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IWG Bats, Insulation and Lining Materials
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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. Therefore insulation to control energy loss is important; but bat colonies are seriously endangered by 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 a network of roosts in buildings as breeding, swarming, hibernation and transient roosts. Large-scale insulation of buildings causes fatalities and loss of roosts, which influence bat populations not only at local level, but also impact on migratory bats which often use roosts in buildings. These impacts should therefore 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 bat roosts in a variety of situations, but this is the first time the insulation problem has been looked at in detail.

This document summarises accesible data from European countries and adjacent territories and suggests solutions for different insulation methods, with case examples from specific countries. Even though this puplication is focused on bats and bat colonies, many recommendations can be also applied to urban populations of common swifts.

1. Situation in Europe and adjacent territories – short overview

Analysis of the situation in Europe is based on results of questionnaires 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, where as in some southern countries insulation is used only on new buildings and the old ones so far remain without insulation. In post-communist states, insulation mostly occurs on housing estates of panel houses, whereas coastal west countries face rapid insulation of individual private houses.

In total, 20 countries are involved in insulation programs. In northern countries, all houses are already insulated, whereas many of eastern countries are so far not engaged 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.

Most often insulated structures are private houses, office buildings and panel houses (blocks of flats); occasionally there are other buildings such as churches or monasteries. Most funding comes from private resources or local funds, but eight countries also use EU grants fo finance their insulation programs. The most affected species are pipistrelles (Pipistrellus kuhlii, P. nathusii, P. pipistrellus, P. pygmaeus), noctules and serotine bats. In countries with panel houses the most affected species also include parti-coloured bats (fig 1.).

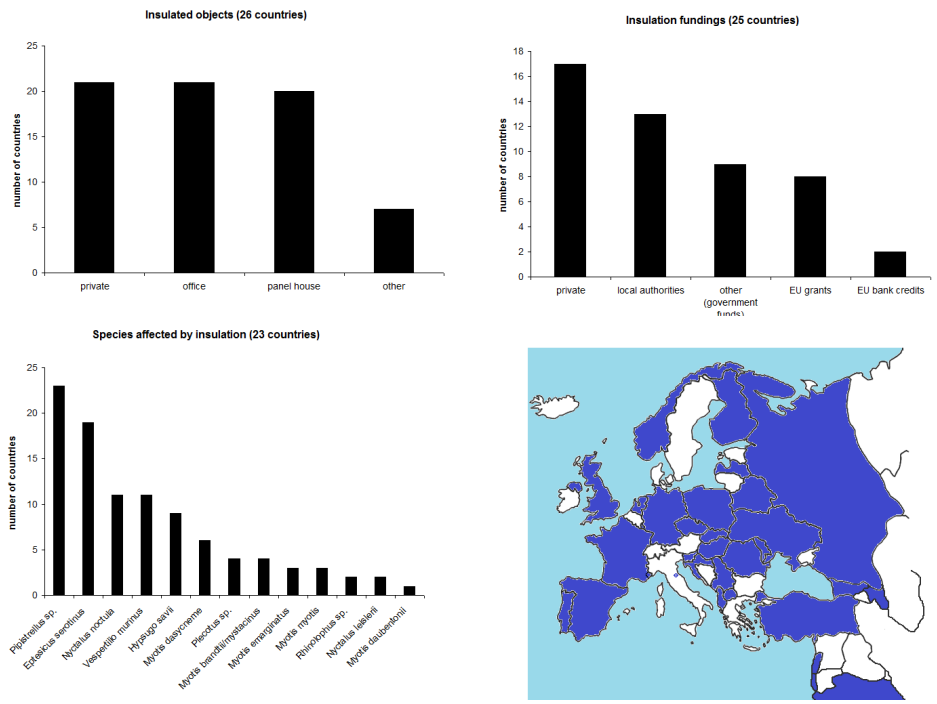


Fig.1. Bats and insulation – results from 31 questionnaires.

Only three countries have developed national guidelines detailing survey methodology prior to building insulation. However, seven countries raise awareness using information sheets and booklets or by publishing possible solutions on websites, and four countries held workshops and training sessions in relation 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, who will offer their own knowledge.

We hope to build understanding of how insulation impacts bats on a global transboundary level, suggest solutions and establish cooperation at an international level.

2. Bat life strategies and insulation

Due to loss of natural roosts bats learn to inhabit also man-made structures, and they can thus get into the 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.

2.1. Life strategies

Critical period, when the large renovation works should be done, should be determined on the basis of appropriate survey based on biology of certain species.
Typical model of bat cycle (fig.2) varies accross Europe, nevertheless it has basic common characters:

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

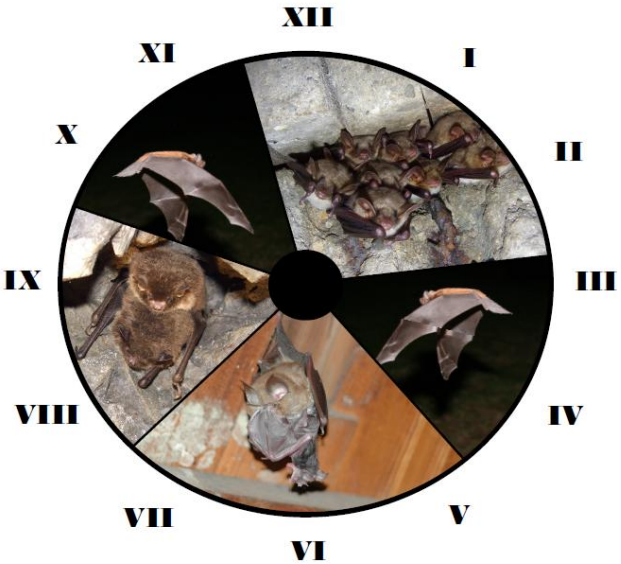


Fig. 2. Cycle of bats living in temperate zone.

2.1.1 Hibernation period (winter)

Insulation works during this period is critical for thousands of hibernating bats, especially in countries where temperatures reach below zero. Exclusion of bats from crevices or cracks is often impossible. Even the large number of bats can be easily overlooked because of winter sleep and bats can be wall up in their roosts especially in case of using polystyrene or glas-fiber wall insulation. Also visual inspection of deep cavities is not always reliable. When hibernating bats are discovered during insulation or renovation works, they can not promptly react and cooperation with animal rescues center is necessary. During warmer periods in

winter, hibernation can be interrupted and bats can appear inside or outside of buildings. The same behaviour was recorded in some types of roosts also during sudden decrease of temperature. Residents both heat and ventilate more, and it can lead to local temeperature rise and awaking of hibernating bats. Nevertheless, in southern countries bats can be active almost whole winter period and insulation works are not so critical as in central and northern Europe. In central Europe is also an evidence of increased bat activity during mild winters with long-lasting warm periods. Especially endagnered are during hibernation big colonies of noctule bats, pipistrelles and parti-coloured bats, which often roost in shafts, ventilation holes and in crevices and cracks of outer walls.

2.1.2. Migration period (spring and autumn)

Population can be mixed in particular roosts in spring and autum. Migratory distances in some species can reach over 2000 km. During migration could be pattern of occurence in the roost random and greatly vary during nights; number of bats can be underestimated or overestimated. Well known is so called „invasion behaviour“ of pipistrelle bats. The groups of hundreds of pipistrelle invade during night in late summer or early autumn into the building and stay there one or more nights. Often, due to their specific behaviour response to social calls, they can get stuck and die in vertical holes, bowls, narrow shafts or barrels inside flats. In some countries these invasions often occur on buildings, which are also important hibernating places.

