ComfyHouse: Innovative pedagogies for sustainable building renovations

Energy efficiency of houses program according to the STEAM method of teaching: a combination of math, science, and artfor kids aged 11-15 years

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What exactly makes a building eco-friendly?

The primary aim of any eco-friendly building is to minimize the building's negative impacts and maximize its positive contribution to the natural environment. Eco-friendly buildings are also designed to be beneficial to the people within those spaces. Improved ventilation, insulation, and natural lighting have a positive effect on the house residents and lead to improved health, productivity, and overall quality of life. The design of the house will depend on the type of building, its location, and intended use. Different countries and cities have different building regulations that must be taken into account in conjunction with the building's environmental objectives.

The manual can provides resources for school teachers on how to make our homes more environmentally friendly. In particular, it discusses the following topics:

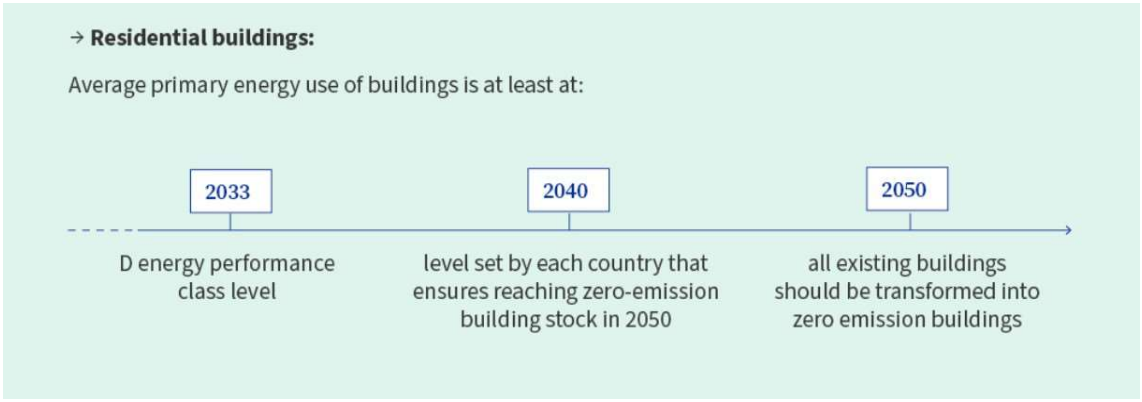
- How to build the house using ecological materials?
- How to place the house in your land?
- How to use natural light, water and plants to improve house efficiency?
- Renewable energy sources.
- Environmental savers.

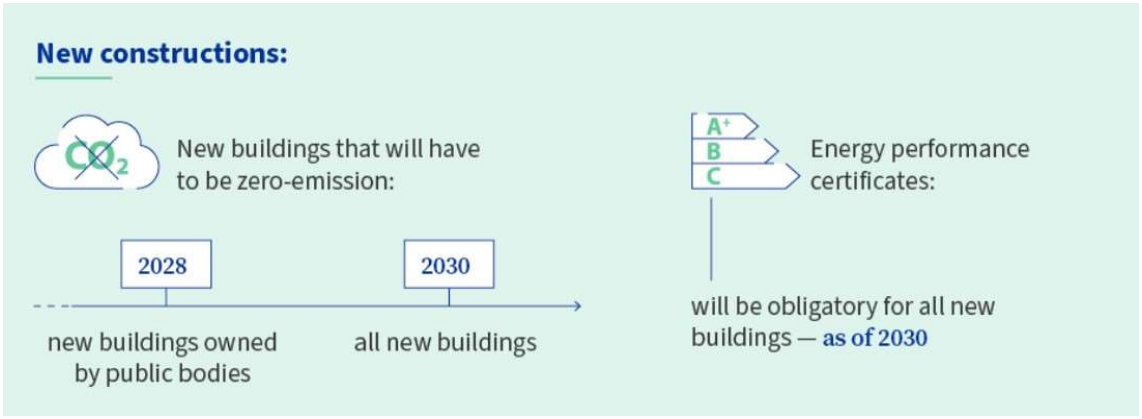
The materials and lessons prepared as part of the project ComfyHouse show the aspect of environmental protection that is closest to the children, namely their family homes, the place where they live and perform their daily activities. Educating children in this area in the future will make them aware of the need to save resources, importance of building energy-efficient homes and using environmental friendly and resources saving solutions.

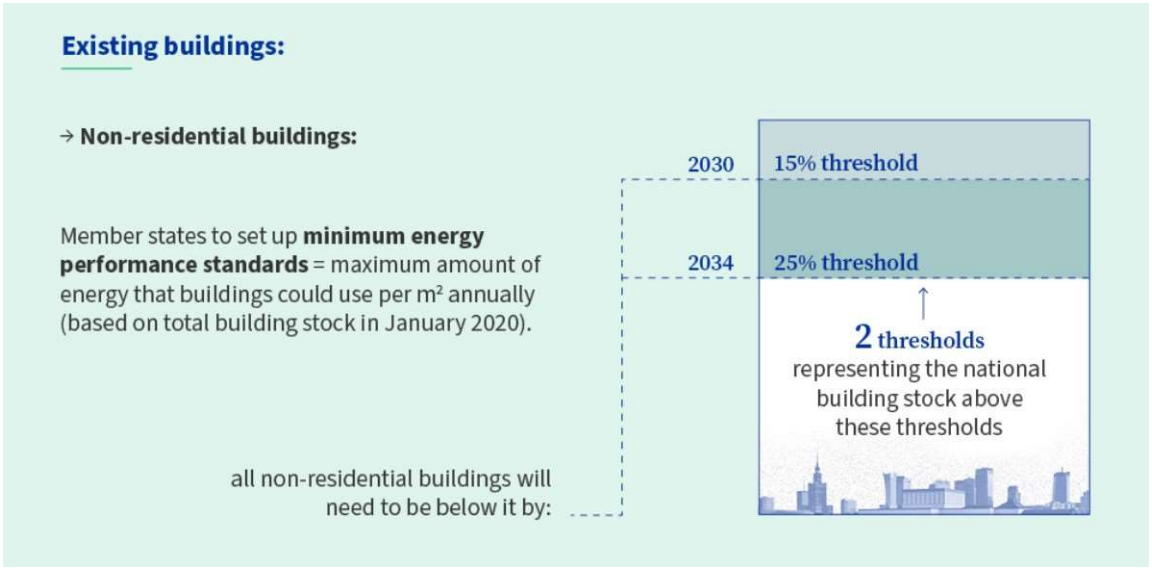
This guide collect in one study the most important information on energy-efficient homes.

This topic is especially important because buildings are responsible for more than a third of EU greenhouse gas emissions.

The European climate law makes reaching the EU's climate goal of reducing EU emissions by at least 55% by 2030 a legal obligation. EU countries are working on new legislation to achieve this goal and make the EU climate neutral by 2050.







Energy-saving and passive house

An energy-saving house, as the name suggests, is an object with reduced energy demand (compared to the standard one). It happens, however, that this term is confused with another very similar one: the concept of a passive house. However, the difference between the two is fundamental.

Energy consumption in a passive house is minimized and amounts to less than 15 kWh/(m²/year), which is much lower than in an energy-efficient house, where it is about 70 kWh/(m²/year). For comparison, the energy demand in a standard single-family residential building is 120 kWh/(m²/year). In addition, it is worth remembering that the energy-efficient house and the passive house also differ in their assumptions. Simply put, an energy-efficient house is one that is built with the least possible energy loss in mind (e.g. through effective insulation). On the other hand, a passive house is one whose construction is focused not only on reducing the energy consumed on a daily basis, but also on obtaining it and reusing it (e.g. through solar panels or an appropriate arrangement of rooms).

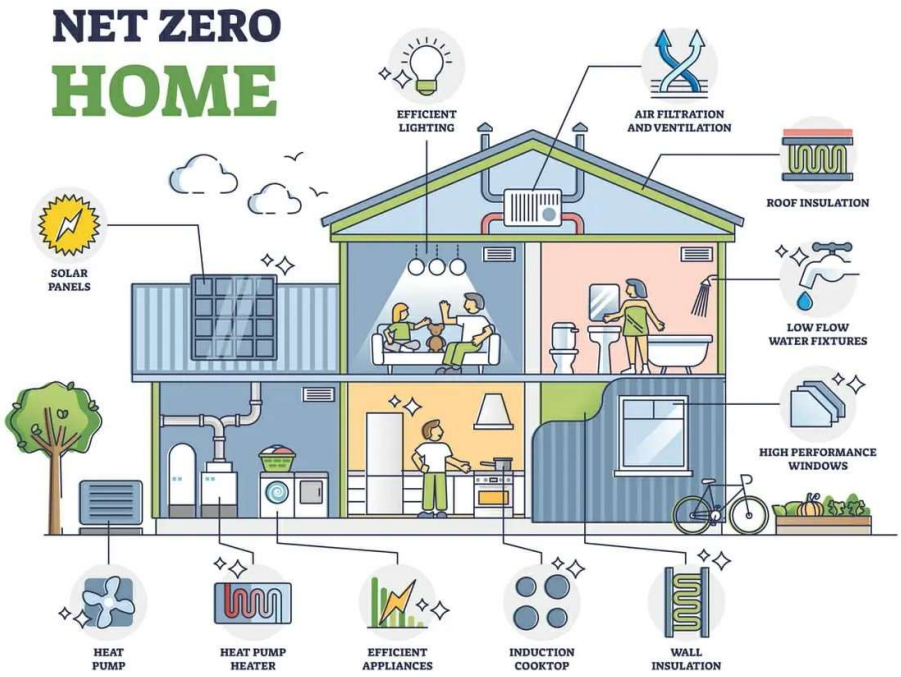
The biggest advantage of zero- and plus-energy houses is significant savings on operating costs. In the case of the latter, there is even a surplus that can be used freely, e.g. to heat water or the whole house. According to the idea, the obtained energy can be resold to the electricity supplier, thanks to which, in theory, even individual investors can earn additional money on the resources that their house produces. In order to obtain an energy self-sufficient house, two aspects must first be taken care of: high-class insulation of the entire building and maximum reduction of heat loss. If our goal is to raise the standard from energy-saving to passive, additional investment in the form of photovoltaic panels will be necessary. It is worth remembering that there must be enough of them and of sufficiently high power to be able to produce energy to heat and service the entire building. In the case of a 140 m² house with heat recovery and efficient insulation systems, an installation of up to 10 kWp will be sufficient. In this case, the building runs entirely on electricity.

