

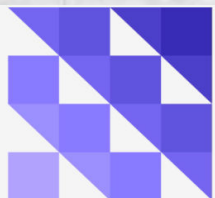
ARENCO S

February 2024

Passive House Constructions in Crete, Greece

ARCHITECTURAL ENGINEERING
CONSULTANCY SERVICES

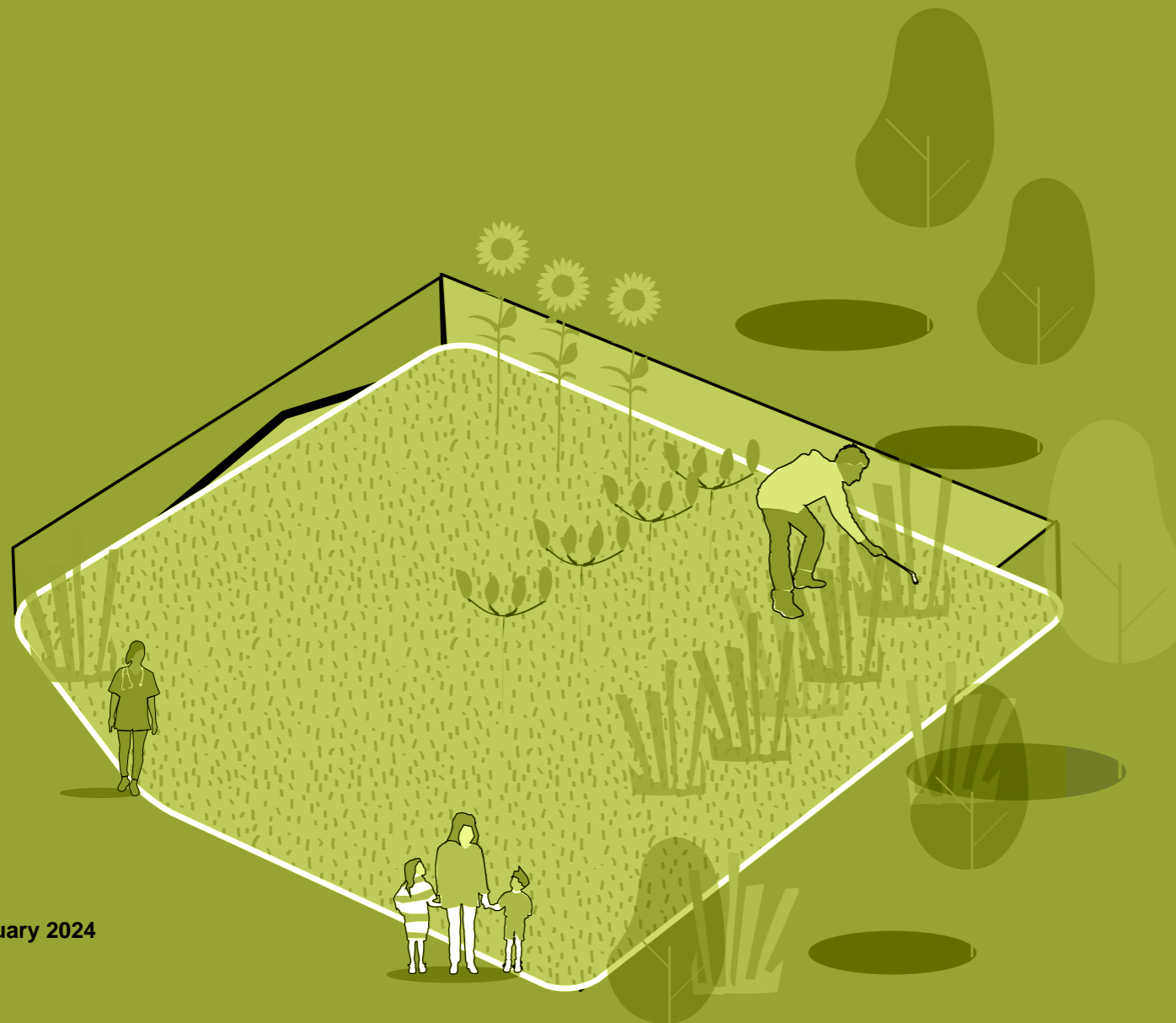
The most critical
parameters and
strategies.