2.1.3. Maternity colonies (summer)

Insulation works during this period is critical. Size of maternity colony depends on species, region and roost paramateres, and can reach even to thousands of individuals. Mostly, bat juveniles stay inside the roost until they are fledged. If disturbed, mothers can leave the roost together with juveniles, but also abandon their juveniles in a roost, or . part of adult bats abandon roost and part of adult bats with juveniles stay inside. Some species with thousands of individuals in maternity colony (e.g. Myotis myotis) are bound to a specific roost and destruction of it influences the local population. Some species (e.g. pipistrelles) used a network of particular roosts and form subcolonies. Destruction of one roost is not thus such deadly to the local population, nevertheless insulation project in large scale can lead to destruction of the whole network of roosts and influence local population as well. Also, males can form colonies during summer (e.g. noctules, parti-coloured bats, pipistrelles) or roost as solitaires in particular building roosts.

2.2. Types of roost in buildings which are planned to be insulated

All roosts of bats are protected in many countries by law but in some situation the exclusion of bats is necessary according to specific case depending on type of roost, season of year and facilities of bat experts or organisations. Presence of bats in the roost could be both remarkable and discreet depending on season, number of bats, and type of the roost. Traces of their stay include pellets under the roost or stuck on facade, odour, noise, dark colour of roost entrance and evening or morning activity around the roost. Also, some types of roost act as natural traps (e.g. narrow vertical schafts). 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 are planned to be be insulated:
Block of flats – fissures between panels, ventialtion holes, space behind ventilation holes which lead to the space under the roof or into the pantry, ventilation shafts, crevice between

layers of insulation and cladding of roof and balcony, crevices under the lodge, construction joints (fig.3).

Other types of houses - crevices between bricks, crevices caused by mortar drop out, crevices under the roof, crevices under the lining, any bigger holes (in grilled entrances depends on size of grid or ablation of grill from surface), crevices under roofing tiles and timber, space between roofing tiles and old insulation or wall of builed-in attic room (fig.4).

Fig.3. Example of bat roosts in not-insulated block of flats (Czech Republic; photo courtesy of ČESON).

Fig. 4. Example of bat roosts in not-insulated house of rustic type (United Kingdom; photo courtesy of BCT/Shirley Thompson).

3. Pre-insulation survey

Ideally, prior to ratification of insulation projects by authorities, a pre-insulation survey should be done. Surveys should be done by bat specialists equipped with appropriate equipment, for example, ultrasound bat detectors, endoscopes, thermocameras, etc. to confirm presence of bats or presence of roosting traces (e.g. droppings, typical smell, fig.5). A pre-insulation survey will ensure that bats are considered at an early stage and therefore reduce the likelihood of conflict between nature conservation agencies and construction companies. Part of pre-insulation survey should be also the assesment of roost potential in houses planned to be insulated (presence of suitable holes, crevices, cracks, etc. See chapter 2.2).
The process for obtaining pre-insulation surveys is different in different countries, but bat presence and function of roost must always be assessed so that the correct techniques and mitigation can be applied if needed.
Ideally, full survey should be done, which cover all periods of bats. Nevertheless, timing of insulation and capacity of bat workers do not allow full survey.
Slow and moderate rate of insulation is applied usually in complex buildings, where polystyryne or wall-to-wall type of insulation is used. Insulation works take more time and survey can be done in whole year or at least in critical period.
Rapid rate of insulation with fibreglass loft type of insulation or cavity wall insulation is very fast and often takes only one day. In such cases, assessment of bat presence and bat roosts is usually applied.

Fig. 5. Bat droppings (guano) between panels and in the gorund under the bat colony.

3.1 Pre-insulation survey scheme – slow and medium rate of insulation (e.g panel houses)

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

Ideally the survey should cover the whole of the bat life-cycle. In central Europe bats often use roosts in buildings during whole year and ideally a survey should cover periods of hibernation, migration, and maternity colonies and it is necessary to carry out repeated controls. In northern and southern parts the occurence of bats in buildings tends to be more seasonal, but some species will roost in buildings throughout the year.

The survey method is easy, but takes a lot of time and volunteer capacity.

- evaluate bat roost potential of building (presence of holes, crevices, droppings, etc.)
- on a calm evening at least half an hour before sunset slowly pass along chosen buildings back and forth several times until one hour after sunset and listen to output of bat detectors as well as observe the potential roosts on the buildings (echolocation or social calls uttered from roosts which are high above is not always audible in a bat detector); this method can be used in panel houses, where roosts are placed relatively high whereas in smaller building a person should be stood still, watching the emergence with use of bat detectors or thermocamera
- results, both positive and negative, and basic information about the locality should be noted on a form
- ideally, the survey should be undertaken several times throughout the year: firstly during the end of hibernation and start of spring migration, the second and third period is during maternity season, the fourth period during dispersal of maternity colonies and autumn migration, and the final period in late autumn prior to hibernation.
- if possible, two surveys should be untertaken in each period. Just one survey may give a false impression of absence of bats in a roost.

An surveyor will generally only be able to observe a short section of the building, in order to idenitfy entrance/exit points of maternity colonies or confirm the absence of bats. Long transects can not be recommended, because smaller bat colonies can emerge inconspicuously and fly directly to foraging area. Where bats are observed additional data can be obtained using simple questionnaires given to residents and/or from databases (e.g national faunistic databases, animal rescue centre databases, etc.).

There is often not sufficient time to carry out surveys in all of the periods listed above, because the insulation companies push to carry out their works quickly. Often there is only time for a single survey to assess bat presence in the locality prior to the start of insulation works, and if insulation works start in the cold part of the year, no activity can be recorded at all. If the legislation of the country does not require a pre-insulation survey and the companies put pressure on to continue, the only possibility to assess bat presence and roosting possibilities with the application of passageway bat boxes which avoid possible entrapment of bats in a roost.

Case examples

Pre-insulation survey: three panel houses, Praha-Ruzyně, Czech Republic, solved by ČESON (Czech Bat Conservation Trust)

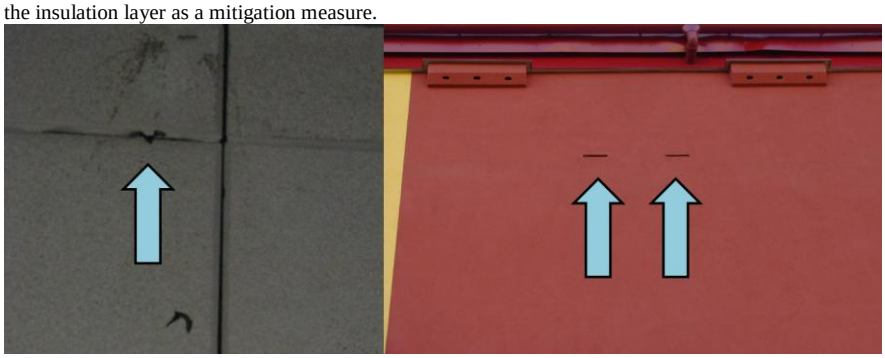
2011 – an inhabitant reported the occurence of noctule bats.

2011-2012 pre-insulation survey was done in post hibernation period, in lacatation period, in autumn migration period and in period before hibernation by using time-expansion bat detectors. The controls started 30 minutes prior sunset and finished at least 60 minutes after sunset in more days, so the observers can control visually each wall. In all three panel houses were found bat roosts in a fissures between panels in different floors which were used during whole year. Together with noctules were discovered also roosts from pipistrelles and serotine bats and eventually also nesting activity of swifts. The reuslts were provided to municipal authority, owner and custodian.

2013-2014 a project for insulation started. In the beginning, the meeting of owner, architect, officals from municipal authority and member of ČESON. In the meeting was established the proper procedure and the statutory exception was released.

Realization took place during 2014-2016 and ČESON was set as the supervisor of the observance of the rules.

2015-2016 the survey of the same schema was done and noctules were observed to use bat boxes set in the insulation layer as a mitigation measure.