While it is obviously easier to build a passive house from the foundation, refurbishing old buildings is more challenging. According to the information placed on the Passive House Institute website, an independent research institute set up in 1996 in Germany, it is possible to achieve energy savings between 75 and 90% when refurbishing existing buildings, considering that not all measures can be applied to all these constructions.

The areas of intervention that have been outlined are:

- improved thermal insulation;
- reduced thermal bridges;
- improved airtightness of the house;
- use of high-quality windows;
- using a ventilation system with efficient heat recovery;
- identifying efficient heat generation;
- using renewable energy sources.

So, there is good news – it is possible for us to reduce our energy use and consumption, thus contributing to the overall goal of safeguarding resources and improving the quality of the environment.


NET ZERO
HOME
EFFICIENT LIGHTING
AIR FILTRATION AND VENTILATION
ROOF INSULATION
SOLAR PANELS
LOW FLOW WATER FIXTURES
HIGH PERFORMANCE WINDOWS
HEAT PUMP
HEAT PUMP HEATER
EFFICIENT APPLIANCES
INDUCTION COOKTOP
WALL INSULATION

Chapter 1. Eco friendly building materials

When it comes to eco-friendly building materials, some people focus on using new materials with great ”green credentials” and those who focus on reusing materials that may not be as eco-friendly as their modern counterparts. Others combine these approaches. New, innovative, eco-friendly materials can require a large initial investment, which will be recovered over time in savings on utilities (and tax concessions in some areas). Reclaimed or reused materials are much cheaper but it can be challenging to find exactly what is needed. Generally, reclaimed materials are used in smaller, more flexible projects and home buildings.

Eco Friendly Green Building with Used Empty Bottles

Examples of eco-friendly building materials include:

- reclaimed wood,
- recycled steel,
- biocomposites,
- bark siding,
- solar roof shingles,
- adobe and rammed earth,
- grasscrete paving,

- ferrok - an environmentally friendly building material used as a substitute for cement. It is mainly made from recycled materials such as scrap iron and silica from crushed glass,
- insulated concrete forms,
- plant-based polyurethane rigid foam,
- straw bales,
- structural insulated panels,
- plastic composite lumber,
- bamboo and hemp,
- low-emissivity window glass,
- vacuum insulation panels,
- mycelium – mushroom insulation and particleboard replacement.

Thermal insulation and airtightness

Although the details vary in different climates, all green buildings must be well insulated and have high levels of airtightness. It is often wrongly assumed that adding insulation to a building will increase the temperature and warm up the building, but this is not the case in summer. Insulation does not generate any additional heat, it only reduces the heat exchange between systems with different temperatures. Therefore, it also protects a cool system from gaining heat from the surroundings.

We can compare a well-insulated house to a thermos - it works just as well for a cold liquid as for a warm one.

https://passipedia.org

Insulation is a great way to improve the energy efficiency of the home. With proper insulation, we will be able to keep the heat in during the winter and the cool air in during the summer. Insulating a home will also make the space more comfortable throughout the year as we will enjoy consistent indoor temperature. In many cases, it will eliminate condensation on walls and ceilings.

To understand why insulation is important, we need to understand thermodynamics. It sounds complicated but it is actually quite simple. Basically, we were told that heat moves from areas of high temperature to low temperature and that warm air rises. This is true, but not always. Heat can move in all sorts of directions. The temperature difference causes heat to move up, down or sideways. The role of insulation is to prevent the air movement. And since air can move in all sorts of directions, insulation is needed in walls, roofs, ceilings and floors to prevent air from entering and leaving.

The effectiveness of insulation is measured by the thermal resistance value, or R-value, a number between 1 and 60 that reflects the material's resistance to heat transfer. The better the insulation, the higher the R-value. This number is determined by the type of insulation, its thickness, density, and where and how the insulation is installed. Typically the cooler the climate, the higher the R-value you will need. The climate, the type of heating and cooling systems installed, and the area of the house to be insulated, all affect the required R-value.

In order to limit our carbon footprint, we need to think about using eco-friendly home insulation options. These materials are primarily made of recycled materials. Ideally, we should go for materials that are not manufactured with a lot of energy. Lots of home insulation materials can also be recycled

later, reducing the amount of waste that is sent to landfills. Using insulation in your home will also significantly reduce energy consumption and energy bills.

What are the ecological materials used to insulate buildings?

- Sheep's Wool

We can use sheep's wool in clothes and blankets to keep us warm, but we can also use it to warm walls and ceilings. This material works just in our homes as it does on a sheep. As we know, sheep can survive long, cold winters on farms and in the mountains. This is because their warm fluffy fleece is able to keep in the warmth, no matter how cold the outside environment gets. Traditionally, many communities have also used sheep's wool to keep warm during the colder seasons. The standard sheep's wool home insulating material is made using 5% to 20% polyester for extra strength. Sheep's wool is probably the best material as far as the environment goes.

- Aerogel

Eco-friendly does not always mean naturally occurring. Aerogel developed in the 1930s, it primarily contains air. Insulating your entire house with aerogel has previously been considered a wild idea, but many people are opting for this insulation material today. The product usually contains silica, but other materials like iron oxide, copper, carbon, gold, and organic polymers can be used to form aerogels. The solid material is only less than 5% of the volume of the aerogel, the rest is filled with air.

- Denim

No, there aren't stacks of jeans inside the walls, the material is rolled into batts like fiberglass. Since this material is made from old denim, it helps to reduce the amount of waste thrown into landfills. Denim also does not contain the dangerous gas formaldehyde. Furthermore, cotton does not cause respiratory problems and it is also an insect repellent.

- Cork

Cork is 100% natural and is considered one of the most environmentally friendly building materials. Cork is made from oak trees, using only the outer bark, and can be recycled. Once it is completed, the material will have a negative carbon footprint, which is why it is considered the most eco-friendly material. It is also very durable and will never need to be replaced. The main disadvantage of this insulation material is that it is costly.

- Polystyrene (Styrofoam)

Polystyrene is a widely-available plastic that is used to make products like toys and packaging. In its expanded form, this plastic has very low thermal conductivity, that makes it great for insulating houses. It has a lot of small bubbles of air inside, and the polystyrene itself is highly resistant to heat. Although it is eco-friendly, this material often ends up in landfills since there are no biological agents that can break it down. Its manufacturing process can also release harmful pollutants into the environment, but it insulates so well that it ultimately saves a lot of energy.

- Cellulose

Cellulose is a fairly popular insulation material for the roofs and walls of modern buildings. The material is made from recycled newsprint and denim, and it is highly environmentally friendly and biodegradable. When using this material for insulation, you will reduce the amount of waste in landfills, which will in turn lower the release of harmful greenhouse gases.

- Icynene

This is a spray foam insulation that is made of castor oil. When sprayed on a surface, it expands by 100 times its volume. A benefit of icynene is that it does not contain any harmful chemicals or blowing agents, and this makes it an eco-friendly insulation.

The ecological house foundations

The foundations are the most important part of the house, the whole structure rests on it. They must be adapted to the size of the house, and the material used in the construction of the house (its heaviness), but for an ecological house, it is also important to insulate the foundations and protect them from moisture. The better the insulation of the foundations, the less energy will be lost to heat or cool the house in the future.

Absence of thermal bridges

Properly insulating a building is not only measured by how much insulation you have but also by whether that insulation is used effectively. Insulation is most effective when it wraps the building uninterrupted by other materials, but there will always be areas where this is not possible, such as around components used for structural reasons. When a material bypasses the insulation, it is known as a thermal bridge and can significantly reduce the effectiveness of insulation, especially if that material is very conductive, like metal.

While understanding wall and roof insulation is relatively straightforward, insulation under the ground floor can be a bit of a mystery by comparison. Not only is it buried in the ground, but there are also difficult places, such as wall-floor junctions that need to be detailed and insulated properly. The design of your foundation often depends on site conditions and the type of structure you are going to build. The most important thing is to ensure high levels of unbroken insulation. That means the entire envelope of the house – roof, walls, windows, and ground floor.