RESEARCH
DATA ANALYSIS
INSIGHTS

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Introduction

Passive House structures seamlessly merge comfort with minimal energy usage. Unrivaled design, skilled craftsmanship, top-tier windows, advanced insulation, and heat recovery ventilation distinguish Passive House construction.

Despite their high efficiency, these buildings harmonize inconspicuously with their traditional surroundings. Notably, Passive House denotes a performance standard rather than a fixed construction approach. Designers have flexibility in achieving mandated energy targets, allowing creative freedom in construction methods.

Enhanced comfort, reduced energy consumption.

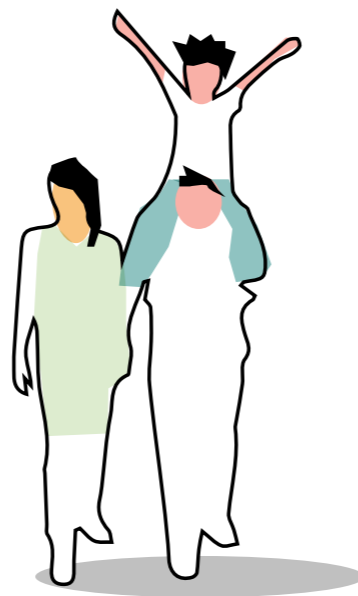
In the realm of Passive House, meticulous planning and execution are imperative. This precision guarantees a minimal energy demand: envision a 20 m² Passive House room staying warm in winter with the equivalent heat of 10 tea lights or the body warmth of four individuals, even in severe cold climates.

While, in reality, Passive Houses do not rely on tea lights for heating, they leverage efficient heating systems and essential ventilation for optimal indoor air quality. Remarkably, Passive House structures offer exceptional summer comfort, rendering air conditioning unnecessary in most climates and maintaining minimal requirements even in extreme conditions. In essence, Passive Houses significantly minimize the overall energy required for heating and cooling.

Tailored to the regional climate, perfectly.

The global applicability of the Passive House Standard remains consistent, employing a universal methodology. Adaptations, however, emerge in response to regional climates, leading to variations in the attributes of specific components. In warmer regions, emphasis is directed towards integrating passive cooling strategies like shading and window ventilation, ensuring optimal comfort in hotter seasons.

Customization of each Passive House's distinctive features becomes imperative for optimization in alignment with local conditions.



Expert testimony

Our dedicated research about Passive House Constructions in Crete, Greece includes the following:

1. Passive House Components
2. Climate Considerations
3. Energy Performance Metrics
4. Case Studies
5. Technological Innovations
6. Environmental Impact
7. Economic Analysis
8. Policy and Regulation
9. Challenges and Barriers
10. Occupant Comfort and Health
11. Future Trends
12. Global Perspectives
13. Recommendations and Conclusion

“
Passive House significantly minimizes building heat losses, rendering extensive heating unnecessary. A substantial portion of the heating demand is met by the sun, occupants, household appliances, and recovered heat from used air. The ventilation system often fulfills the remaining requirement.
”

Our research and findings

Research on Passive Houses consistently highlights several key findings:

Energy Efficiency:

Passive Houses significantly reduce energy consumption for heating and cooling, often achieving more than a 90% reduction compared to conventional buildings.

Comfort Levels:

Occupants of Passive Houses report high levels of comfort, thanks to consistent temperatures, excellent indoor air quality, and a well-ventilated environment.

Health Benefits:

Improved indoor air quality and a focus on natural ventilation contribute to a healthier living environment, reducing the risk of respiratory issues and allergies.

Cost Savings:

Despite initial construction costs, Passive Houses demonstrate long-term cost savings through significantly lower energy bills, making them economically viable over time.

Structural Longevity:

Passive Houses exhibit structural longevity, with a reduced risk of moisture-related issues such as mold growth, contributing to a durable and sustainable building structure.

