

Spread of Innovative Solutions for Sustainable Construction

Handbook

3 Possibilities to Improve Sustainability at Different Life Stages of a Building



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Possibilities to Improve Sustainability at Different Life Stages of a Building

The growing demand for green buildings presents both challenges and opportunities in terms of used raw materials. The aim is to encourage the use of materials that have a lower environmental impact during their life cycle, and to recognize and encourage the use of materials produced in a responsible way, in both the starting and finishing phases of the construction.

The choice of more sustainable materials can mean, on one hand, the choice of materials from a local source that contain fewer toxic components or are recycled to a greater extent, and this can lead to reduce environmental impact. Besides that, life cycle, reuse and recycling all reduce the impact on the overall life cycle, as fewer materials enter the manufacturing and waste processing process.

There is a growing industry using renewable construction products, which in the right context can lead to buildings with higher levels of environmental properties - such as more efficient use (energy consumption, thermal properties, easier maintenance) and end-of-life management (recycling, recovery or disposal).

3.1 Design

It is not an easy task to choose a building site, at least if there is even a possibility to do it. This aspect is often neglected, but it is of utmost importance what the neighbours are like. This is not a direct urban geographical, technical, nor an architectural question, and it is not directly related to sustainability. However, this factor will have the greatest impact on the lives of the residents for decades to come. It is not just about the fact that the neighbours own a pig farm, a cable burner, or a nightclub as these could ruin shortly the joy of a new home. The culture, the restraint and cooperating ability of those living in the neighbourhood can turn life pleasant for the community, while their loudness, carelessness, and conflict of interest can make life in such a neighbourhood hell.

These are social considerations, but the location and orientation of the building plot are both very important for the topic of our handbook, as they have an impact on energy consumption and the load on the environment as well. From the point of view of the plot, the solar radiation and thus the solar gain, and unsurprisingly, the wind conditions are the most important aspects. The air movements are also affected by the topography, the vegetation and the buildings too. In installations with more density, the distance between buildings and the height of the surrounding houses are also important because they affect the solar gain of the facades and the natural lighting of the rooms of the building.

It is not insignificant whether the plot is located on flat terrain, or possibly on a northern or southern hillside, as these will play a major role in the location, orientation and consequent architectural design, as well as the structural details of the building to be built on it. In Hungary, the south-direction inclination of the plot is the most favourable in terms of energy gain. Of course, it is also possible to build a useful house on a slope with an eastern, western or even northern slope, provided that it receives sufficient sunlight for at least in one part of the year. In such cases, there is a necessity for the architectural tricks of the trade, so those architectural solutions that allow sufficient sunlight to enter the building even in unfavourable terrain conditions.



Once the building site, the legal framework and financial limits have been all clarified, and also the planning program has been put together, the meticulous work of planning then shall begin. Based on the design program, it becomes clear the architectural and energetic vision, as well as the structural and building technology solutions the designer is targeting. The planning is moving towards the right direction when the designers work closely together. The detailed solutions that are related to the individual environmental load elements are developed in this phase. The materials, structures, equipment, and systems relevant to the topic of our handbook, will be discussed in more detail below, will also be selected at this phase. The used materials do influence the way of construction, the shape of the building, its architectural appearance, the structure and the costs, and have a significant impact on the internal and external environment.

The choice of materials must also take into account ecological aspects, such as the optimal use of resources, the lifespan, the avoidance of not easily degradable materials where possible, and the use of recycled materials as much as possible.

When designing a building, shaping the house and designing the spaces, the basic design decisions concerning the dimensions, shape, orientation and relationships of the spaces determine the environmental impact of the building and the relationship between the user of the building and their environment. From the point of view of the spatial design, the environmentally conscious approach means a conscious and careful application of well-sized spaces that are in intense contact with the natural environment, natural daylight as well as air currents, and the sun heat.

Let's have a look at two examples differing in space and time, but they are essentially related. The ancient Greeks used to build their dwellings preferably on the northern side of the plot with thick northern walls without openings. An overhanging roof structure, supported by columns on the south side prevented the summer sun from entering the interiors and heating them up. However, the light and heat of the sun shining at a lower angle in winter was able to get into the building. Concerning the location of the basic element of Hungarian folk architecture, the farmhouse, the dominating wind direction as well as the positive and negative effects of sunlight were also taken into account. These houses were preferably built on the worse, usually northern side of the site.

A common and characteristic architectural element of the Hungarian farmhouses is the porch that was built on the more favourable side of the building, open from the side, protected from rain and wind, which, among other functions, played a significant role in the thermal protection of the building, similar to the ancient Greek houses. Whether it was energy awareness or energy instinct may not even matter. The porch of the farmhouse lives on in the indoor-open spaces, which are also used in today's architecture and are aesthetically, functionally and energetically useful.