These are parts of the building where different architectural features meet that require additional attention in construction so that thermal bridges can be avoided or minimized as far as possible. Examples include how a window is attached to the walls, how a wall meets a balcony, and how walls meet at corners, edges, connections, and penetrations.

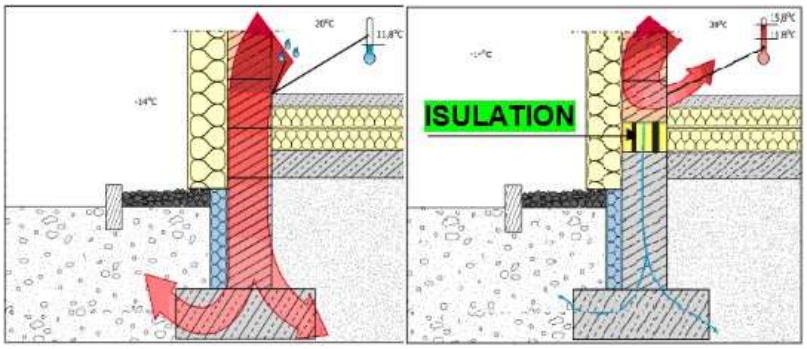
The key is good detailing. This can mean wall insulation that continues down below ground level, reaching down below the floor insulation, and ensuring a sufficient overlap of thermal insulation between the wall insulation and underfloor insulation.

We should remember not to damage the insulation when installing windows, external lighting, lamps, address plates, rain gutters, roller shutters, or other decorative details.

https://www.liderbudowlany.pl

Although it may not seem obvious, the thermal bridges caused by window-to-wall interfaces can have a very large impact. The total perimeter of all the window-to-wall connections can add up to several

kilometers on some projects, so the way a window is installed into an opening plays an important role in minimizing the heat below.



Chapter 2. Eco-friendly solutions for different types of houses

The ”green roofs”

There are plenty of eco-friendly roof designs, and each offers something different for various types ofhomeowners.

- Green roofs**,** called also rooftop gardens, use a layer of small trees, bushes, grass, and other plants fixed over a waterproofing system installed on a flat or slightly sloped roof. He can be a great habitat for insects, birds, and other nearby wildlife.

- Metal Roof, made of materials such as aluminum, copper, galvanized steel, and tin, metal roofs offer a durable, long-lasting, and fully recyclable roof. They’re also a smart and eco-friendly roof option. Metal roofs can last between 40 and 80 years, and some materials, like copper, may last for more than 100 years. In addition, metal roofs are often made from recycled metal and can be recycled again if you would like to replace them, keeping your roof out of the landfill.
- Reclaimed Clay Roof - although building clay roofs is a centuries-old practice, clay roofs turn out to be a highly environmental option. Not only do clay tiles have an average life span of 100 years, but they are also made of all-natural materials, meaning you won’t be adding plastics or other forever chemicals to your roofing. Traditional curved red tiles reflect sunlight due to their lighter terracotta color and air, making them an energy-saving choice in warmer climates.

- Cool Roof - often simply called a “white roof” keeps a house cool by using reflective color. Although it is not often you see white roofs, they are becoming increasingly popular as an energy-efficient alternative to dark, asphalt roof shingles. The lighter colors reflect light, resulting in cooler temperatures inside the house.
- Solar Roof – a solar roof is created from small, high-efficiency, monocrystalline solar panels that imitate the appearance of roof shingles. You can also get similar panels laid flat against your roof. With a solar roof, you can check the energy consumption and goals through active monitoring. This service can be offered in the form of a smartphone app. Many solar roofs and solar energy systems also utilize solar batteries. These batteries are now often designed to work as an electric vehicle (EV) charger. This way, you have a fully integrated, clean, and renewable energy system.

Windows

While the walls typically make up the largest area of a building's facade, the glazing systems (windows and glazed doors) can play an even bigger role when it comes to contributing to space-heating energy. Due to their function (providing light and visibility), glazing systems cannot be insulated to the same degree as a wall, resulting in the windows being the weakest areas of the envelope in terms of heat-flow resistance. Therefore, high-performance glazing systems must be used to reduce that heat flow as much as possible.

What makes a window more sustainable? The materials used to construct them are a top concern. If you want to use window materials that have the least environmental impact possible, this can mean using renewable materials, recycled products, responsibly harvested wood, and other eco-friendly materials. Additionally, windows are more sustainable when they promote better energy efficiency, which is better for the environment and can save you money. The most efficient windows will keep your heated or cooled air where you want it and not let drafts in.

Let's take a closer look at some of the best window materials and the benefits of each:

- Composite materials

Windows are made of two or more different materials. They can be considered an eco-friendly option because they are incredibly durable, energy-efficient, and have excellent insulating abilities.

- Wood

Wood frames take less energy to produce. Wood products can be harvested sustainably because of forests are managed as a renewable resource. Therefore, look for certification of an organization dedicated to responsible forestry management. Wooden window frames also take very little energy to produce compared to other types and do not have harmful by-products or pollution related to their manufacture. Wood frames also make very efficient windows, stand up well to extreme temperatures, and provide a beautiful, natural look for your home.

- Vinyl

Vinyl windows have many benefits that can contribute to the overall sustainability of a home. The manufacturing process for vinyl is not the most planet-friendly, but vinyl is still considered an eco-friendly option because of it is durable, efficient, and recyclable. Vinyl windows require little maintenance and never need to be painted, stained, or refinished, but vinyl windows are prone to warping when heated by the sun and eventually, the seal can fail.

- Glass

The glass used in your windows is a very eco-friendly material. Glass is made from sand, a natural, renewable resource, and is endlessly recyclable. Glass can be melted down and made into new glass products again and again. For an even more sustainable glass choice, we can look for windows **made**

from recycled glass. Much of the home's heat transfer happens through the glass of the windows, so if you choose an eco-friendly, well-insulated glass that is more energy-efficient such as glazed, double- or triple-paned, you will protect your home climate better.

The window frames must be well insulated and can be fitted with argon- or krypton-filled low-emissivity glass to prevent heat transfer.

Draught-proofing

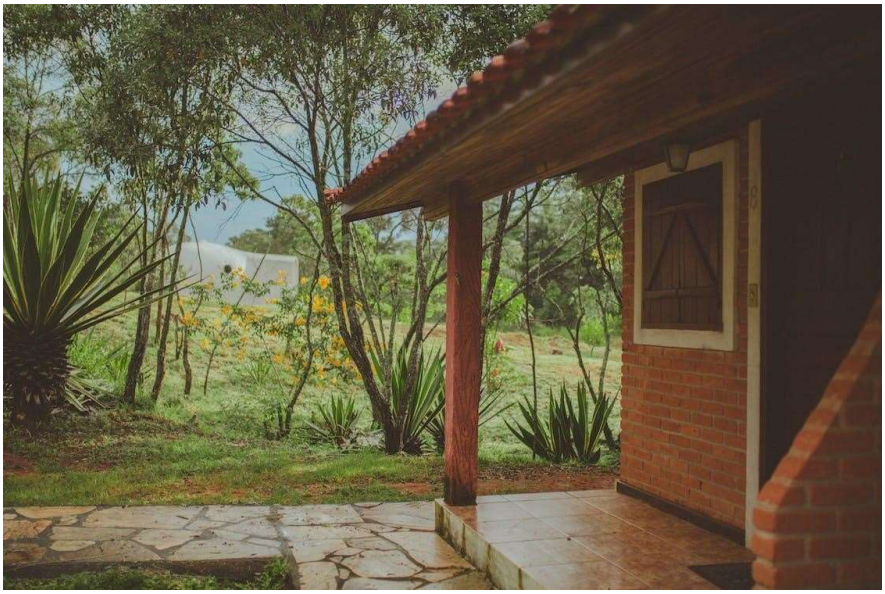
Up to 25% of winter heat loss from existing houses is caused by air leakage (also known as draughts). Seal gaps around doors and windows to draught-proof your home and save energy and money.

Roof overhang

A roof overhang is not just for looks. Properly designed overhanging roofs shelter from the sun in the summer and let it enter during winter. Without a proper overhang, a house will get wet when windows are left open in the rain. The building materials in the weather with no protection from sunlight and rain will deteriorate much faster.

Designing green buildings in hot climates requires additional external shading devices to control solar insulation in the summer. The roof overhang prevents overheating by shading the glazing from the summer sun but allows solar gains from a lower angle of the winter sun.

The rules above can be adapted to suit any climate around the world, the general approach is usually the same. In hotter climates, more attention is paid to cooling measures, such as shading and window ventilation.



However, we can not simply copy all the solutions, because there is a specific building tradition in every country and climatic conditions in every region, but the goals are the same in all climates and for all countries.

In very cold areas, such as mountainous areas, special features can be added to promote the insulation of the house: an entrance hall to limit heat exchanges when opening the main door, doors to insulate corridors, and different floors to concentrate the heat of day rooms or night rooms.

How do you place the house of your dreams on your plot of land?

Where should you place the house and what kind of house is best suited for you?

We all know that the safest road is the one you know. Therefore, the best place to start building a house is in the geographical area you live in, as you know the weather, the soil, the heating necessities, the social needs, and the interactions of the people. Some geographical clarifications about climate are also required and are presented below.

Continental climate

The temperate continental climate is usually specific to the inner parts of the continents, where there arelarge areas of land spread in all directions, and it is sometimes determined by the orientations of mountain ranges.