Global Applicability:

The Passive House concept is adaptable to various climates worldwide, showcasing its versatility and effectiveness in both heating-dominated and cooling-dominated regions.

Environmental Impact:

Research indicates that the energy-efficient design and construction of Passive Houses contribute to a reduced carbon footprint, aligning with sustainability goals and environmental conservation.

ARENCOS RESEARCH

At ARENCOS, we acknowledge that the concept of long-term value for contemporary clients is multifaceted and constantly changing. Our efforts frequently involve bridging the structural design of a project with the positive social and environmental impacts it aims to achieve. Through meticulous and imaginative research, we unify these aspects for the benefit of our clients and partners in both public and private domains.

Our scope encompasses diverse areas, encompassing construction excellence, sustainable strategies, circular economy endeavors, and inventive approaches to addressing climate change and modern construction challenges. Our research methodologies are comprehensive, incorporating both breadth and depth, and integrating design exploration, research driven by practical application, and rigorous scientific methods.

The way forward

The path to advancing Passive House structures involves a commitment to continuous innovation and implementation of key principles:

Technological Integration:

Embrace cutting-edge technologies in construction materials, energy-efficient systems, and smart building solutions to enhance the performance of Passive House structures.

Design Optimization:

Focus on refining design processes to maximize energy efficiency, occupant comfort, and structural longevity, ensuring that each element contributes to the overall success of Passive House principles.

Global Collaboration:

Foster international collaboration to share best practices, adapt Passive House standards to diverse climates, and promote a unified approach towards sustainable building practices on a global scale.

Regulatory Advocacy:

Advocate for the integration of Passive House standards into building codes and regulations, emphasizing the economic and environmental benefits to garner widespread recognition and adoption.

Education and Training:

Invest in educational programs and training initiatives to equip architects, builders, and stakeholders with the knowledge and skills required to effectively plan, design,

Public Awareness:

Increase public awareness of the benefits associated with Passive House structures, fostering a demand for sustainable, energy-efficient buildings and encouraging the broader construction industry to align with these principles.

Continuous Improvement:

Embrace a culture of continuous improvement, with regular evaluations and updates to Passive House standards based on emerging technologies, research findings, and lessons learned from implemented projects.

By navigating this forward-thinking trajectory, Passive House structures can not only maintain their reputation for excellence but also contribute significantly to a sustainable and energy-efficient future in construction.

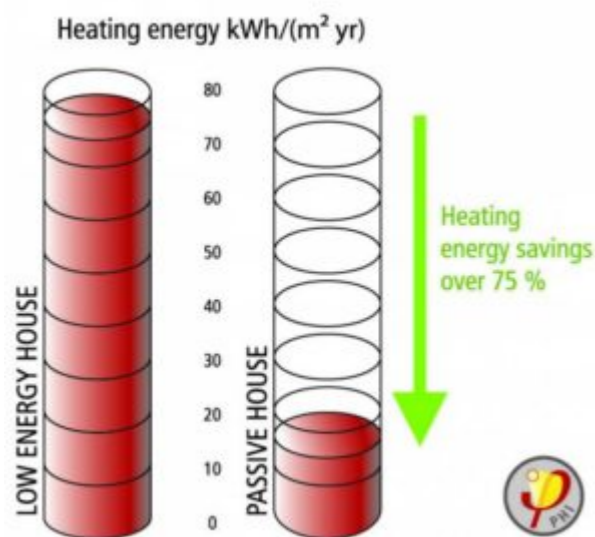
Achieving More with Less.

Definitive benefits and substantial savings.

- Superior comfort levels
- Continuous supply of fresh air across the entire building
- Structural durability: mold-free structures with a considerably reduced risk of moisture damage
- Remarkably low heating and cooling expenses, even amid escalating energy costs
- A profoundly enhanced indoor environment

The essence of the Passive House concept lies in its commitment to energy efficiency. Annually, a Passive House structure requires no more than 1.5 liters of oil or 1.5 m³ of natural gas (15kWh) per square meter for heating. This represents over a 90 percent reduction in energy consumption for heating and cooling compared to standard building stock. In contrast, a conventional new build consumes 6 to 10 or more liters of oil per year per square meter, dependent on building quality and location.