The design of the house is related to environmental protection and energy use in many points. One such connection is the surface/volume ratio, which would lead the designer to form compact masses, but a number of other considerations, such as usability, architectural appearance, or the possibility of utilising solar energy, all urge against the mass spread of igloos. During the design of the house, continuously decisions must be made, the shaping of the building and its integration into the environment is the art of reconciling different aspects and interests and of resolving conflicts. It has become fashionable and it also conquered our rural settlements, the design of houses with low pitch or flat roofs. There may be many reasons for such a decision at from the builder's or designer's point of view, here it is now worthwhile to mention that the placement of energy-collecting elements on high roofs is much simpler and more feasible aesthetically than on flat roofs.

Finally, some thoughts about the implementation of the construction. The builder has little influence on the construction process and its organisation, but the environment can and must be kept in mind at this stage as well. This starts with the fact that the distance between the places of purchase must be taken into account when choosing the materials used for the building, as the transport of building materials is a very serious load on the environment. Most of the processed materials do not come directly from the manufacturer, but from a warehouse or a trader, so significant differences can occur here. However, this issue necessarily contradicts the use of prefabricated, industrialized materials and structures with the use of locally produced, close-to-nature building materials. It is a difficult task to find the optimum. The environment must also be taken into account in the organisation within the building site, so in the location of the contractors' work and storage areas and in the organisation of the work processes as well. One of the basic ways to do so is to conserve the existing vegetation.

3.2 Use

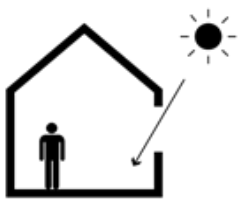
By living in our homes, apartments or using any building we all constantly get in contact with the issues of environmental awareness, energy awareness and life cycle without even noticing it. When using a building, with many little acts a lot that can be achieved for sustainability. These are such small acts that we might not even think about the underlying connections and the consequences behind them. Looking at an outdoor example, one walks down the street and sees someone throwing a cigarette stub. First, one might be outraged about the character of the person we have met, their impoliteness and carelessness. Litter thrown away in such a manner is ugly and can be even harmful to our health.

After that, two outcomes can happen, in case we disregard the most favourable solution as telling off the littering, who picks it up and puts the cigarette stub in the right waste bin. One possibility is that after a while, a road sweeper passes by and removes the trash. In this case the littering man makes the road sweeper work, as that person would have to collect the garbage littered. This is unnecessary working time that could have been used for something else. The other option is that no road sweeper passes by so after a while the rain washes it into the sewer. So, on one hand, such a substance enters into the sewer that should not have a place there, so it burdens the system unnecessarily. In addition, a toxic substance gets into the system. It may seem insignificant, but if we multiply it by a larger number, it turns out that recyclable materials are also included in the waste.



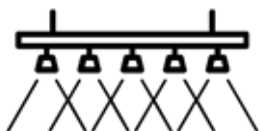
It also shows how small actions also have significance. We will briefly review these options. You can read more about some of them in other chapters of the book.

Taking advantage of natural daylight ²⁷



It is not necessary to prove how much energy the lighting requires. The light sources wear up, break down, increasing the number of devices to be purchased again and the amount of waste as well. It is easy to save on lighting. Take advantage of the possibilities provided by nature regarding lighting. By the windows the necessary lighting is provided in many cases. This can be used well by placing furnitures properly. Keep the reading chair and desk near the windows. The bathroom and toilets of the apartment can also have a window. If properly designed, there is no need to turn on the light on the corridors either during the day. Windows, glazed doors, and possibly skylights make this possible. With a little attention, a lot of energy can be saved by avoiding unnecessary use of artificial lighting. It is also worth considering that the sunlight has been scientifically proven to have a good effect on the state of mind.

Turning on the light, but only where it is needed²⁸



Significant savings can be achieved with well-chosen light sources and well-designed lighting. This action also aims to reduce the purchase of devices and to reduce the amount of waste. With controlled lighting and several lighting units directed to the specific work area, we can achieve adequate lighting and more efficient work with significant energy savings. The equipment of the rooms must be carefully designed and the lighting needs must also be taken into account. We put a “two hundred watts” bulb in a lamp in vain when the light comes from behind us. Thus, it will be worth nothing, and would only mean unnecessary purchases, unnecessarily used energy and unnecessarily generated waste. When designing the building, the apartment, general lighting must be planned in the rooms, it is wrong to influence the light use in advance. A general lighting can be used to serve normal needs. The design of the electrical network must enable to accommodate mobile light sources that meet changing needs. The parts of the rooms used for work and study, the tables should be illuminated with direct day light of adequate intensity.