Pre-insulation survey, Slovakia

Most of the high panel builduings are surveyed in phase of projecting. Because of expenditures and insufficient bat-worker capacity, only one visit is done in a critical period. We epmhasize the experience of surveyor, who can find bat roosts or predict presence of bats based on experience from similar buildings. We use inspection cameras and binocular to observe traces around potentional roosts (e.g. staning from holes or crevices, guano on windows or window sill). Surveyor also controls the groud around the building and looks for guano or dead animals. There should be also done control from the flat roofs. There are controlled ventilation shafts, ventilation holes and crevices under metal sheeting. When colony of bats is confirmed, detailed check from scaffolding is made shortly prior the start of the insulation works. Appropriate compensation measures are included into the project, usually bat boxes placed in walls without windows.

3.2 Pre-insulation survey scheme – rapid rate of insulation (e.g private one-store houses)

In areas with private single storied houses where quick insulation is done is the full survey impossible. Cavity wall insulation is often undertaken rapidly and cheaply, and it is important that bat presence is assessed so that the correct techniques, timing, and mitigation if needed, can be applied (see Chapter 4.3).
Surveyors work with presumption that on every house bats have their roosts. The basis for estimates (irrespectible of the precise location or number of roosts and bats) must be solid to follow this scheme of mitigation measures. To create the basis for such estimate, survey in several types of urban areas in different landscapes should be investigated thoroughly to establish representative sample. Care should be also taken for the various bat diversity of species in different towns and cities. Peforming night long surveys using static automatic bat detectors can show the species diversity of cites.

Herman

Multiple layer aproach, writte why multiple approach - differnet level approach, private own houses, private home houses wall to wall associtation own houses, two store apartment buildings
connection to municipality,....
In some countries, where quick insulation during the day is done, there will be helpful to contact companies and discuss tu put bat boxes as compensation.

Case examples

Case example – Netherlands approach with private in conrary to office buildings – Herman.

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

It is important for a bat population that there are sufficient suitable roosting opportunities close to good foraging grounds. A town or part of a city can be be regarded as a colony's home range, and this is an important consideration for planning insulation schemes. A policy aimed at always providing sufficient roosts of sufficient quality, regardless of the type of house, block or flat to be insulated, will be beneficial for bats and will not delay insulation works.
Depending on the type of building and insulation company there are several different materials and methods that can be used. However, there are some basic principles that should be followed for all construction works. All works should be undertaken before winter, as it can be hard to locate mass hibernacula of some species. All work should be undertaken when bats are not inside the roost to prevent victims during insulation works.

- Avoid working during the most ‚vulnerable' periods: maternity season and winter season
- Any modifications should preserve the quality and conditions of the roost
- The primary purpose is to maintain the existing roosts with the conditions as close to the original as possible, so that they can continue to be used by the bats after the building renovation (e.g. „passage-away bat boxes") or even during the works.
- Where it is not possible to keep the roost because of technical reasons or construction works cannot be timed appropriately for unavoidable reasons (e.g. to meet a subsidy deadline) and some element of the works need to be carried out when bats are present in the roost, exclusion devices must be put in place prior to the start of constrution so bats can leave the roost but are not able to return (by using one-way closure of the roost entrance). This is not appropriate for use 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 during hibernation time. This process must be supervised by a suitably experienced ecologist.
- Damage of the roost should be compensated by appropriate mitigation measures guided by a suitably experienced ecologist

4.1. Polysterene or glass-fibre boards

Where legislation and construction rules allow, extensive insulation use of polystyrene boards is successfully used in many countries for the insulation of **panel buildings**. A cheaper option it is also sometimes used the plugging of all gaps with foam. In older panel buildings bats (mainly noctules, parti-couloured bats, serotines and pipistrelles) roost in a number of parts of 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 bat groups can reach several hundreds to thousand animals.

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. Entrapement of bats when using playstyrene blocks can be sometimes revealed by strange bat behaviour – repeated landing to the freshly closed entrance, and inspection how to get in, probably because of silent, but still audible bat social calls. It is also possible that hibernating bats or maternity colony will be uncovered when parts of the roof are removed at the beginning of the construction works. There is not only a risk to individual **bats being harmed or killed** during insulation works, but also that the whole **roost** will be endangered. The use of insulation using polystyrene or glass fibre blocks is increasing markedly across Europe (fig.6).

Fig.6. Left: Hundreds of bats entombed during renovation and insulation works. Right: Winter colony discoverered during insulation was put in the buckets by construction workers and left to die.

4.1.2. Technical solution

The most important consideration is correct timing of construction works, taking into account the presence of bats and the potentional bat roosts identified during pre-insulation survey. The lifecycle od bats must be taken into account. The priority is to conserve the bat roost. Ideally the roost should remain unmodified or as close to its original state as possible. If this is not practical, then the negative impact on the bat colony should be minimised. Solutions which avoid negative impact on the bats and their roost during insulation with polystyrene boards are relatively easy and cheap to implement, but the methods used always depend on the specific situation and should be discussed with bat expert and project engineer to ensure that conditions such as temperature remaint he same.

4.1.2.1 Crevice roosts

Crevice roosts include gaps between panels, crevices behind insulation and cladding of roof and balcony, and construction joints. These crevice bat roosts are covered by polystyrene blocks during insulation.

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 wooden-concrete bat boxes or polystyren bat boxes. They are usually 8-12 cm wide and can be very simply 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 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 are 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 bricks“ boxes are used successfully in Germany, Czech Republic and Slovak Republic (fig.7.).

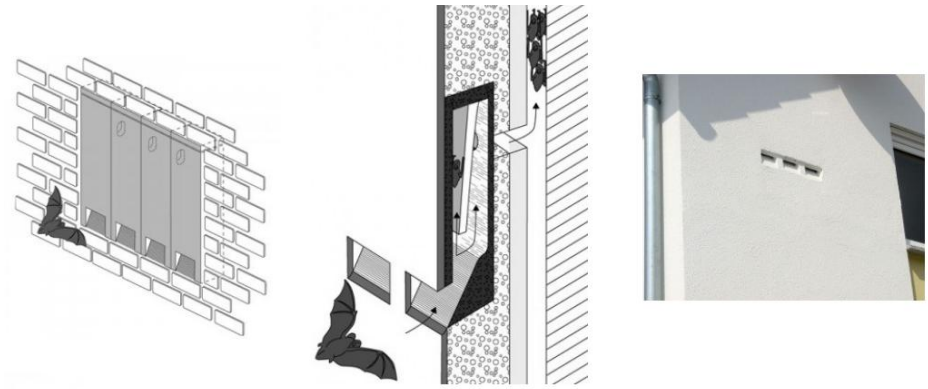


Fig.7. Instalation of bat boxes, which save original roost after insulation. Nevertheless, after several years according to the size of colony, bat guano can concentrate in the original roost behind the insulation layer.

If it is technically not possible to save the roost, it is necessary to ensure that all bats leave the roost prior to the covering of its entrance. This method can not be used during period shen bats give birth and raise their offsprongs and in the hibernation period. At least a week prior to works, the square **„exclusion flap“** made from soft wire grid (mesh should not be bigger than 0.5mm) should be placed over the entrance and fixed only at the top (fig.8). It is also possible to use a firmer plastic square. Three sides of the square remain free, but should not stand away from the wall. This one-way enclosure made in correct way enables bats fly out from the roost, but does not allow them to return back. Similarly a metal or plastic tube can be used (length 20cm, diameter a bit more than 4 cm but not much bigger, according to the bat species), to fasten to the roost entrance, angled downwards. The slope, diameter and smooth surface of these tubes prevent the bats returning. It is necessary to ensure that bats do not enter the roost by different entrances, e.g in long fissures. The one-way enclosure can not be there for long time (more months), because weather changes, wind and other cirsumstances lead to the deterioration and its function is reduced. Loss of the roost should be compensated by placing bat boxes close to the previous roost (see chapter 4.6).

Fig.8. Exclusion flap allows bat to leave the roost but prevents return. The flap is fixed on the top and it must closely cover the whole entrance and not stand away from the wall. Photo courtesy of Petra Schnitzerová (ČESON).