In addition to space heating, energy needs for domestic hot water in Passive Houses are comparable, if not larger than those for space heating. Individual usage differences can lead to significant variations. To further diminish energy consumption and ensure year-round comfort, selecting highly efficient electrical appliances is crucial. The minimal energy requirement of approximately 2 kWh/m² for a heat recovery ventilation system is almost negligible in the overall context



Where are we now?



The facts behind the numbers

0.6 air changes per hour at 50 Pascals

Over half

Passive Houses typically achieve a very high level of air tightness, often with rates below 0.6 air changes per hour at 50 Pascals (ACH50) during a blower door test.

ROI

5-12 Years

The energy invested in constructing a Passive House is often recouped through energy savings within a relatively short period, with an estimated payback period 5-12 years.

Energy Saving

Passive Houses typically achieve energy savings of 80-90% compared to conventional buildings.

Renewable Energy Integration

Passive Houses often integrate renewable energy sources such as solar panels, contributing to a significant portion of the building's energy needs.

Only 15kWh

The annual space heating requirement is often below 15 kWh/(m²a).

Occupant Comfort 90%

Occupant satisfaction and comfort levels in Passive Houses are often reported to be high, with a satisfaction rate of over 90% in many cases.

Indoor Climate Quality 48%

The ventilation system in Passive Houses typically achieves an efficiency rate of 90-95%, recovering heat from the outgoing air.

Construction Costs 5-10%

The cost difference is often within the range of 5-10% higher for Passive House construction.

A global standard of change

Energy Efficiency is impacting us all

The global interest in Passive House is on the rise. While this document predominantly explores Passive House in Mediterranean climates found in Crete, Greece, it is crucial to emphasize that the Passive House Standard is international.

It remains not only applicable but also economically viable across nearly all inhabited climates worldwide. Comprehensive studies by the Passive House Institute, such as "Passive Houses for different climate zones," "Passive Houses in tropical climates," and "Passive Houses in South-West Europe," have demonstrated the enduring validity and effective application of Passive House principles on a global scale. The evidence lies in the thousands of Passive Houses constructed in over 45 countries, showcasing the adaptability of Passive House standards internationally.

Building to the Passive House Standard in any climate involves optimizing design considerations with local conditions in mind. This task is facilitated by the Passive House Planning Package (PHPP), a tool for Passive House energy balance and building design.

The increasing interest in Passive House beyond Europe is evident in the growing number of Passive House buildings and EnerPHit retrofits—refurbishments built according to Passive House principles—globally. While certain products needed for extreme climates may not be universally available, the core concept of energy conservation remains a driving force in the global adoption of Passive House principles.

As awareness of energy efficiency grows and the demand for suitable components increases, the availability of these products also rises, subsequently driving down associated costs. These trends consistently manifest wherever there is an increased demand for Passive House and highly energy-efficient buildings.

Passive House & Components

Passive House demands top-notch components to attain exceptional energy efficiency. The specifications of these components vary according to climatic conditions: regions like Scandinavia or Canada necessitate higher insulation levels compared to Passive Houses in Mediterranean climates.

Mechanical systems may also differ significantly based on the building's climate. The accompanying map serves as a guide, outlining the characteristic qualities generally required for Passive House components across the world's diverse climatic regions.