²⁷ Source of the picture: Seona Kim, KR from Noun Project

²⁸ Source of the picture: Nuttapon Pohnprompratahn, TH from Noun Project

Choosing the right lighting units²⁹



Modern, energy-saving light sources, such as LED lamps, are commercially available. We only mention it here as a non-negligible act, but you can read more about this topic in Chapter 6.2.

Taking advantage of natural shading³⁰



One of the biggest problems in our buildings is keeping away the unwanted solar radiation. Cooling overheated buildings consumes a lot of energy, so it is necessary to keep the rate of mechanical cooling to the lowest possible level. The first step is to properly orient the building. There is no doubt that there is a contradiction between the need for shading to keep heat and thus light away, and the need for lighting that provides as much natural daylight as possible, and the need for energy from solar radiation in winter. Of course, this problem also varies by geographical region. This contradiction must be resolved by a well-prepared designer. In addition to orientation, there are adequate tools and structures to simply prevent excess sunlight from entering into the building and thus heating the rooms. The vegetation can be beautifully used for shading. Also, in the past, they used deciduous trees with lush foliage in summer for offering good shading, then losing their leaves in winter and allowing sunlight to pass through. The design of the building, the eaves, the porches and loggias all provide adequate help to keep out unwanted solar radiation. There are also many shading structures made of natural materials. No doubt it is a convenient solution, but if possible, it is essential to avoid the use of motorized shading devices. More detailed description about shading solutions can be found in chapter 5.2.

Taking advantage of natural ventilation³¹



It is easy to save on ventilation. One shall take advantage of the opportunities provided by nature regarding ventilation. In an environment where the air is good, where the users, residents of the building do not need to be particularly protected from health risks, ventilation

29 Source of the picture: icon 54 from the Noun Project

30 Source of the picture: H Alberto Gongora from the Noun Project

31 Source of the picture: Tomas Knopp from the Noun Project

can be achieved by allowing direct fresh air inside. It is an undeniable fact that there is a serious debate in this area representing different views. Many people prioritize mechanical ventilation and there is a lot of truth in that option. Ventilation systems with adequate heat recovery are sufficiently energy efficient by using the heat of the exhaust air. In addition, they provide constant, continuous air exchange. It is not a negligible consideration either that suitable filters can be placed in the ventilation system to filter out various pollens and other particles are responsible for allergic diseases. It is not necessary to abandon these benefits. In cases where the risk of allergies does not exist or is limited to well-defined periods, and the building is located in a geographical region with a climate where heating is not required for a significant part of the year, it is advisable to develop a natural ventilation solution. A detailed description about built-in ventilation can be found in chapter 6.1.b.

Saving water³²



Water is the strategic raw-material of the future. There is no doubt that drinking water is a huge asset and it is not evenly distributed across different geographical regions. It is extremely important to save water. Of course, saving does not mean that you have to avoid taking a bath or drink water. Saving must be achieved through thinking and pre-planned solutions. A lot of water can be saved by paying attention while showering, doing the washing up, washing dishes, cleaning or doing plant care. On one hand the properly selected equipment and faucets do save a lot of water in the bathrooms and kitchens. However, in the event of improper use, even the most professional and purposeful structures do not save water. Personal attention is also needed. Washing machines and dishwashers consume a lot of water, so it is important to consider their water consumption when purchasing them. Water saving should be considered already at the design phase of a building. In order to be able to use grey water to flush the toilet a properly designed and constructed pipe system is required. This must be considered well in advance. Building such a network means a slightly higher investment cost, but it can save a lot of water. If possible, no tap water should be used for plant care, such as garden watering. The easiest way to save water in this instance is to collect rainwater. This is not only possible by using rainwater collection tanks in family houses. On a smaller scale, also in multi-apartment houses, there is a solution for collecting rainwater, which can then be used to care plants.

³² Source of the picture: Luis Prado from the Noun Project

Producing as many vegetables and plants ourselves as possible³³



At first glance, this question seems independent from the topic of the building. While it might be true, there are still many minor correlations. When we grow plants ourselves, we choose what we really need and only as much as we will consume. We pay more attention to our own plants, we care more about them, and they also require less chemicals. Self-grown vegetables do not have to be transported from distant places, possibly from foreign countries, therefore, less transport is needed, so there will be less pollution caused by transport and vehicles. It is possible to grow our own plants in larger quantities in garden houses, however consumable plants that can be grown in small quantities on the terrace, balcony or even on the windowsill of an apartment. We can adapt the cultivation of our own plants to our needs, and we can strive to consume seasonal plants, so we need less storage space and refrigeration equipment. The amount of home-grown vegetables can be better planned, so less waste is produced.