Other features are:

• Summers are hot (average monthly temperature during summer is 20 to 30 degrees C).

• Winters are harsh (the average monthly temperature during winter is -1 to -40 degrees C).

• Annual precipitation of approximately 500-800mm, especially in summer and spring.

• The west winds are blowing.

• It has 4 seasons.

The climates of Europe:

Continental environments are present in the central parts of the continents, located at great distances from the oceans, most of the time being framed by high mountain systems. These environments are widely spread in Eurasia and North America. Temperate-continental air masses are predominant here, but other air masses (arctic, dry tropical, etc.) also influence the climate. The annual amount of precipitation is below 500 mm, and in the regions interspersed with high mountains severe droughts are recorded.

The large land mass amplifies the effect of the continental climate in both heat absorption and heat loss.

There are different types of climates:

- equatorial climate,
- temperate-continental climate,
- tropical-dry climate,
- polar climate.

An important aspect to consider in choosing the place to build a house is the fact that most of our planet's human population lives in temperate zones, especially in the northern hemisphere.

Even though choosing the familiar climate to place the house of your dreams has a big impact on placing the house, it is also important to study some house models around the world.

Some of the most spectacular houses around the world are the following:

Palafito

These houses are built on stilts/pillars and can be found in lagoon areas, lakes, or even on the coast; they are specific to Argentina, Colombia, Benin, Chile, or Peru.

Igloo

It is generally dome-shaped and constructed of snow blocks, used in frozen areas such as Antarctica and Alaska.

They were usually built by the Eskimos as temporary shelters for hunting reasons, but some igloos serve as permanent houses. There are also igloos with several rooms or groups of small or medium igloos linked together by permanent tunnels. These types of shelters are proof of human adaptability to living in harsh weather conditions.

Ruca

It is the traditional house of the Mapuche tribe, who live in Chile and Argentina.

They are built from reeds or straw, using only natural materials. They are always oriented to the east. In the past, building a ruca required the permission of the Ngen-mapu spirit. Also, ruca houses are proof that human beings have always been preoccupied with the environment, as the houses are built from natural materials, with little impact on the environment.

Tipi

It consists of a cone-shaped tent covered with animal skins and fixed with wooden sticks.

The most important thing is that it is a transportable house, which makes it perfect for the way of living in these villages. This type of housing was used by the indigenous peoples of the Great Plains and the Canadian Prairies of North America. This type of house is a classic of Western films and it originates from the native peoples of the United States. The tipi house is the equivalent of a mobile home showing the fact that man has always sought the comfort of houses that can be moved.

Iurta

Another type of house that can be transported and is easy to disassemble is a kurta, used by the nomadic peoples of Asia. It has a rounded shape and is covered with waterproof material. In the past, it used to be covered with wool and straw.

The criterion of easy transportation is an important aspect in building these houses, reaffirming that houses have always been a natural extension of the human being.

Wigwam

Another ecological house is the wigwam, used by American Indians. It had the shape of a dome and the roof was made of grass, bush, bark, clothes, mats, reeds, skins, or cloth. It was not portable like the tipi house or your house.

Hanok

The traditional house from Korea is a very durable one and it is made of natural materials such asmud, wooden beams, tiles, and nails.

Minka

It is a Japanese country house built in the traditional manner, using simple materials such as bamboo, earth, and straw. The Japanese, aware of the disappearance of rural architecture, have refurbished villages with such houses (Ex; the village of SHIRAKAWA-GO).

Trullo

This is an old rural building with stone masonry walls. The houses had a conical shape and were decorated with figures that referred to the spiritual and magical. They can be found in the region of Apulia, Italy, and have dry stone masonry walls.

Underground houses

Used frequently during the oil crises in the United States, but also found in other regions around the world, this type of house is similar to creating your cave, but keeping as much as possible the appearance of a normal house. It takes advantage of the geological formations of the earth to make greatwalls that protect it against extreme temperatures.

Izba

Traditional Russian houses are made of wood. In the past, the boards were fastened with ropes and therewas a rather large stove in the house. As the winters were very cold, people used to sleep on boards built on the top of the stove.

Mudhif

This house is the traditional home of the Madan (Arabs who live in the swamps of southern Iraq). It is made of cane.

Houses from totara

They can be found on the floating islands of Lake Titicaca in Peru and are built from totora.

After deciding on the location and the shape of the house, some basic knowledge about building a house is needed.

Science and technology

Depending on the position relative to the ground level, the buildings have three parts:

- **The foundation** - located below the natural ground level. This offers safety and stability; it is made of reinforced concrete with steel bars or nets. Natural materials (sand, gravel, water) and cement (as a binder) are used to lay the foundation of the house;
- **Elevation -** located above the natural ground level, consisting of walls, slabs, and pillars. The walls arebuilt from brick, autoclaved cellular concrete (BCA), large prefabricated panels, soil or clay (ecological material), wood (natural material), glass, and others. The pillars are made of reinforcedconcrete, wood, or masonry. The floors separate the building vertically or close it at the top and are made of reinforced concrete or wood;

- **The roof -** the element that closes the building in the upper part.

Also, there are aspects of **Quality in construction** that need to be taken into consideration**.**

The quality of the constructions resides in their behavior during the entire exploitation period. Quality constructions must correspond to their destination, protect people's lives and their goods, be useful to society, and not affect the environment. It must also comply with rules regarding strength and stability, hygiene, people's health, fire and earthquake safety, noise protection, thermal insulation, waterproofing and energy saving, restoration, and environmental protection.

Safety and security in construction is an important aspect, too.

Safety in constructions refers to their ability to protect people, animals, and material goods existing inside or around them so that they are not in danger. Safety during the use of buildings takes into account:

- the safety of pedestrian traffic, which involves protection against the risk of injury by slipping, hitting, or falling;
- safety regarding the risks arising from the electrical, thermal, ventilation, and sanitary installations, which implies protection against the risk of injury through electrocution, explosion due to gas accumulation, intoxication with harmful substances, burns, or scalding;
- burglary security.

Security in constructions refers to their ability to respond to the risk of certain phenomena or processes such as fire, earthquake, strong wind, and floods.

Types of houses

There is a wide variety of houses, each adapted to the specific needs and conditions of the area in which they are built. Some examples of house types include:

- **Traditional houses** - these are houses built to incorporate traditional styles and local materials. They can be built from wood, stone, clay, or other local materials.
- **Modern houses** - these are houses built using modern technologies and materials, such as concrete, glass, and steel. They are adapted to modern lifestyles and are often built to be more energyefficient.
- **Ecological houses** - these are houses built with environmentally friendly materials and technologies. These can include solar panels, rainwater storage systems, and natural thermal insulation.
- **Prefab houses** - these are houses built from components manufactured in factories and then assembled on site. They are quick and easy to build and can be adapted to modern lifestyles.

- **Mountain houses** - are built to withstand extreme environmental conditions such as cold temperatures and large amounts of snow. They can be built from local materials such as wood, stone, or clay, and can be thermally insulated to keep the heat inside. Other features of mountain homes include pitched roofs to allow snow to run off, covered patios to protect from wind and snow, and large windows to let in natural light.
- **Houses in hilly areas** - are built to cope with the sloping terrain and to adapt to the topography of the area. They can be built of stone or brick and have pitched roofs to fit the sloping terrain. Other features of hillside houses include covered terraces, which provide a beautiful view and sitting area, and raised floors, which allow ventilation under the floor to prevent dampness.
- **Lowland houses** - are built to withstand high temperatures and strong winds. They can be built of brick, concrete, or stone, and the roofs can be flat or slightly pitched. Other features of lowland houses include large verandas or terraces to allow cooling on hot days and large windows to allow air circulation.

Choosing a suitable plot of land for the construction is essential to the success of the project. Here are some factors that need to be taken into consideration when choosing a plot of land for the construction of the house:

- **Location** - It is important to choose a location that suits your needs and lifestyle. If you have children, it may be important to choose an area with good schools and play areas. If you work in a specific city or area, it can be helpful to choose a location close to your workplace.
- **Land size and shape** - It is important to choose a plot of land that matches the size and plan of the house you want to build. It is also important to check if the land has any shapes or configurations that could limit construction or increase construction costs.
- **Access to utilities** - Make sure the land has access to necessary utilities such as drinkable water, sewerage system, electricity, and natural gas. Also, check if the land is connected to the public sewerage system, otherwise, you will need to install an independent system.
- **Topography of the land** - It is important to check the topography of the land and make sure there are no problems with landslides or flooding. You also need to consider drainage and make sure the land is suitable for building a solid foundation.
- **Construction zone** - Check with local authorities if there are any restrictions on construction in the area or if there are any special construction requirements (e.g. special roofing materials, colors, etc.). Also, check if there are plans for new construction in the area that could affect the quality of lifeor property value.