4.1.2.1 Cavern roosts behind ventilation holes

The bats use cavities behind ventilation holes which lead directly to the pantry in flats, or caverns which function as an extraction system of roof spaces. In case, that the roost can not be posssible to save is neccesary to use exclusion flap described in previous chapter in the same conditions (fig.9.). All mitigation measures should be in place before the original roost is lost.

When bats use caverns 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. Circle openings in insulation are are usually provided with plastic end covers to prevent rain and water leaking in, but often they contain grids or horizontal plates. Such plastic end covers must be modiefied to allow bats enter the roost (e.g. remove horizontal slats). The lower edge should be rasped to ensure it is sufficiently rough for bats to land and hold on to. Instead of using a plastic end cover, a plastic tube that has a diagnonal cut at the end (so the upper part forms a ‚roof‘, see figure below) could be placed at the end of the vent plastic tube. The inner parts 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 in smaller diametres they can stick (fig.10.). Rectangular horizontal openings should be equipped with a ‚roof‘ made from a metal plate fixed on the previous wall before the insulation material is laid. A plastic rough 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.

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

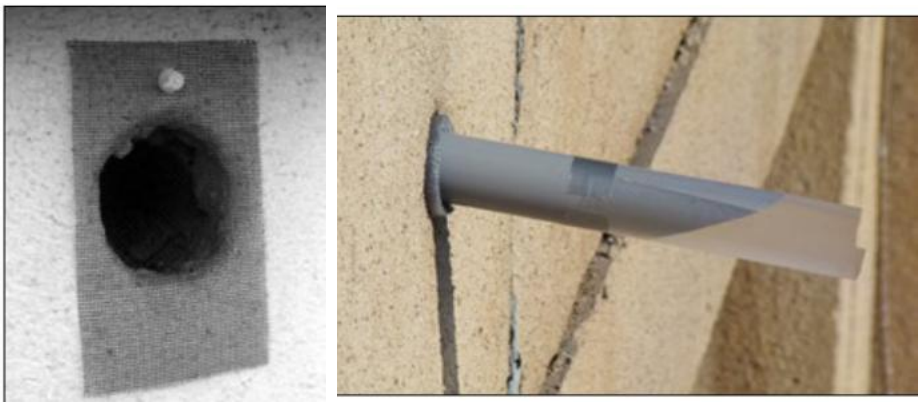


Fig.9. Exclusion flaps covering ventialition hole and variation of exclusion flap - a sloping plastic tube with at least 4 cm in diameter. The plastic cover around the tube prevents entering by bats or swifts. Photo courtesy of ČESON and Martin Ceľuch.

Fig.10. Covers of ventilation holes were modified to serve both bats and swifts. The diameter is at least 6 cm. Photo courtesy of Martin Ceľuch and Lukáš Viktora.

c) the insulation plan includes the insulation and reconstruction of the roof, which should 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 etablisehd that all bats have left the roost. The one-way enclosure method described above is used in this case. The loss of the roost needs to be compensated by placing bat boxes close to the previous roost (see chapter 4.6). It is also possible instal bat boxes inside the roof wrapped in insulation material which lead to ventilation hole or a more exacting method of digging new artificial cavities into the panel. These methods can only be applied in some cases, where the heat audit of building stays unchanged. Parameters of artifical cavities should be at least 30 x 15 x 15 cm with entrance 4 x 7 cm, but the real parametres should be adjusted to the concrete house (fig.11)

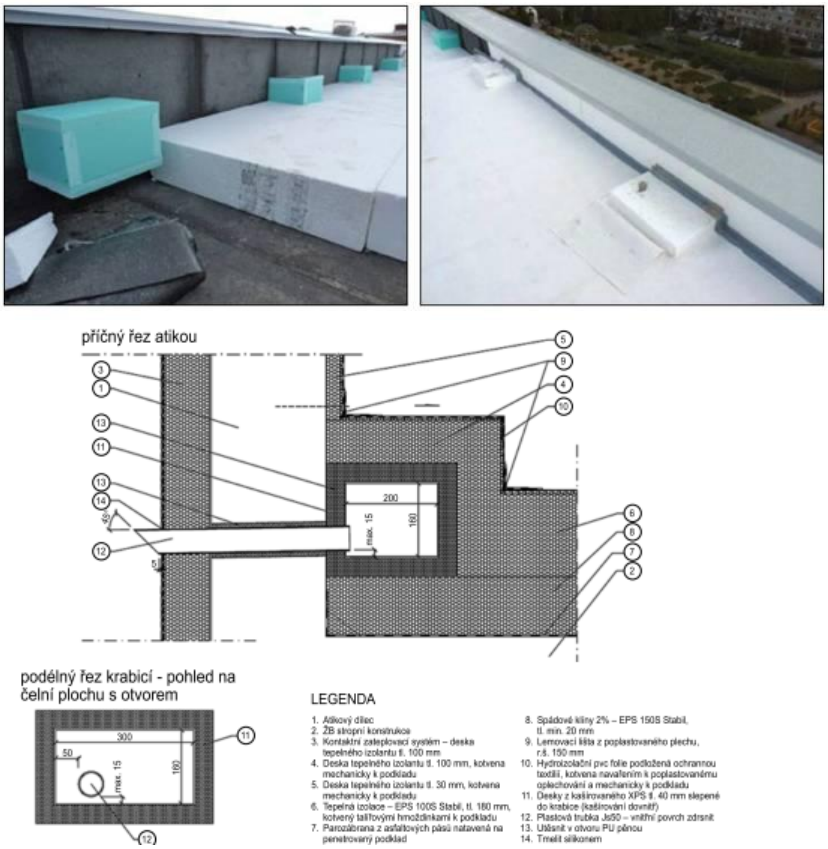


Fig.11 Insulation and reconstruction of the roof. The roof was changed from a ventilated to an insulated roof, which led to destruction of all cavities. One possibility is make artificial cavities. Photo courtesy of Lukáš Viktora and Ivan Řehoř.

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Case examples

Insulation of three panel houses and mitigation measures, Praha-Ruzyně, Czech Republic, solved by ČESON (Czech Bat Conservation Trust)

After pre-insulation survey, which revelead plenty of roost of noctule bats and aditionally also roost of pipistrelles, serotines and swifts in fissures between panels, the meeting of owner, architect, officals from municipal authority and member of ČESON. In the meeting was established the proper procedure and the statutory exception was released. The conditions determinated in the permission were as follows:

1. Construction works involving insulation must not be done during 15.10. – 31.3. and can not start in time of maternity colonies and swift nesting 20.4.- 10.8.
2. Just after the setting of scaffold were all fissures inspected by memebres of ČESON (visually and by endospoic camera) and all roost or possible roosts were markedy by spray. On these sites were set exclusion flaps (one-way enclosure). Rest of fissures was filled to prevent wanderings of bats do different sites. The flaps were here 5 nights. Afterwards, a control by members of ČESON was made to confirm abandoning of roost and the fissures were then filled. These works passed over step by step, which allowed bats to use alternative roosts in other house.
3. As a mitigation measure were installed bat boxes (wooden concrete and polystyrene types) to the insulation layer. The passage-away boxes were not allowed by architect. In three hauses were installed altogether 14, 13 and 15 bat boxes. The distribution of bat boxes were projected on the base of previous survey and with the agreement with architect (to be as close as possible to the previous roost, but not under the windows of the individual flats).
4. Also were set swift boxes (16,16 and 16) on the elevator shafts along the adge of the house.
5. ČESON supervised all construction works involving insulation close bats and swift roost.

During and after construction was done survey to control the presence of bats in the new bat boxes (four controls per year) **.** The bats used newly installed bats boxes in all three houses during the whole year. In the last house the start to use bat boxes just after the finishing the works and removing of scaffold.