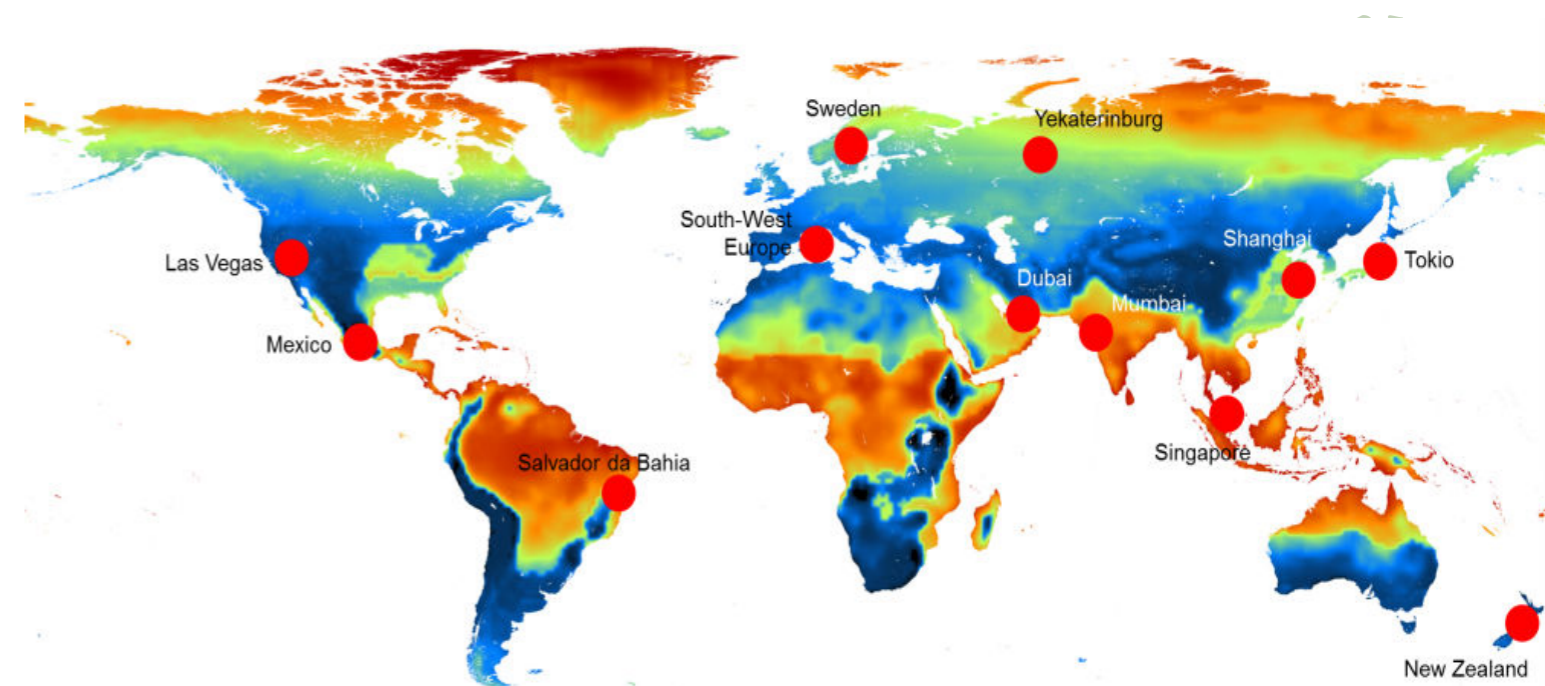
Categorizing the globe into seven general climate types, the map derives from an economic analysis determining the optimal balance for meeting the Passive House Standard in terms of investment costs and energy savings throughout a building's lifecycle.

Passive House Planning Package

In the "warm" climate zone depicted in yellow, achieving Passive House standards involves using moderate insulation, double-paned windows, and incorporating exterior shading devices. Heating can be facilitated through fresh supply air, and passive cooling by opening windows during warmer nights can be advantageous.

Contrastingly, the cool temperate climate zone in turquoise requires higher insulation levels and insulated, triple-paned windows. Summer shading and passive cooling through open windows at night are recommended. For specific details on Passive House components tailored to various climate regions, refer to Passipedia (www.passipedia.org).