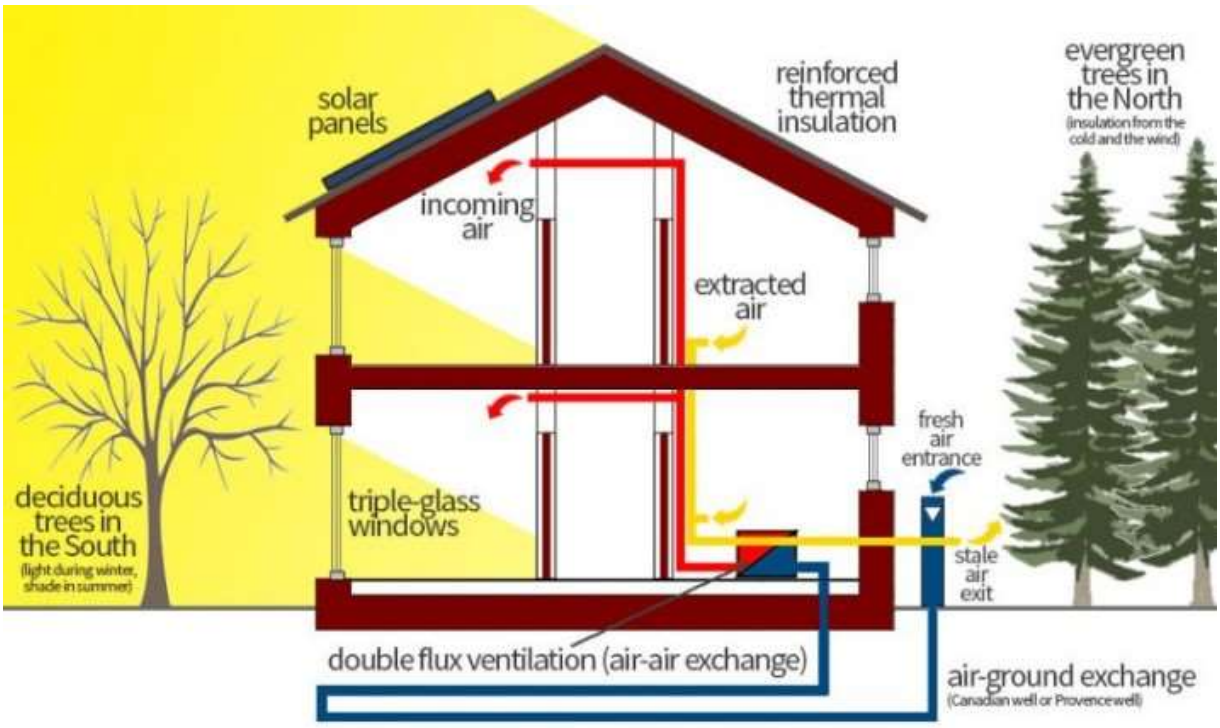
- **Budget** - Finally, make sure the plot of land you choose is within your budget. Consider acquisition costs, construction costs, maintenance costs, and any additional costs (for example, to connect the property to the main road or to do a soil survey).

It is important to consider all these factors and do further research before making a final decision. It is also recommended that you speak to an architect or structural engineer for professional advice and guidance.

Other key factors influence the construction of a house:

- **Design and style -** The design and style of the house are also important factors that influence the construction of the house. It is important to consider the tastes and preferences of the homeowner, as well as the architectural features of the area where the house is located.
- **Land size and configuration:** The size and configuration of the land can influence the design and size of the house. For example, if the lot is small, a multi-story house may be needed to have enough space. The terrain can also influence the position and orientation of the house.
- **Building materials:** The building materials used for the construction of the house are important from an aesthetic point of view, but cost and durability also need to be considered. For example, some materials may be more expensive than others but may offer greater durability or be more aesthetically pleasant.
- **Climatic conditions:** The climatic conditions of the area where the house is located can influence the design and materials used for construction. For example, in areas with very high or very low temperatures, special building materials may be necessary to ensure adequate thermal insulation.
- **Interior design:** The interior design of the house can influence the layout of the house, especially in terms of the number and size of rooms. It is important to consider the preferences of the homeowner in terms of interior design, to create a comfortable and pleasant living space.

Chapter 3. Can we use natural light, water,and plants to improve house efficiency?



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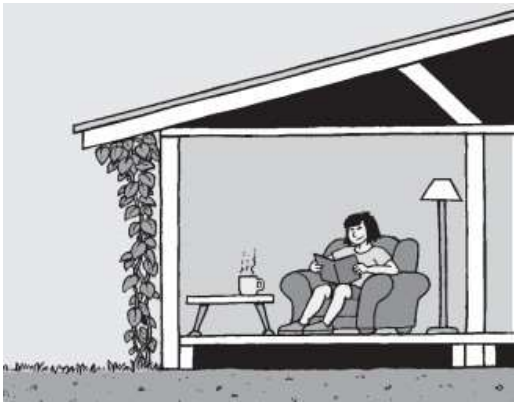
Natural light

For deciduous species, planting a tree on the west side of your house is typically the most effective for summertime cooling, specifically if the canopy shades windows and portions of the roof. Another effective spot is to the south. Plant deciduous trees close to the house, in the sun's path, but not right up against the wall.

Vines on the outside wall and around windows can increase the effectiveness of an insulated wall. The air space left between the walls/windows and the vine reduces the absorption of summer heat and reduces winter heat loss.



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Plants

Natural shading can be achieved by planting specific trees, shrubs, and vines to shade the house from the summer sun and also provide outdoor shade for summer and significantly reduce the ground temperature around the house.

In cold and temperate climates it is best to allow wintertime sunlight to reach those south-facing windows and reduce the need for mechanical heating.

We should use trees with non-invasive roots so as not to damage pipes and foundations.

A good solution for an eco-home is a green roof, which has many benefits at economic, ecological, and societal levels. A green roof provides a rainwater buffer, purifies the air, reduces the ambient temperature, regulates the indoor temperature, saves energy, and encourages biodiversity. Green roofs are part of climate-proof construction. What's more, people are happier in a green environment than in grey surroundings.

A Living Roof, called an eco-roof, garden roof, vegetated roof, a green roof is a lightweight, layered roofing system that allows virtually maintenance-free plants to top a waterproofed substructure. If you have been hearing more about them lately, that is because the technology has become simpler, making installations, especially residential ones, more common.

Eco-roofs help to purify the air by absorbing pollutants; soak up rainwater, thereby reducing storm-water runoff that pollutes rivers and streams; and keep a rooftop 10 to 20 degrees cooler in the summer and warmer in the winter, which means lowered air conditioning and heating bills, fewer fossil fuels wasted, and a healthier environment.

“Extensive” systems are the lighter, low-maintenance variety, usually planted with hardy, drought-tolerant perennials such as sedums and other succulents. Because an extensive system requires no watering or special care, it’s environmentally preferred.

It is recommended to do some research and consult with a local nursery for advice on what and where to plant. To take benefit of the advantages that plants give us, we should know evergreen trees, plants that survive drought, trees specific to different geographic areas, rainwater, and green roofs. All this helps us make the best decisions when building a house.

Trees that remain green throughout the year and do not lose their leaves are called perennial trees or plants. They maintain their foliage all the time due to mechanisms of adaptation to lower temperatures or drought. Some examples of trees that remain green throughout the year include:

- Fir - a tree with perennial needles, which maintains its foliage throughout the year.
- Spruce - is another evergreen tree with needles that stay green even in the coldest areas.
- Juniper - this tree has needle-like leaves and stays green all year round.
- Laurel oak - this is a tree with lance-shaped leaves that remain green throughout the year and thrives in the Mediterranean climate.
- Magnolia - some magnolia species are perennial, retaining their foliage throughout the year.

These are just a few examples of trees that remain green throughout the year, but many other species of perennial plants retain their leaves even during winter or drought periods.

Several plants have developed special mechanisms to adapt to drought conditions and can survive prolonged periods of water deprivation. These plants are called xerophils or succulents and evolved in arid or semi-arid areas where water is a limited resource.

Some examples of drought-tolerant plants include:

- Cacti - these are among the most well-known succulent plants and can store water intheir stems and leaves.
- Aloe vera - this succulent plant can survive in extreme drought conditions as it can store water in its thick leaves.
- Lavender - this aromatic plant needs little water and thrives in dry, well-drained soils.
- Yucca - this plant has a strong root system and can survive in areas with little water.
- Sage - this plant has dense leaves and grows well in dry areas, being also used in medicine due to its antioxidant properties.
- Thyme - this aromatic herb has small, dense leaves and can withstand drought conditions and poor soils.

These are just a few examples of plants that can withstand drought, but many other species have developed a mechanism to adapt to extreme environmental conditions. It is important to choose the right plants for the environment we live in, to minimize water consumption and protect the environment.

The northern areas of the Earth have a cold and harsh climate, characterized by long, cold winters with very low temperatures and heavy snow. Under these conditions, the trees that grow in these areas must be adapted to extreme temperatures and poor and acidic soils.

Some examples of trees found in northern areas:

- Spruce - a tree that grows in the boreal forests of Canada, Russia, Scandinavia, and Alaska. It has evergreen needles and adapts well to low temperatures.
- Fir - is a common tree in northern forests and is traditionally used in the production of paper and timber. It can grow at high altitudes and adapt well to extreme environmental conditions.
- Pine - is a tree that grows in the boreal areas of Europe, Russia, and Canada. It has persistent needles and adapts well to poor soils and low temperatures.
- Aspen - is a tree that grows in wet and swampy areas in northern regions. It can survive low temperatures and poor soil conditions.
- Maple - this tree is found in the forests of northern areas and can adapt to low temperatures and poor soils.