Insulation of typical panel house and mitigation measures in Prešov city, Slovak Republic. Solved by members of SON (Slovak Bat Conservation Society)

During the official project phase, the survey of protected species (birds and bats) was realised. It was a building with 354 round attic openings and several hundreds of meters of crevices between panels. Openings and crevices were used by 100-130 breeding pairs of common swifts, then also house sparrows and several hundreds of common noctules. Bats are present typically from autumn to spring with most animals present in the winter during hibernation. One such building can offer hibernation places for hundreds or also thousands of noctules

Insulation works were realised from March to September 2014, because it was a massive building. Attic with active nests of swifts was kept open until last nestlings jumped out. Nests in the crevices were found by inspection from scaffolding, marked and free space around them was left.

It was not possible to keep the attic openings or crevices between panel open, because there will be to high thermal loss. Nest places of birds and bat roosts were replaced by XPS polystyrene boxes type BAT-MAN APUS-4 and BAT-MAN APUS-3. For swifts and sparrows altogether on three walls 112 nest boxes were installed. For noctules 8 double chamber boxes of type BAT-MAN Maxi-B were installed.

Most of the boxes were installed on side walls without windows, to lower the impact of animals and falling bat guano from boxes on dwellers. We have big concentrations of noctules in buildings and their sounds and guano makes problems to people.

Boxes were used in the upcoming winter by bats and next year also by first breeding pairs of swifts. Adaptation of swifts on new boxes takes usually more time than by noctules. Hundreds of such building were realised in similar way all over in Slovak Republic and similar mitigation measures were taken successfully.




4.2. „Wall on wall“ insulation = Zero-on-the-counter

’Zero-on-the-counter’ or ’rapid’ is a insulation scheme where the cost of insulating is being paid for by the reduction of the energy use. It comprises placing a complete new outer wall over the original outer wall. The new walls are fabricated in a factory and are placed in situ in a rapid 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 a industrial process, with quick turnover times and pre-fabricated 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 unreachable. When **bats** are present during the work, 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 might be work for common pipistrelle, but not for many other house-dwelling species such as serotine, pondbat, 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. These measures however might harm the bats (e.g. putting nets up to prevent birds from using the nestplaces).

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. 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 done in these two periods, measures are taken to prevent bats from using the roosts. Prior to starting work measures are always taken to prevent bats from using the roosts and to remove bats from roosts. Measures considered are opening the original outer wall to expose the wall cavity to make an unfavourable climate for the bats. Exclusion flaps and/or filling gaps are also used, but only in period when non-volant juveniles are not present.
The project should be discussed with the architect (fig.12).

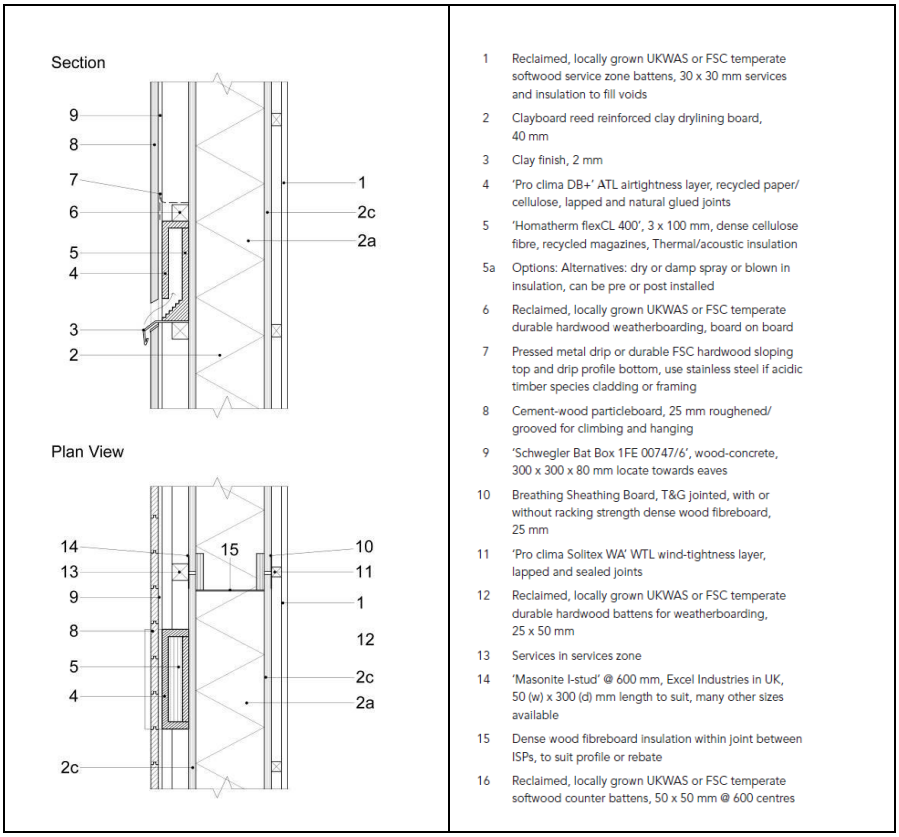


Fig.12. The schema of bat box, which is incorporated into the insulation layers during rapid insulation to take mitigation measures **(the Designing for Biodiversity – Kit or Jo please ask for permittion)**

Case examples

Wall-to-wall type of insulation, Netherlands

In this country, most of the insulaton works are undertaken using rapid rate by wall to wall insulation. To prevent groups of bat casualties the maternity season is avoided for works, and if this is not possible for some reason, measures are taken to prevent bats being present in the cavity walls. Other mitigation measures are always undertaken, e.g. large built in batbox, and leaving several small spaces for bats, irrespective of whether or not bats are present. A so called 'surroundings check' evaluates whether the standard measures are adequate. The ‚surroundings check' is heavily based on existing data, which is not thorough as there are a lot of areas where there is no data present. Both the Dutch network of ecological bureaus and several NGOs have strongly protested this approach. They fear the ‚surroundings check' is not complete enough and state that measures taken are not proven to work for species other than common pipistrelle.

Left: House with completely new outer walls and roof (note solar panels as well). Right: Entrance to a large built-in bat box is visible in the new outer wall.

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 assess any use by bats of the cavity wall, and the works must be undertaken at a suitable time of year and using methods that will minimise impact to the 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.

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 19mm holes. It completes its expansion by moulding itself to the unusual shapes within a cavity and sets to form a rigid insulant.
- EPS beads. The expanded polystyren bead used for cavity wall insulation is in the form of virgin pre-formed bead 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.

Fig.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 entrance / exit points, entombing bats within the cavity wall. This is a particular issue during the hibernation period as bats cannot react in time to potentially escape and 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 is found of bats using the cavity walls, advice must be sought from a specialist. He should suggest on this concrete case 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 proces and machinery monitoring 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 it must be always checked with the installer whether the method is appropriate; it may be that the type of filling, wall in question or building construction means that this isn't possible.

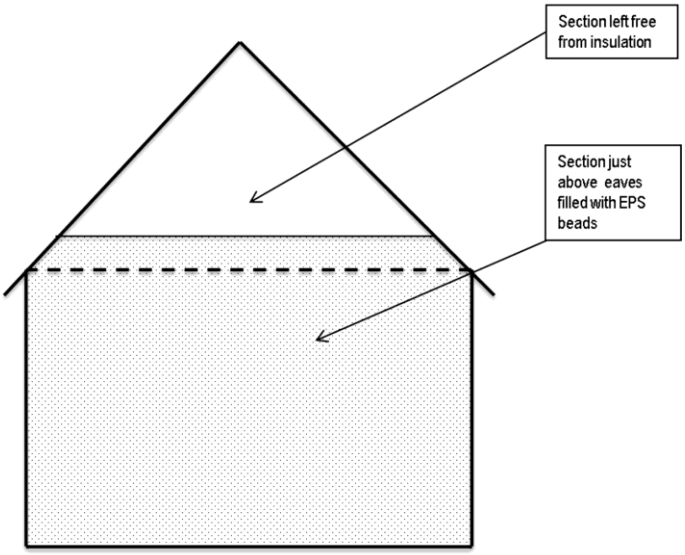


Fig.14. Retaining a section free from insulating material. Photo courtesy of BCT.