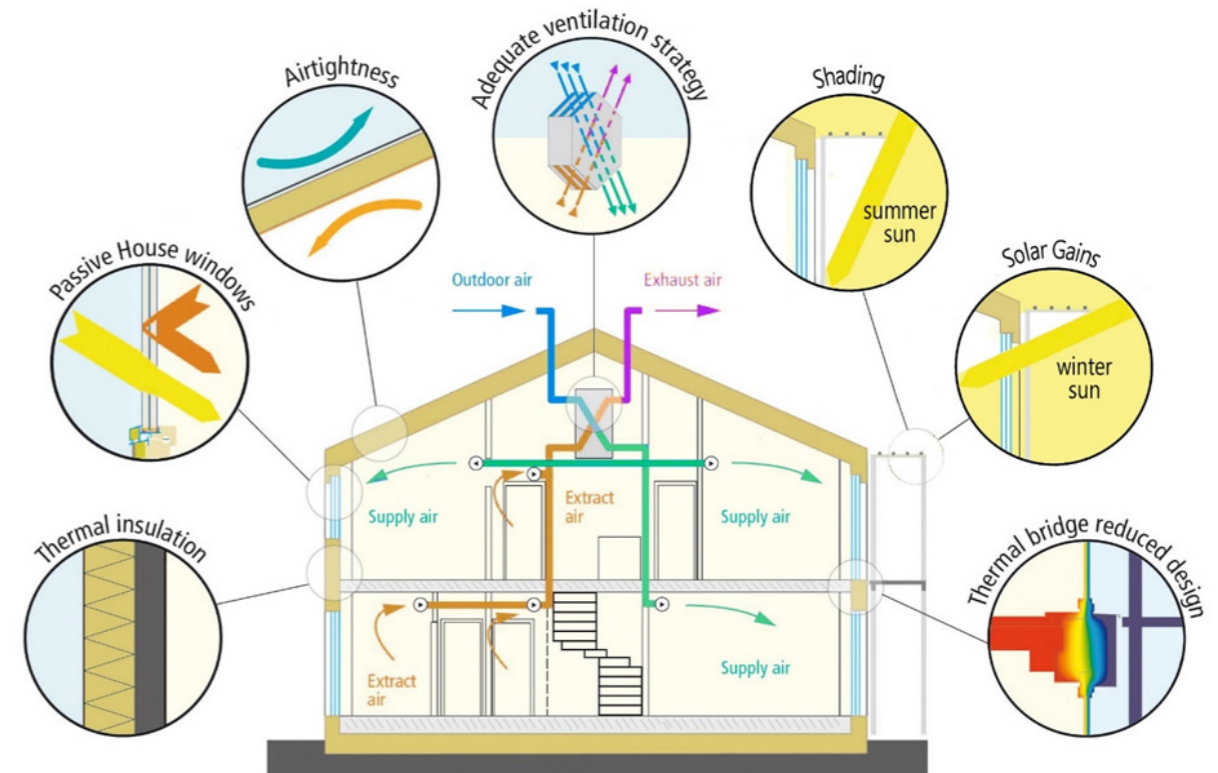
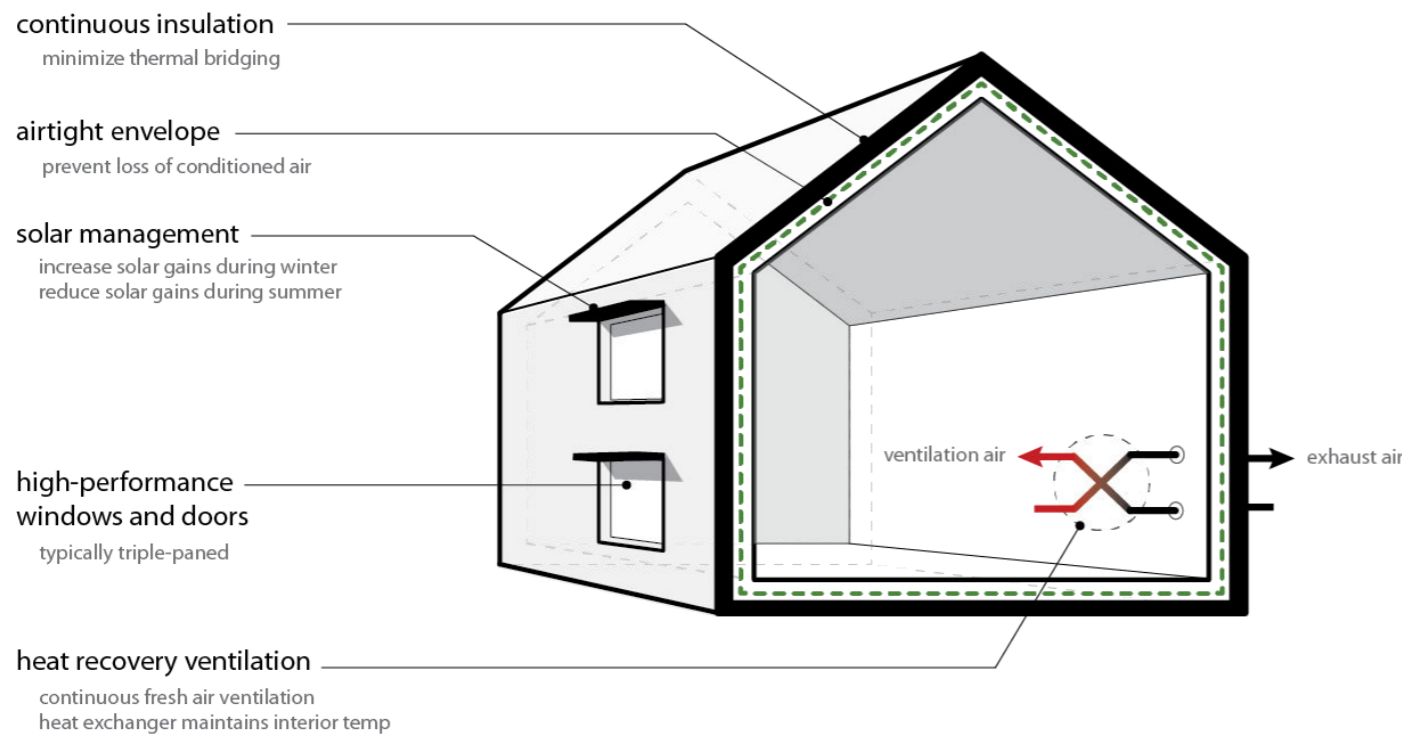
It's essential to note that these guidelines are general and may not encompass micro-climates, especially prevalent in coastal or mountainous areas. In instances of challenging sites or buildings, the ideal Passive House solution may differ from the map's recommendations. Each building should be meticulously planned with the Passive House Planning Package (PHPP), utilizing local climate data for accurate customization.