These are just a few examples of trees found in northern areas. Other trees that can survive these harsh conditions include birch, hazel, lime, and maple.

The subpolar area is a region characterized by cold temperatures, long winters, and short summers. In these conditions, the trees that grow in this area must be adapted to low temperatures and extreme environmental conditions.

Some examples of trees that are found in subpolar areas:

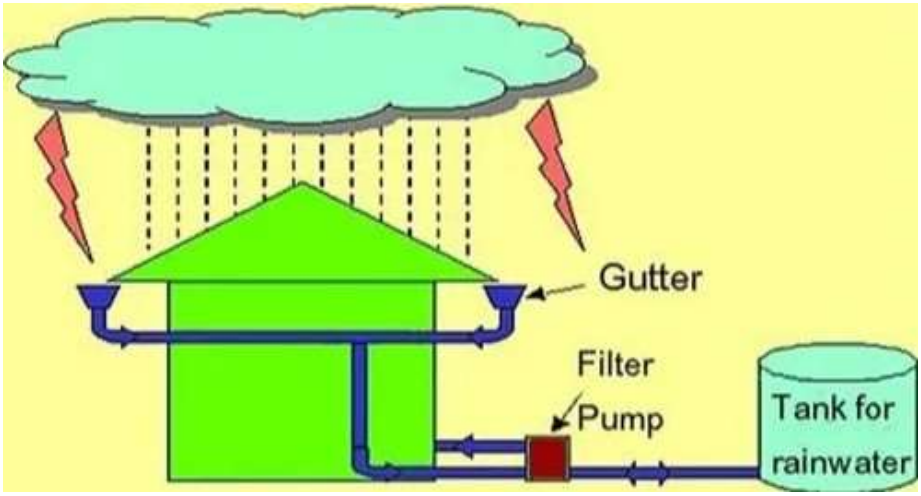
- Siberian spruce (Picea obovata) - is a deciduous tree that grows in the subpolar areas of Northern Asia and Europe. This is one of the most important commercial trees in the region, being used in the production of lumber and paper.
- Siberian larch (Larix sibirica) - is a tree that grows in the subpolar regions of Siberia, Russia. This is one of the few trees that sheds its leaves every fall.
- Tundra maple (Acer spicatum) - is a tree that grows in the subpolar regions of North America. This is a small tree with small, glossy leaves that change color in autumn.

- Polar willow (Salix polaris) - is a small tree that grows in the subpolar areas of Canada and Greenland. This is one of the few trees that can survive the extreme conditions of this region.
- Siberian pine (Pinus sibirica) - is a tree that grows in the subpolar regions of Siberia. This is one of the most important commercial trees in the region, being used in the production of lumber and paper.

These are just a few examples of trees that are found in the subpolar regions. Other trees that can survive these conditions include birch, lime, and alder.

Rainwater harvesting for sanitary use and watering the garden

Water is an essential need in the garden. Rainwater harvesting for use in the garden helps us to use water that would otherwise go to waste. Having rainwater around the garden is very convenient, during a dry spring it's a must-have. Rainwater is free, fairly clean water that is a gift from the sky. Even though the water is free, harvesting it might not be legal at your place. Usually, however, if you only use the water in the garden and not in the house, it is not a problem. If in doubt, check with your local municipality.



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Chapter 4. Renewable energy sources

Alternative, renewable energy is currently not only a fashionable term but also a relevant and promising field of energy production.

Increasing energy needs as well as depleting fuel resources and increasing environmental pollution, force mankind to search for ways to use energy that is renewable and not so harmful to the environment. Nowadays already available renewable energy sources are running water, solar energy, and wind as well as sea waves and tides plus geothermal heat.

Wind energy

Wind energy has been used in various countries since ancient times. In the Middle Ages, windmills were used to grind grain, and nowadays wind is increasingly used to generate electricity. Wind energy, like flowing water, now has the greatest commercial importance in the world. There are many places on earth where strong winds blow. Wind energy is the fastest-growing form of all renewable methods of energy.

Wind turbines come in many different types and sizes. Diverse turbines are adapted to different wind speeds, but higher wind turbines produce more electricity. To produce a larger amount of electricity, wind turbines are often connected to wind farms. The best places for setting up wind farms are hilltops, plains, and sea coasts. More and more wind farms are being installed in the open seas, several tens of kilometers from the coast, because this is where the strongest winds blow.

Unfortunately, due to the limited infrastructure of transmission networks, it can be difficult to build a wind farm anywhere.

The optimal height of a wind power plant built for commercial purposes is 30 m, and the distance between the wing blades is 35 m or more. Installing and maintaining such a power plant is expensive, therefore, for economic reasons, a complex of at least 25 wind power plants - a wind park - is usually built in one place. By the way, the first wind farms were built in California (USA). One of the world's largest wind farms is near San Francisco, where 8,000 wind turbines are installed in a small area. Most of the wind power plants are now being built in European countries. Germany is the leader in the use of wind energy. In 2030, such an energy source should provide about 40% of the produced electricity. Like all other types of renewable energy sources, wind energy has both advantages and disadvantages.

Advantages: it does not pollute the environment with harmful substances as well as does not promote the greenhouse effect. The installation of power plants also has little effect on the

surrounding ecosystem. In addition, the winds are the strongest in winter, when electricity needs are the highest. Plus the construction of wind farms is expensive but the cost of the electricity produced is low. As wind farms are built in rural areas, new jobs are created and farmers can start businesses and increase their income.

Disadvantages: the wind strength is not uniform, and it is impossible to generate electricity when the wind blow is insufficient. On the contrary, when they are strong for example during strong storms, the excess of it cannot be stored. Moreover, wind power plants darken the landscape and also harm people's health with the noise, causing radio and television interference displeasing people living nearby. What is more, many animals leave such places.

Hydropower

It can be generated from reservoirs and rivers. Reservoir hydropower plants rely on stored water in a reservoir, while run-of-river hydropower plants harness energy from the available flow of the river. Hydropower reservoirs often have multiple uses - providing drinking water, water for irrigation, flood and drought control, navigation services, as well as energy supply. This is one of the most important and widely used renewable energy sources. Currently, the falling water‘s energy is mainly used for building dams and installing hydroelectric power plants nearby.

When a dam is built, the water level is higher on one side and lower on the other. A stream of falling water is formed causing turning turbines, and these are generators that produce electricity. Hydroelectric plants are especially suitable for being built in mountains where the slope of the rivers is high. And about 30% of water energy resources in the world are being produced. Countries such as China, Brazil, Russia, and Canada have the greatest potential in this area. There are states where hydroelectric power plants produce all or most of their electricity (100% in Paraguay, and 97% in Norway. Many developing countries have great opportunities to use flowing water‘s energy as well. They mainly build small hydropower plants. It is estimated that if all possible resources of flowing water are used, about 40 percent of the world's electricity would be produced.

Advantages: the energy of flowing water is inexhaustible. Hydroelectric power plants are built in sparsely populated areas, they have a long operating time, and the price of the produced electricity and operating costs are low since no fuel is needed. Electricity generation is considered clean and ponds can store water and reduce the risk of floods supplying water during droughts.

Disadvantages: installation of dams in addition to construction of power transmission lines is expensive and takes a long time. After the construction of dams, water bodies are formed, which sometimes flood a huge area. People living there are being removed to other places and they lose a

lot of land. Furthermore, vegetation and animals are destroyed. Because of the earthquakes' landslides, the dam might collapse creating devastating floods in the river valleys.

Wave energy

Wave energy is another form of renewable energy that can be used as an alternative to traditional energy from fossil fuels – finite resources that release harmful carbon emissions into the air when harnessed for energy. Waves, especially when there is a strong wind, produce a lot of energy therefore they can be used to generate energy. Unfortunately, it was proven difficult to create materials that could withstand the destructive force of waves and convert wave energy into electricity. The first wave energy collector is installed in Scotland. Small power plants powered by wave energy are located on the coast of Norway and Japan. The energy produced is used to supply the lighthouses. But after several years of testing these projects were abandoned due to technical difficulties.

Tidal energy

Since ancient times people have thought about how to harness the energy of tides. Mills were built in areas where water flowed at a speed of 6 km/h during high tides. They used to mill grain, sawed wood, and crushed plaster in them. This energy is quite reliable and can be used where the amplitude of the tides is large. The blades of such electric turbines are arranged in such a way that they can be rotated by both rising and falling water. The technique of using tidal energy is proven and pays off butit requires huge funds to be implemented. Tidal power plants are a clean and safe source of energy but they prevent fish from spawning and tidal waters flood swamps. Tidal power plants of various capacities operate in France, Russia, Canada, China, and other countries.

Geothermal energy

Geothermal energy is heat energy from the earth—Geo (earth) + thermal (heat). Geothermal resources are reservoirs of hot water that exist or are human-made at varying temperatures and depths below the Earth's surface. Wells, ranging from a few feet to several miles deep, can be drilled into underground reservoirs to tap steam and very hot water that can be brought to the surface for use in a variety of applications, including electricity generation, direct use, and heating and cooling. In some places, cold water is pumped into the depths of the Earth through boreholes. It heats up there and rises to the surface as steam. An example of the use of geothermal energy is Iceland, where the heat from the depths is used to heat the streets, settlements, and greenhouses of the capital

Reykjavik. In addition, this energy source is used quite widely in New Zealand, Japan, and Central American countries.