Case examples

Estimation of number of insulated houses by cavity filling, 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, much less than E1000,-.
Based on `Feiten en Fabels na-isoleren van spouwmuren. Milieu Centraal, 2015` several tens of thousands of houses are being insulated.

Tab: 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. It is used manily for roof insulation. The sheets of this material is usually layed 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 saved, there would be a change in the conditions (for example, temperature, moisture) which may mean the roost is no longer suitable for the original species **The roof void should be inspected** by a suitably qualified ecologist prior to works taking place, to ensure access points are located and to ensure that no bats are present when the work is carried out. 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 10cm from the eaves (this also helps to maintain building ventilation); or to insulate the floor of the loft only and leave the roof as a cold space. Make sure bats have other types of material to cling onto when they return after the insulation has been added e.g. rough sawn timbers at ridge.

Case examples

Fibreglass loft insulation, Romania

Bats have been observed roosting in fiberglass insulations 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 upon to mitigate human-bat interactions. In general bats find shelter in the residential buildings, built in the communist era, which are made of concrete slabs that offer generous spaces for bat roosts, but in the city outskirts or in rural places, where optimal summer roosts are not abundant, the animals can choose sub-optimal roosts, such as the fiberglass insulations. Several species have been observed roosting and raising pups in such roost, like *Pipistrellus pipistrellus, P. kuhlii, P. pygmaeus*. In some cases, even hibernation roosts have been formed in such insulations, containing *Nyctalus noctula, N. leisleri* or isolated individuals of *Eptesicus serotinus*. House renovations usually meant that the animals needed to be relocated, so 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 parts of fiberglass. Such roosts are potentially dangerous to these animals. The fine particles which are generated when the animals move in the fiberglass can be inhaled and cause serious damage. Bats usually roost in places where the fiberglass was not properly installed or was compacted by various repairs to the house, forming small spaces in which portions of the colonies can roost. They access the pockets from the exterior, where the insulation is not properly installed, leaving small openings, and usually move in the fiberglass through the joints of two insulation layers, where material tends to be thinner or lack entirely. 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 animals which will return.

4.4.2. Spray foam insulation

This method is being 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. Also, 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 saved, there could be a change in conditions (such as temperature) that would make it not suitable for the original species.

The roof void should be inspected by a suitably qualified ecologist prior to works taking place, to ensure access points are located and that there are no bats around when work 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 10cm 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, the use different method.

4.4.3. Sheepswool insulation

This method is being used in modern ecohomes as a sustainble natural roofing and wall insulation material. The it is not known how widespread this practice is in the UK.

Bats are threatened by entnglement. The wool strands become loose and beome tangled around a bats' feet and wings, resulting in bats becoming immobilised and eventually dying (fig.15).
Also, present bats can be disturbed by accessing the roosting site in the loft. If the roost is saved, there yould be change in conditions which will make the roof less drafty / warmer and possibly not suitable for original species.

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 is work done. Sheeps wool could be packaged loosely in some sort of pillow case to stop the spreading at the eaves and the bats coming into contact with this. Avoid disturbance to the roost by working when bats aren't present and ensure any wool is 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.

Fig. 15. Sheeps 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 over with dust sheets to prevent bats getting tangled and there haven't been any further problems since doing this (Credit - Pers.coms. 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) shows that 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 is affected by the bats as urine can degrade it.

4.5.1. Main threats for bats

The spun-bond filaments in NBCRMs are exposed to abrasive forces not currently covered under standard testing by manufacturers when placed in a bat roost; bat claws tease 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 non-bitumen coated membranes currently on the market. 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 membrane.

4.5.2. Technical solution

There are currently no known NBCRMs that do not pose a risk to bats; therefore these products should not be installed into a roof or wall used by bats. Only woven bituminous roofing felt that does not contain polypropylene filaments should be used. For example bitumen felt type 1F, which is hessian reinforced.

However in May 2020 an independent testing methology paper was published which allows the independent testing of membranes to answer the question of what constitutes a roofing membrane with minimised risk to bats where they are or could be present. Until these independent tests are completed the original advice stills stands, currently the only 'bat safe' roofing membrane is bitumen 1F felt that is a non-woven short fibred construction.

Case examples

BCT If there is any . If not, we will have it even without case exmaple..

4.6. Roost compensation – commercial bat boxes

Roost compensation is usually done by placing various types of bat boxes on/in the building. There are many types of bat boxes and their use depends on the agreement with architect or owner of the house. They can be either almost invisible or they can be used as interesting feature of the insulated building, for example, if they are painted with bat motives. However, bat expert advice is needed during installation to ensure that correct type of box is used for the concrete species and seasonal useage, as well as that their installing was done corretly and in suitable spot on the concrete house (e.g. avoid to set bat boxes above windows of flats). Also, there is possibility to suggest to owners installing of decorative, but functional bat boxes on freshly built and already insulated houses 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 differs according to the species and the situation (e.g seasonal bat boxes, whole-year bat boxes). The correct temperature and moisture specifications inside the bat box are regarded as a precondition them being used as a technical solution and should suit both bats and insulation requirements When bat boxes are used as roost compensation for roosts affected by insulation, the the measurements are taken by the companies installing the insulation, and the e conditions (and therefore likely effectiveness) of the bat box should be based on evidence and their thermal characteristics tested if possible. The aim is to set the bat boxes directly on the roosts „passage-away bat boxes“. These boxes are used, when the original roost can be saved or there is cavity where bats can live instead of their original roost. Bats crawl through the bat box to the original cavity or they can stay in a box. Nevertheless, after several years according to the size of colony, there can be problems with bat guano accumulation.

Sometimes it is not possible and bat boxes have to be placed as close as possible to the original roost according to situation. The probability of acceptance of bat box decreases with increasing distance (for noctules even 50cm can be a problem). In the rest of cases, bat expert should recommend the correct spot based on height, orientation (north, south, west, east) dependening on the country, design of the house and tak into account also surrounding objects. It is not recommended that new bat boxes are installed above the windows because of bat dropping and not-intentional invasion into the flat during morning swarm. If it is not possible a narrow metal deflector board (shelf) above the windows should be installed to prevent droppings falling down. It is also recommended for residents to put in windows insect mesh 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, often one passageway bat box placed on the original bat roost entrance is enough. In cases, where the original roost has been lost, it is recommended that four potential roosts are provided for each roost lost. If possible, the inside width of the box should be aligned with the inside width of the original hiding place. The number of bat boxes should suffice to compensate 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 field surveys in the area and from comparable areas can give a good basis for this estimate.

Case examples

Effectivenes of mitigation measuers including bat boxes, United Kingdom, solved by BCT (Bat conservation trust) Could be here some figs or graphs?
A study in the UK (BCT 2020) into the implementation and effectiveness of a range of mitigation measure, 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 treemounted 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 25mm wide. Ninety-two percent of 1FF boxes that were occupied 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

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 statiscally 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 the isulated buildings. The bat boxes can differ according the material (wooden-concrete, ploystyren, wooden), function (passage away bat boxes, which lead to original roost, bat boxes installed into the insulation, bat boxes installed on facade), size and design. Bat expert should choose the proper type of bat box to the concrete situation which reflect also bat biology of the goal species in the concrete case (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 from XPS polystyrene, they are lightweight, cheaper and easily integrated into the insulation layer. They contain a thin inner layer of concrete which enables

the bats a better grip and protects the box from wearing. In the winter they use residual heat from the building to keep thermal conditions stable around 6 °C. They are succesfull for wintering of noctules, for example box type Maxi-B for 50-100 noctules. Ff they are heavily used by noctules, there could occur staining under the box from bat guano and urine.