Composting³⁴



Composting has several benefits. There is no need to transport waste and no need to deliver nutrients. This fact reduces the pollution coming from vehicles and the use of chemicals. The compost can be recycled back into the soil of our self-grown plants, thus providing a high-value of nutrients to them. There is a large literature available about composting where relevant information is available for everyone. It is important to inform ourselves about the appropriate solutions. Professional storage and handling larger quantities of compost is possible primarily in garden houses, but composting is possible also in multi-apartment residential buildings. With care and proper handling, compost will not have an unpleasant odour, and with proper disposal it will not disturb the occupants. The best solution is if the residents design and operate the composter in collaboration.

33 Source of the picture: Icongeek26 from the Noun Project

34 Source of the picture: Bakunetsu Kaito from the Noun Project

Separating the waste right at the beginning³⁵



If we manage a problem right at the beginning of the process, it can be solved with less work and more simplicity. The treatment of selective waste must begin at the place and time of its generation. Selecting the parts to be removed selectively from the mixed waste is an inconvenient and unnecessary activity. This can be easily prevented with a properly designed waste collector and waste container and care. The possibilities and rules differ from country to country and settlement to settlement, so it is necessary to find out about the appropriate methods. The separate waste collectors must be designed according to the conditions. It then quickly becomes routine to immediately place the generated waste in the appropriate container. The selectively collected waste saves unnecessary work and unnecessary fuel consumption. With this behaviour, we enable used materials to be reused.

Reusing materials³⁶



There are many opportunities to reuse used or surplus materials. Many of them are already existing best practices that should be replicated. New solutions can be developed according to the habits of everyone's own household and must be used regularly.

It is a good practice to use plastic bottles for storage instead of throwing them away. There are also many possibilities for reusing paper, but in most settlements the selectively collected paper is transported separately. The appropriate part of the organic waste can be composted by sorting it properly, thus saving its removal and obtaining new, useful nutrients.

The importance of recycling is well known by all of us. Recycling generates less waste. There will be less pollution by vehicles; fewer raw materials should be used when using recycled materials.

35 Source of the picture: mynamepong from the Noun Project

36 Source of the picture: Chanut is Industries from the Noun Project

Smart homes, control systems

Smart home solutions are becoming more and more wide-spread. By using them, we can plan better the use of our house and apartment and thus our energy consumption. Pre-programmable thermostats have been used for a long time, with their use, heating can be pre-set according to the planned needs. With the help of smart solutions and control systems, not only the temperature and heating can be controlled programmatically, but also the lighting, shading and, if required, the planned operation of household appliances. By pre-planning in such a way, we can save not only time but also a significant amount of energy. With the help of smart home systems, the house can be controlled remotely, thus creating an opportunity to make the necessary changes.

You can read more about smart home solutions in chapter 6.4.

3.3 Renovation, maintenance



Planning the maintenance of the building³⁷

If we plan in advance the maintenance of the building, we reduce the damage caused by malfunctions. The first steps to take are presented at the phase of design and construction of the building. The basis of a good building is a floor plan corresponding to the function, proper lighting, a well-planned energy design and the use of modern building engineering systems. In the design phase, it is necessary to select construction products of adequate quality and to accurately determine the expected technical performance. This is the responsibility of the designer. This is one of the essential elements of ensuring good quality. By installing quality construction products, which are suitable for a given function we can ensure that the building gets out of order less often and less maintenance will be required.

³⁷ Source of the picture: Lihum Studio from the Noun Project



A building management manual is needed, which includes a maintenance plan. The inspection cycle of each construction product and building structure can be defined. This can be specified by the designer or the manufacturers of the construction products. The first element of a scheduled maintenance is a routine inspection. For example, the manufacturer specifies in the operation manual of the doors and windows, the frequency of inspection and how they should be handled. Similarly, the manufacturers of the mechanical equipment and fittings provide inspection and maintenance instructions.

There are also areas, which are not linked to construction products and where frequent but preventable failures cause damage for the buildings. Most problems are caused by water presenting itself in inappropriate locations. Cleaning the gutter, anti-clogging measures and maintenance can prevent soaking. Hidden pipe breaks can be noticed by checking the water consumption from time to time. Wasting water and damaging structures therefore, can be prevented.