Advantages: renewable and almost non-polluting. It produces a high amount of extracted energy. And the energy is used to heat homes and generate electricity.

Disadvantages: high costs of construction and maintenance of facilities. Power plants and pipelines are at risk because of earthquakes and volcanic eruptions. Several harmful gasses rise to the surface with the steam as well.

Solar energy

Solar energy is the most abundant of all energy resources and can even be harnessed in cloudy weather. The rate at which solar energy is intercepted by the Earth is about 10,000 times greater than the rate at which humankind consumes energy.

Solar technologies can deliver heat, cooling, natural lighting, electricity, and fuels for a host of applications. Solar technologies convert sunlight into electrical energy either through photovoltaic panels or through mirrors that concentrate solar radiation. Although not all countries are equally endowed with solar energy, a significant contribution to the energy mix from direct solar energy is possible for every country. The cost of manufacturing solar panels has plummeted dramatically in the last decade, making them not only affordable but often the cheapest form of electricity. Solar panels have a lifespan of roughly 30 years and come in a variety of shades depending on the type of material used in manufacturing.

Harnessing the energy provided by the sun is not so easy. It is the easiest to take it for heating - the object built in the sun heats up, so you can even heat water for home use. To produce electricity ourselves, we have to use complex mechanisms. One of them is the use of solar cells to generate electricity. A solar cell is a device that converts sunlight into electricity. This is allowed by theadditive photovoltaic effect. When the material that makes up the solar cell absorbs a photon of the right wavelength, the electrodes in it gain more energy. This allows them to move more freely in the material. The movement of these electrons creates an electric current.

Bioenergy

Bioenergy is produced from a variety of organic materials, called biomass, such as wood, charcoal, dung, and other manures for heat and power production, and crops for liquid biofuels. Most biomass is used in rural areas for cooking, lighting, and space heating, generally by poorer populations in developing countries.

Modern biomass systems include dedicated crops or trees, residues from agriculture and forestry, and various organic waste streams.

The energy created by burning biomass creates greenhouse gas emissions but at lower levels than burning fossil fuels like coal, oil, or gas. However, bioenergy should only be used in limited applications, given the potential negative environmental impacts related to large-scale increases in forestand bioenergy plantations, and resulting deforestation and land-use change.

Such raw materials as sugar (from sugar cane and sugar beet) and starch (from potatoes and grains) and biodiesel produced from vegetable oil (rapeseed, flax, soy, sunflower, etc.) and alcohol (from methanol or ethanol) can be used to produce bioenergy as well.

Air source energy

Air source energy is a type of energy present in nature, renewable and free. Air source energy is defined as energy stored in the form of heat in the air. This is possible because thermal energy can be extracted from the air around us, and for this, we need an air source heat pump. An air source heat pump extracts the energy contained in the air, even when we are at negative temperatures, and transfers this energy for the production of heating and domestic hot water. Furthermore, an air source heat pump is capable of producing cold in our home, even when we are at high temperatures, ensuring comfort throughout the year. The air source heat pumps consist of a thermodynamic cycle that uses a refrigerating gas in its interior capable of being compressed at a very low temperature to extract heat from the exterior air. Normally, air source heat pumps are made up of two parts: an exterior module where the refrigerating circuit is located and an interior module where the control unit and the rest of the elements needed in the installation are located, with different combinations.

An aerothermal heat pump has an efficiency of 4 to 1, that is, for each kW consumed by the heat pump, it is capable of producing 4 kW of heat. Thanks to this, the savings achieved in a home are spectacular, significantly reducing the heating bill. The operating principle of the new heat pump is so economical that the amount of electricity used to produce heat energy can be up to 80% less than that of electric radiators.

Heat pumps are machines that can be used to heat buildings and provide hot water using renewable energy sources such as the air, in turn, the ground, or water. Here's how the heat pumps work, explained in a way children can understand: A heat pump consists of three main parts: an evaporator, a compressor, and a condenser. A vaporizer is like a large metal box that is usually located on the outside of a building.

Inside the evaporator, there is a special liquid, which is called a refrigerant (freon), which can absorb heat from the air or the ground. The refrigerant starts as a liquid but turns into a gas as it absorbs the heat. The compressor is like a big pump inside the heat pump. It takes the gaseous refrigerant from the evaporator and squeezes it very hard, causing it to heat up even more. These hot gases then enter the condenser, which is usually located inside the building. A condenser is like a large radiator used to heat a building. The hot gas from the compressor passes through some condenser coils, which are supplemented with cool air or water. As the hot gas moves through the coils, it releases heat that warms the air or water. As heat is released from the hot gas, it turns back into a liquid and returns to the evaporator to start the process all over again. In summary, heat pumps work by using a special liquid called refrigerant to absorb heat from the air or the ground. The refrigerant is then compressed, making it even hotter, and then is released into the building to heat the air or water. This process is repeated over and over to keep the building warm while providing a hot water supply as well.

Advantages:

• Energy efficiency: heat pumps are good at converting the energy they use into heat. This means they can heat buildings and water using less energy than other heating systems such as gas boilers.

• Renewable. Heat pumps use energy from natural sources such as air, earth, or water, which are constantly being replenished. This signifies that the heat pumps are a source of renewable energy, which is good for the planet.

• Low carbon emissions: heat pumps do not burn fossil fuels such as gas or oil, so no harmful gases are produced. Instead, they use renewable energy sources that emit very little harmful gases.

• Universal. Heat pumps can also be used to cool buildings, so they are really useful in warm climates or in the summer.

Disadvantages:

• High initial costs: Heat pumps can be very expensive to buy and install. And this means that they may not be affordable for everyone.

• Depending on location. Heat pumps must be installed where there is sufficient space, a suitable heat source, and a heat distribution method. This means that they may not be suitable for every building or location.

• Weather dependent. If it's very cold outside, air source heat pumps can become less efficient, meaning they may not perform as well in very cold weather.

• Maintenance. For heat pumps to work properly, they need to be done properly.

Chapter 5. Environmental saving measures

The entire modern economy and people's way of life are based on the use of electricity.
It is needed every day and almost everywhere: in the home, in manufacturing, in tourism, in services and industry, in medicine and science. Although electricity is produced in many different ways today, it is not provided to people for free. On the contrary, electricity, like other products, tends to become more expensive. Saving electricity is not only worthwhile to reduce household costs, but alsoto contribute to saving the planet. After all, being resourceful is not only useful but also fashionable. To reduce the cost of electricity use, it is important to know what you use it for in your home in the first place. Most of the energy is consumed by the most important and commonly used large appliances: the fridge, oven, washing machine, tumble dryer, etc. The heater and air conditioning come second. Lighting, small appliances, and electronics are in third place.
Households use energy for space heating, hot water, general electricity, cooking, and cooling.

Energy saving steps in households

Step I: Starting with the habits that determine energy consumption (behavioral transformation):

1. Working remotely (at least 2-3 days a week if you drive your car to the workplace). It's good to know that a laptop consumes up to 90% less electricity than a stationary computer.

2. Reducing indoor temperature:

- Reduce the temperature by 1 degree (or more, but under hygienic conditions);
- Reduce the temperature to 17-18 degrees when you are not at home and night.
- The temperature in the kitchen can be lowered, as it is usually warm anyway because of the heat from steaming pots, ovens, etc.

3. Use the washing machine efficiently:

- wash with a full load;
- wash in cold water (depending on the situation);
- use the delay function (using the night rate).

4. Use your fridge efficiently:

- do not leave the door open and wipe the rubber seals on the door;
- regularly clean the heatsink on the back of the fridge.

- It is also important to pay attention to where the fridge is placed. If you put the fridge near a window with direct sunlight, a radiator, or another heat source on the side, it may be a top-end economy model, but it will still consume a lot of electricity.

- periodically defrost the fridge;

- set the temperature higher according to the food storage conditions.

5. Efficient use of air conditioning. In summer, many people install cooling systems to avoid the sun streaming through their windows. Air conditioning accounts for around 17% of a household's average annual electricity consumption. And on hotter days, maybe even more. Adjust air cooling systems according to the ratio of outdoor to indoor temperatures. Modern technology makes it possible to do this. The air conditioner will only cool the air when the corresponding air parameters change.

6. Properly ventilate your home:

- Ventilate as needed;

- Do not leave windows and doors open for long periods during the cold season;

- Use the cooker hood only when cooking.

7. Scheduling energy consumption for night time or weekend (for those with a dual time zone electricity plan). Replacing conventional light bulbs with LED bulbs can save up to 80 percent of electricity. Lighting with LED bulbs is three times more efficient than with fluorescent bulbs and up to 12 times more efficient than incandescent bulbs.

8. Switch off unused household appliances.

9. Boil water in a kettle according to individual requirements, but no more.

10. Use the dishwasher more effectively: - use the eco mode; - load the dishwasher fully; use the delay function.

11. Smarter cooking uses energy more wisely.

Step II: Review energy consumption:

1. Assess household energy consumption:

- Assess energy consumption;

- Identify the most energy-consuming appliances in the home and assess opportunities to reduce costs;

- Ask the energy supplier if they offer free or low-cost home and utility inspections or advice on energy saving.