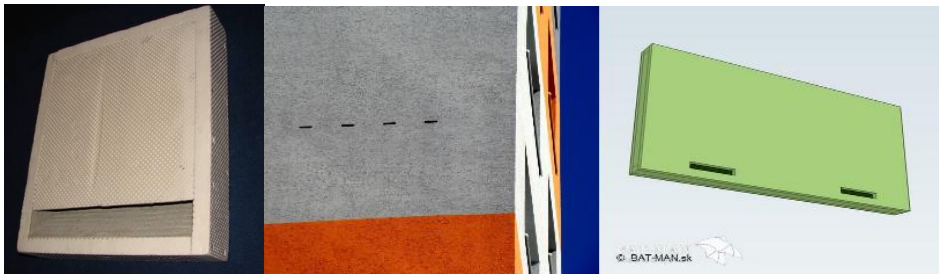


Fig.16. Example of polystyrene bat boxes to the insulation layer (JIZECO, CZ and BAT-MAN, SK).

Wooden-concrete boxes (figs.17, 18, 19)

Bat boxes made from wooden-concrete mixture are durable, permeable, and are used with success for a number of bat species in several countries. However they are rather heavy and more expensive. There is plenty of types and designes. It is necessary to consider, for which species it shall be used. In some types the inside width is too wide for small species. Ideally, the inside width of the box is similar as inside width of the original hiding place. They can be both placed into the insulation layer (as a non-passageaway boxes or as a passageaway boxes) or set on the facade and serve both as a functional bat roost and design element. They can be also used as an example for public education.. .

Fig.17. Different types and design of non-passageway box (courtesy of Schwegler).

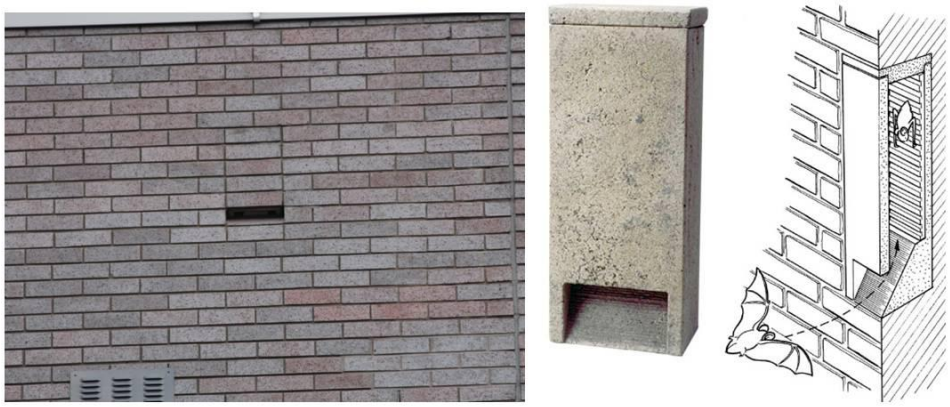


Fig.18. Left: Habibat integrated bat box in grey brick © Graham Jeffery / BCT. Right: Inside facade bat box (courtesy of Schwegler).

Fig.19. Passageway bat box (courtesy ofNaturschutzbedarf Strobel).

Wooden boxes (fig.20)
Wooden bat boxes are used only on facade in specific cases, especially when is on the building wooden lining and the bat box imitate the roost.

Fig.20. Use of the wooden boxes in the facade of the newly insulated school (photo courtesy of Evžen Tošenovský).

4.6.3. Custom made artifical 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 used for specific cases. This solution can prove much more effective than commercial bat boxes, but it is often more complicated. The type of new roosts on buildings, even the more unusual solutions, should be recorded as a case example so that others can get inspiration (fig.21).

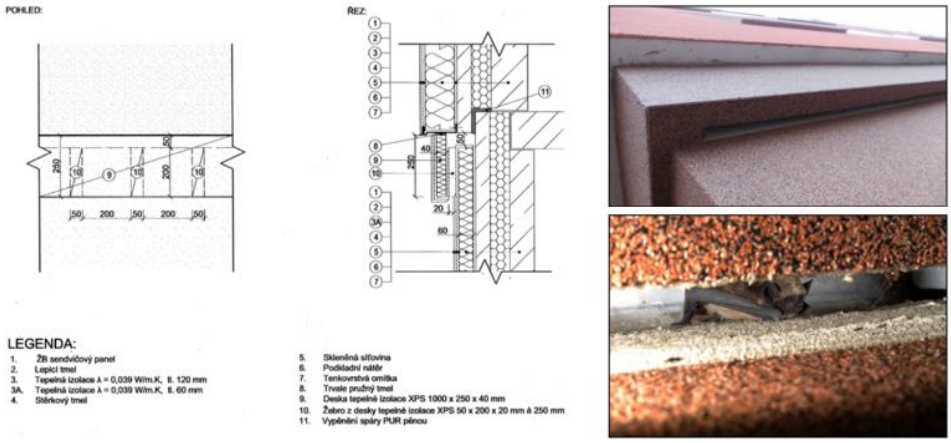


Fig.21. Example of new artifical bat roost in insualtion house simulating the crevice roost in fissure between panels (photo courtesy of ČESON).

Komentář [hj2]: Legend will be translated

5. Post-insulation survey and and results of mitigation measurements

To assess impact of insulation on bat populations and the efficiency of mitigation measures, a post-insulation survey is needed. Unlike a pre-insulation survey, lack of time should not be a critical factor influencing the method of survey, so a post-insulation survey should be done thoroughly and across the life cycle of bats. The ideal survey should cover hibernation, spring and autumn migration and the maternity season, and if possible, include two surveys in each of these periods. A smaller number of surveys within a period may give a false impression of absence of bats in a roost. A full research involving evidence of functionality of performed mitigation measures together with ecology and requirement of concrete bat population is needed.

Using bat-detectors and the direct observation of emergence from 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 checked by bat specialists.

Direct observation of bat presence during day with an endoscopic camera may be possible, if it is easily accessible for the bat expert. Some types of bat boxes (vertical ones with bottom entrance) attached to the facade allow the presence of bats during the day to be confirmed with a strong torch.

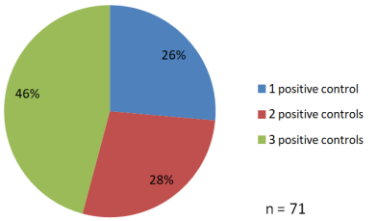
The presence of bats in a supplementary roost, compensatory roost or modified old roost can be confirmed also by bat droppings or changes of colours of the facade close to the entrances of the bat box.

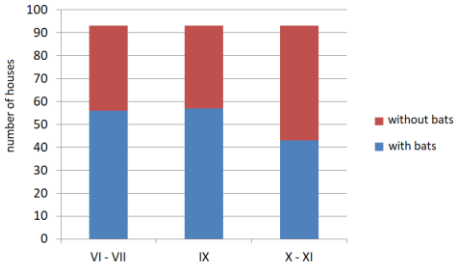
Case examples

Post-insulation survey and bat boxes efficiency, Czech Republic:

During 2015 and 2016 the efficiency of mitigation measures used during building insulation was evaluated. In all buildings was discovered presence of the bats during pre-insulation survey and boxes there were installed as a mitigation measures. New bat boxes were checked during night controls (30 minutes before sunset till 60 minutes after sunset) during three periods (lactation period in June till begining of July; migration period in September; beginning of hibernation in November) on 93 buildings in 15 towns. Emergence behaviour with the use of bat detectors was observed by 35 volunteers of the Czech Bat Conservation Trust, eventually presence f social call or feces. Use of bat boxes in at least one time period was recorded in 76% of observed 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 was a little higher in the autumn migration period which is the same as dynamic observed in non-insulated buildings.