You've got questions? We've got answers!

The concept of Passive House represents a revolutionary approach to building design and construction that prioritizes energy efficiency, comfort, and sustainability. Originating in Germany, the Passive House standard is characterized by meticulous planning, high-quality components, and a commitment to minimizing energy consumption. Passive House buildings achieve remarkable energy efficiency by incorporating superior insulation, airtight construction, and advanced ventilation systems. This results in homes that require minimal active heating or cooling, relying on passive measures like sunlight, occupant heat, and efficient ventilation. The concept is adaptable to various climates globally, showcasing its versatility in achieving exceptional energy performance while providing occupants with unparalleled comfort and environmental benefits.



Top questions



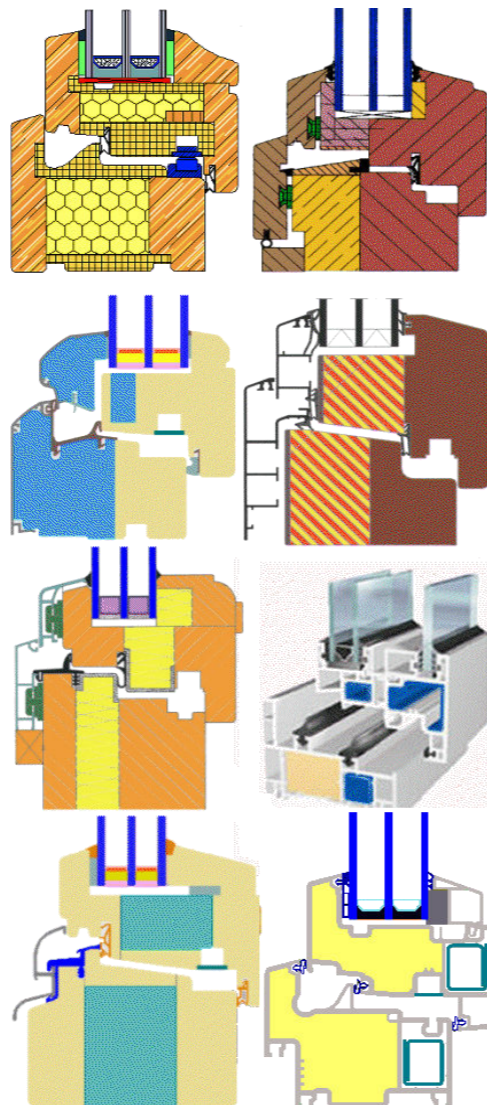
What is passive about a Passive House?

