in insulation projects about bat protection in buildings.
8. Encourage the sharing of data and good practice in relation to bats and insulation.
9. Encourage the collation of standardised bat records (for example, by setting up a database), so these are easily available to bat experts and officials.
10. Develop appropriate national guidelines, drawing on the general guidance to be finalised by the Advisory Committee.

Instructs the Advisory Committee:

1. To finalise draft Guidelines for Bats, Insulation and Lining Materials, currently available as Annex to this Resolution.
2. Publish the Guidelines following circulation to all Parties for approval.

Annex 2 - EUROBATS Questionnaire

Questionnaire: Bats and insulation (new version)

Country:

1. **Is your country involved in insulation programs?**
- ○ Yes
- ○ No

2. **Which buildings are insulated?** *multi-choice*
- ○ Panel houses (block of flats)
- ○ Private houses
- ○ Office buildings
- ○ Other: churches, monasteries

3. **Who funds insulation?** *multi-choice*
- ○ EU grants
- ○ European bank credit
- ○ Local authorities
- ○ Private
- ○ Other-specify: Ministry of Culture

4. **Is pre-insulation survey requested in your country to get permit for reconstruction/insulation of building?**
- ○ Yes
- ○ No

5. **Can you by statutory means stop insulation progress when bats are found in the building?**
- ○ Yes
- ○ No

6. **Do you use any mitigation and compensation (e.g. bat boxes) during/ after insulation?**
- ○ Yes
- ○ No

7. **Do you carry out any post-insulation survey?**
- ○ Yes
- ○ No

8. Which species are affected by insulation in your country?
Assess also number of findings (A – found many times, B – found not so often, C – found only occasionally)

- ○ Nyctalus noctula
- ○ Pipistrelles (kuhlii, nathusii, pipistrellus, pygmaeus)
- ○ Vespertilio murinus
- ○ Hypsugo savii
- ○ Eptesicus serotinus
- ○ Myotis dasycneme
- ○ Others (specify)

9. Do you have any national guidelines of methodological survey prior to insulation of a building? *(if yes, please provide link or citation)*

- ○ Yes
- ○ No

10. Do you have any references (papers, booklets, information sheets, etc.) concerning bats and insulation from your country? *(if yes, please provide link or citation)*

- ○ Yes
- ○ No

11. Do you hold any workshops/training concerning bats and insulation?

- ○ Yes
- ○ No

12. Do you have documentation (photo, studies, case examples) concerning bats and insulation which you can share?

- ○ Yes
- ○ No

13. Does cooperation between stakeholders (builders, owners, state conservancy) exist?

- ○ Yes
- ○ No

Contact person (you or somebody else):

EUROBATS

Buildings account for over a third of total energy consumption and greenhouse gas emissions globally, making insulation to control energy loss a critical priority. However, insulation programs that overlook the presence of bat roosts pose a significant threat to bat populations.

Bats rely on networks of roosts within buildings for various essential functions: breeding, hibernation, swarming and temporary shelter. Large-scale insulation projects can inadvertently lead to fatalities and the loss of these roosts, impacting local bat populations and even migratory species that depend on buildings as stop-over roosts along their routes. These impacts are far-reaching and should not be underestimated. This publication consolidates expertise from several European countries and presents solutions tailored to different insulation methods. Through specific case studies, it illustrates effective ways to balance energy efficiency with the protection of bat habitats.

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