No clear pattern was observed in relation to south-north or east-west orientation of boxes. Longer existence of the roost (newly installed bat box) increase the chance of inhabitating the new roost by bats. No difference was found out between inhabitating of polystyrene or wooden-concrete 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 whole year. In case, bats use hibernacula for many periods, guano can accumulate under the colony inside the building. There is so far no evidence of maternity colonies during early summer. The roosts were known from 12 buildings which were realtively closed each other and form one joined system of roosts. During insulation works, roosts on 11 buildings were destroyed. As a mitigation measure, 31 bat boxes or substitutive roosts were made. One half of them have entrance at the same place. In the first phase of construction works bats inhabited only unchanged roosts, but after loosing 70% of roosts they started to settle in a new bat boxes on facade or inside insulation. About one third of roosts was inhabited during following three months. During observation was discovered, that noctule bats have problems to find the opening entrance of the new bat box and problems increase according to distance of the previous roosts *(Hammer, M.,Zahn. A. Fledermäuse trotz Wärmedämmung ?Artenschutz im Rahmen der energetischen Sanierung von Gebäuden)*

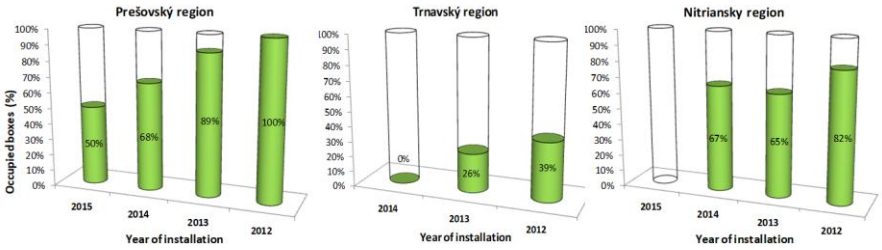
Post-insulation survey and bat boxes efficiency, Slovak Republic

Occupation of boxes installed during renovation of building in years 2012-2015 was surveyed in the year 2015 (Ceľuch et al. 2016). Alltogether 526 bat boxes (chambers) were checked on 90 locatilies in 3 regions in Slovakia. In the survey 4 different types of bat boxes were used – polystyrene Maxi-B, Hibernation box (insulated box from OSB board and polystyrene insulation), UNI-XL and woodconcrete box Strobel Nr. 128. Hibernation box and wood-concrete boxes were installed on the insulation, polystyrene boxes into the insulation layer.

Boxes were qualified as occupied, if bats were found by inspection cameras or seen emerging from the box, guano was found under the box or sounds from the box were identified as noctules social calls. Also typical staining from bats under the box was used as sign of occupance by bats. It was not possible to make emergence observation from all boxes due to high number of boxes and big region. Boxes are mostly occupied from autumn, during winter to spring. In this time emergence could be in different times and there is activity during the winter only if temperature rises to +5 °C or higher. We measured also temperatures inside of boxes on one locality in January and February 2016.

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

Temperatures in boxes were different. Outside temperature during January-February 2016 changed 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. Interesting was, when temperature dropped under -15°C, bats woke up in both types and heated the box actively. Polystyrene bat box Maxi-B is more stable and more suitable for hibernation.



Naformátováno: Písmo: Tučné

Naformátováno: Doleva

Naformátováno: Písmo: 10 b.

Naformátováno: Doleva

6. Communication with public

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

For effective help is necessary to have **a network of experienced bat workers and volunteers**, who can hold **specialist workshops for stakeholders, companies and officials**. The crucial is close cooperation with architects and projectans to find a proper way suitable for both people and bats. It can be beneficial to **cooperate with ornithologists**, who often face similar insulation-related problems with swiftlets, and also with **bat rehabilitation centres**, which receive hundreds or thousands of bats (often from buildings). They can provide useful data when you are assessing whether there is bat presence 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 the whole of Europe. During IBN, information can be given using presentations about bat biology, or through information leaflets, or quizzes or games for children. At a local level, **exhibitions or traveling exhibitions of bat life cycles** with information on insulation can be installed. A promotion can also involve **schools in educational programs for children** or **literary or art competitions**.

The system is not effective if the public do not receive any response from bat workers. It is necessary to establish **web pages** with appropiate information, including contacts, to set up a **hot line** for people to report bats at risk from insulation projects, and establish a **database of bats recorded in buildings** that is easily accessible and easy to use by officials.

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

Case examples

Can also BCT add Case example?

Colony found in insulated building and cooperation, Czech Republic

In 24th February 2009 a hibernating colony of noctule bats was uncovered during insulation works. The workers of the company put the bats in buckets, covered by tarred paper and left. The following day a passer-by heard the bats and uncovered the buckets. The workers of the NGO Nyctalus were contacted and 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 Concervation Trust) which resolved this case with lawyers and Czech Environmental Inspectorate. The case was publicised through the media, which started public interest and highlighted the potential conflict between insulation 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 government financial support in some donation programs, must include in their request the results from a basic pre-insulation survey for bats. Since 2010, have ČESON a series of projects dealing with buildings and insulation, more than 30 seminars were made in differnet regions, a booklet about bats, birds and insulation was published, new specialized webpages and help line concening only bats and buildings was established and the cooperation with designersand projectans continues.

7. Nature inclusive buildings

Herman and his new buildings, loose of roost, new roosts during cnstruction, use natural cavities of house, possibilities, communication with stakeholders.....
https://www.checklistgroenbouwen.nl/

Komentář [hj3]: The chapter was suggested by Herman. Unfortunately, if it will be not written, we can not include it manuscript.

8. 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

Netherlands

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

9. Links to companies offering bat boxes

There are several companies producing different type of commercial bat boxes. Bat boxes are traditionally used as a mitigation measure, but we have lack of research into their efficiency. Custom-made bat boxes are often installed with knowledge of internal design of the roost and bat species and thus they can prove more effective. We are now at a stage of collecting evidence of efficency 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

Naformátováno: Angličtina (Spojené království)

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Collins J. H., Ross A. J., Ferguson J. A., Williams C. A. & Langton S.D. (2020). The implementation and effectiveness of bat roost mitigation and compensation measures for *Pipistrellus* and *Myotis* spp. and brown long-eared bat (*Plecotus auritus*) included in building development projects completed between 2006 and 2014 in England and Wales. *Conservation Evidence*, 17, 19-26 https://www.conservationevidence.com/individual-study/8015

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Gunnel, K., Murphy, B. & Williams , C. (2013). Designing for Biodiversity: A technical guide for new and existing buildings. RIBA Publishing https://www.bats.org.uk/resources/guidance-for-professionals/designing-for-biodiversity-a-technical-guide-for-new-and-existing-buildings

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Annex 1. Resolution 7.11

7th Session of the Meeting of the Parties, Brussels, Belgium 2014
Bats and Building Insulation
(later replace by res 8.8. Monaco)

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 bat colonies 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;

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

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 previous decisions of the Convention of 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 large-scale insulation of buildings causes fatalities and loss of roosts, which influence bat populations;

Calls upon Parties and non-party Range States to:

1. Work to ensure that insulation projects are undertaken in compliance with national legislation regarding bat protection and conservation and the requirement to avoid bat mortality by implementing appropriate mitigation and compensation for roost loss;

2. Take into account, when assessing the importance of individuals losses, that the cumulative impact of fatalities and loss of bat roosts in buildings can lead to detrimental effects on bat populations;

3. Work to resolve any possible conflict between insulation regulations and bat conservation;

4. Include the impact on bats in the environmental assessment of insulation programs at a strategic level;

5. Look into the problem of bat roosts and different types of insulation in relation to privately or community owned buildings;

6. Recommend appropriate awareness-raising campaigns, trainings and information materials for stakeholders involved in insulation projects about bat conservation in buildings;

Requests the Advisory Committee to develop guidelines on best practice in taking account of bats in insulation projects.

Annex 2. Questionnaire

Questionnaire: Bats and insulation (new version)

Country:

1. Is your country involved in insulation programs?
   - yes
   - no

2. Which object 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 in your country requested pre-insulation survey to get permit for reconstruction/insulation of building?
   - yes
   - no

5. Can you stop by statutory means 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 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 link or citation)
    - yes
    - no

11. Do you hold any workshops/trainings 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):