2. Identify the areas where the home's energy or engineering systems use the most energy.

3. Use the mobile app(s) to monitor your household's energy consumption.

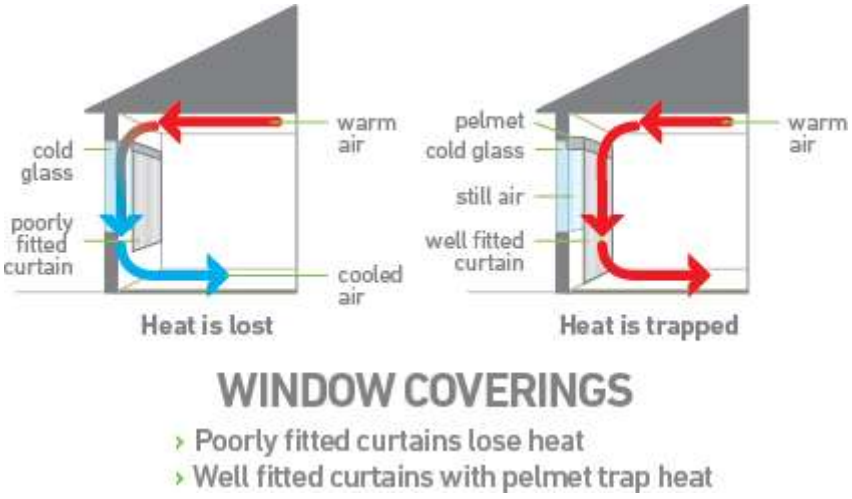
4. Targeted lighting can save up to 40% of electricity in your home. What is target lighting? If you like to read, watch TV, or knit in the evening, put a light on where you are most often. You'll have a cozy

little island for your hobbies or work without having to have the main light in the room. In homes where you don't need constant lighting, but don't want to flick switches every time, you can install touch-sensitive luminaires. For example in the yard. Electricity won't be wasted and you won't have to worry every time about leaving a light on in the yard overnight.

Step III: Reducing consumption (fixing up what's messy or worn out)

The building loses heat through all its parts, only the magnitude of the loss varies. About 35% of the heat is lost through the walls, 37% through the windows, 15% through the roof, and 13% through the basement slab.

1. Reducing heat loss:
- removing leaks (in windows, windowsills, doors);
2. Ensuring that heating appliances work as efficiently as possible:
- keep heating appliances (radiators) clear of furniture or other objects;
- remove dust from heating surfaces;
- choose the right length of window curtains.
3. Maintaining the heating and hot water system of the house:
- Regularly wash and clean the inside of the system;
- Comply with the requirements for the maintenance and operation of the system;
- Air out radiators on time.
4. Use more natural daylight.
5. Neglect of appliances can lead to higher energy bills: a clogged kettle and iron, a dirty cooker and oven, and a full vacuum cleaner will all try to run at full capacity and thus use more energy.



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STEP IV: Install small and medium improvements

1. Modernization of heating stations.

2. Replacement of a boiler with a more efficient boiler or heat pump.

3. Setting up a solar photovoltaic power plant.

4. Installing solar thermal collectors.

5. Improvements to the heating and hot water system of the house:

- upgrading or adding insulation to the heating and hot water pipes;

- installing and adjusting thermostats;

- installing an insulating cover (reflector) behind the heating appliance. In private homes or apartment blocks where the heating system has been upgraded, thermostats are an excellent way to reduce heating costs. They can be installed on each radiator and allow you to regulate their temperature individually. So different rooms can be kept at different temperatures, heating the one you are in the most, and leaving the minimum settings if you leave the house.

6. Replace inefficient light bulbs with more efficient ones.

7. Install motion sensors to control lighting. In homes where you don't need constant lighting, but don't want to flip switches every time, you can install touch-sensitive luminaires. For example in the yard. Electricity won't be wasted and you won't have to worry every time if you've left a light on in the yard overnight.

8. Use of lower-capacity hot water appliances.

9. Installation of plain or insulated blinds.

10. When purchasing new household appliances, choose appliances with the highest possible energy efficiency rating.

STEP V: Upgrade and substantially improve efficiency

1. Renovation/modernization of apartment buildings:

- building insulation;
- ensuring airtightness;
- installing a ventilation system with a thermal break;
- upgrading inefficient heating and hot water supply systems;
- glazing balconies and loggias.

2. Modernization of individual housing units:

- airtightness;
- external insulation of the building;
- internal insulation of walls;
- installation of a second external door.

Reducing water consumption

Do you know that 97.5% of the world's water comes from seas and oceans? Unfortunately, their water is not drinkable. Springs and groundwater reserves are only a small percentage of the planet's total water supply. It is because of that tiny amount of water that we humans still live.

Fresh water is not just for life support. We bathe in it, wash our clothes, and use it in industry. Domestic use is particularly high. Unfortunately, drinking water supplies are not unlimited.

By 2050, the world is predicted to face severe freshwater shortages. In countries where groundwater reserves are slightly higher, it can become a source of income as well as survival. This does not mean that these countries cannot save water. On the contrary, if we do not save, we will waste this potential instead of leaving it for future generations.

How to save water wisely?

- **When brushing your teeth, turn the water**

The average person brushes their teeth for 3 minutes. Do you know how much water comes out of the tap at that time? Eighteen liters. Based on the daily drinking water allowance, this is enough for 9 people to drink. So while you are brushing your teeth, turn off the water. It could save someone's life.

- **Shower treatments should not last for hours.**

We use between 6 and 45 liters of fresh water per minute when taking a shower. Want to reduce your water bills? Consider buying a shower head that mixes air and water, or a water stream regulator.

- **Fix a dripping tap**

It is estimated that a dripping tap can waste up to 15 liters of drinking water per day. That's 5,500 liters per year. In the event of severe water shortages, this would be enough to save a family of 4 people. Acoustic detection of water leakage points is a common method used in practice. It is a very long-established and, on the one hand, very simple and quite reliable method. New technological developments have made it possible to install acoustic sensors directly on water mains in wells.

- **Use rainwater storage tanks**

Rainwater storage tanks are a great way to save money by using rainwater for gardening, vegetable gardening, or outdoor work. Install them and use this free resource to water your flowers, wash your car, or clean your windows. This will save around 5,000 liters of fresh water per year.

- **Use a watering can**

The irrigation hoses can consume 1,000 liters of drinking water per hour. It is therefore much more environmentally friendly to choose watering cans. In addition, mulch and irrigation are best done in the early morning or late evening to reduce evaporation and save water reserves.

- **A jug of water in the fridge**

Fill a jug with tap water and put it in the fridge. If you make a refreshing drink in advance, you will thank yourself later. When you're thirsty, you can pour yourself a glass of cold water and enjoy. You can add mint, lemon slices, or ice cubes. It's a much more pleasant way to refresh yourself than standing by an unturned tap waiting for the cold water to finally start running.

- **Invest in water saving**

Time to update your household items? This could be the perfect opportunity to take the first step towards greener living. Replace your old tap with a new, water-saving one. Choose water-efficient showers, toilets, washing machines, and dishwashers: you'll be doing a favor for the environment andyour pocket.

- **The second life of dishwashing water**

Washing dishes, washing clothes, and bathing accounts for around 50% of daily water use. This creates "gray water". It is so-called because of its grayish color. Using this water would save many liters of water. We can store baths and sink water in 5-liter containers. You can then use it to water your plants or to flush the toilet (of course, it is important to choose. After all, you won't be washing water with detergent or dishwashing liquid impurities on your plants).

- **Wastewater**

The water produced during the production process - can be treated and used to water gardens, flowers, and lawns. We have cooling towers that need a lot of water (untreated to remove bacteria and other pollutants), so if we could use this water, we could save a lot of water.

Other water-saving initiatives include rooftop rainwater harvesting systems and natural freshwater ponds in the surrounding settlements, which are maintained to return water to the ground.

One of the biggest water savings in the future will be the replacement of clean water with recycled water through the use of "clean in place" (CIP) equipment. It's a simple change that will save even more water in the future.

Why is it important to save water?

Did you know that New York City uses 30% less water today than it did in 1979, even though it has 1 million more people? This dramatic change has come about because Americans have taken simple cost-saving measures. Saving money means spending less and living more beautifully with nature.

- **Reduce energy consumption.**

Wastewater treatment is an energy-intensive process. Heating water is also energy intensive. Saving water saves both energy and money.

- **Reduce your costs.**

Water costs money. Reducing its cost will help you spend more money on leisure activities. After all, it's much nicer to spend money on travel or gifts than on water bills, right? Keep track of how much water you use. If you want to get serious about saving water, start counting how much you use each day. You can do this by monitoring your meters. Or, when you get your bill, calculate the amount of water you use by dividing the cubic meters by the number of days and the number of people living in the house.

Summary

As we can see, deciding to build a new house requires reflection on many issues. In the context of changing regulations, including those relating to environmental protection, as well as our shared responsibility for the environment, we should aim to improve the energy efficiency of our buildings. The ideal would of course be a passive house built with ecological materials, but unfortunately, it is not always possible to adopt all the solutions for older houses. However, when you need to renovate, modernize, or repair your house, use sustainable materials and methods. You don’tneed to demolish your building to create a new ComfyHouse, you can gradually adapt the old one. Look for materials that are locally sourced and renewable or recycled. Whatever you are repairing or replacing, there is probably a greener option.