Another important element of scheduled maintenance is the prompt correction of failures that occur during an inspection or unexpectedly. By the replacement of a displaced tile, a full-surface soaking can be prevented, which would cause much more damage. Usually the resident rarely looks at the flat roof insulation; a planned inspection is required. A failure noticed in time can prevent more serious defects like soaking, wetting of the thermal insulation and thus a decrease in the thermal insulation capacity, and less frequently even damaging the supporting structure could all be prevented.

The damage of an element of the facade cladding or of a small part of the facade plaster can be easily repaired. Failing to repair may result in further damage to the facade cladding or facade plaster. The damage to the façade surface is not just an aesthetic problem. For example, water entering into the structure of a building can cause damage over a much larger area and of much greater significance.

It is advisable to document the scheduled maintenance in writing, giving the dates of the inspections in tabular form and recording the detected faults, the measures taken and the repairs. When selling an apartment or a building, this booklet helps the buyer and enhances their confidence.

3.4 Demolition

Demolition is essentially not the responsibility of the user or the resident. Demolition should be left to professionals. When the demolition takes place, neither the residents nor the owners are present.

Demolition activities must be planned in advance, taking into account the general occupational health and safety regulations and other local legal regulations in force. The legislation may require permission, notification, or acknowledgment, but it is also possible that there is no obligation to do so at a given location. It is needless to say that buildings under heritage protection cannot be demolished in any country without strict control and permission. It is also important that the demolition of connecting buildings or those which are structurally connected to adjacent buildings is subject to strict regulations. It is the responsibility of the demolition specialists to ensure that the work is carried out as planned, in a professional and safe way. Strict regulations apply to work with various materials, as well as the protective equipment to be used when dismantling and moving hazardous materials. These rules apply to the shortages caused by the closure of the facility, the safety of neighbours, and the professionalism of work and safety.

During the demolition a lot of debris and waste is generated, which must be constantly monitored and accounted for, therefore the amount of expected waste must be planned when preparing the demolition work. However, demolition

waste is can be seen not only as a problem but can also be useful, as it plays a significant role in the rational management of natural resources and material management. **Waste management** helps to reduce the amount of waste generated, to protect against the harmful effects of waste and to recover waste.



Due to their large volume and quantity the European Union has classified construction and demolition waste as a priority 'waste stream' and aims to recycle 70% of the amount produced in the EU by 2020. To achieve this, the European Parliament published a resolution on a resource-efficient Europe on 24 May 2012. Despite these efforts,

we are still experiencing across Europe serious obstacles to recycling and reusing waste, as there is a high level of distrust towards materials produced from construction and demolition waste in terms of quality and health risks.

The European Commission adopted the New Circular Economy Action Plan in March 2020 which is Europe's new agenda for sustainable growth.³⁸

Waste generated during construction and demolition can consist of a wide variety of materials. It can include bricks, roof tiles and other ceramics, wood, glass, bitumen, metal, concrete and much more. The waste regulations specify the different materials, how they should be handled, stored and transported.

According to their material, construction and demolition waste is classified into eight major groups:

- ▶ excavated soil,
- ▶ concrete debris,
- ▶ asphalt debris,

38 https://ec.europa.eu/environment/strategy/circular-economy-action-plan_hu

- ▶ wood waste,
- ▶ metal waste,
- ▶ plastic waste,
- ▶ mixed construction and demolition waste,
- ▶ waste building materials of mineral origin

Waste and rubbish belonging to the given groups must be collected separately from each other. Waste, which cannot be recovered locally must be disposed in an appropriate landfill.

Waste generated during construction and demolition mostly belong to the group of solid, inorganic, non-hazardous wastes, but in many cases they also contain substances that are unsafe and harmful to health. Examples of such substances are paints, solvents, wood preservatives, etc., which can be flammable and explosive, toxic, irritating, corrosive, allergenic, carcinogenic. These should not be mixed with others under any circumstances.

The construction and demolition waste however, may be used as raw materials or suitable for manufacturing new products in case they are collected separately and treated properly. There is no need to specify that iron and steel or non-ferrous scrap can be recycled by metallurgy. The recycling of aluminium is particularly significant in terms of energy savings. Paper, glass, rubber and plastic can also be reused. Concrete elements, gravel, sand, brick and stone debris can be well used for soil consolidation, backfilling, construction of substructures, embankments or noise barriers.

The builder acts correctly if the selection of building materials and construction products also considers the type of demolition waste generated during the attrition of the building and in case of its renovation or demolition. We must strive to use as few materials as possible that cannot be reused or that will generate hazardous waste.