A Passive House boasts exceptional energy efficiency, requiring minimal active heating or cooling to maintain a consistently pleasant temperature throughout the year. This near "passive" characteristic stems from outstanding insulation and highly effective heat recovery systems.

Passive design principles, recognized in engineering, exemplify strategies to achieve goals with minimal input, such as passive security, filters, cooling, and the Passive House concept. While none of these applications is entirely passive in the strictest sense, requiring minor inputs to guide processes, the focus is on intelligent design.

Airtight construction, often questioned for impeding natural ventilation, ensures optimal efficiency of ventilation systems, eliminating the need for unreliable and uncomfortable air infiltration through conventional building gaps. This approach prioritizes achieving desired goals with minimal reliance on complex systems and non-renewable resources.

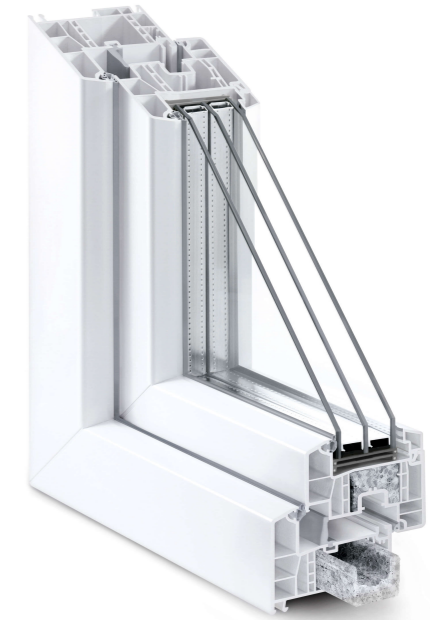
Crucially, airtight construction is vital not only for energy efficiency but also for preventing moisture damage and mold growth. In conventional buildings, gaps in the structure allow air to pass through, leading to cooling and potential condensation risks. The high level of airtightness in Passive House buildings eliminates this concern, ensuring a protective barrier against moisture-related issues.



Can you open the windows in a Passive House?

Certainly, you can open the windows in a Passive House, but the need to do so is minimal and often unnecessary throughout most of the year. Unlike conventional buildings where occupants frequently open windows, even in unfavorable weather conditions, to address stale air, odors, and moisture, Passive Houses maintain excellent air quality without such interventions.

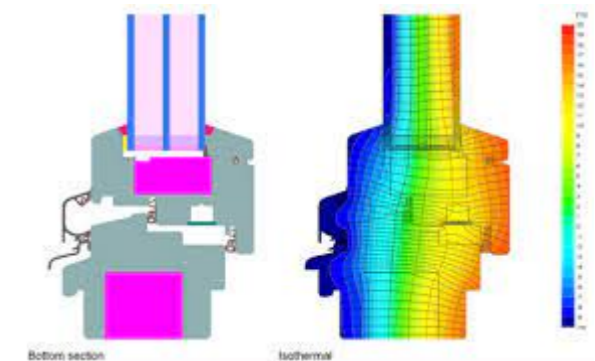
Conventional buildings would need constant window openings day and night to match the air quality achieved in a Passive House, making this impractical. As a result, many homes, schools, and offices with conventional construction are inadequately ventilated, highlighting the distinctive ventilation efficiency of Passive Houses.



What makes Passive House windows distinctive?

Windows not only facilitate the entry of daylight into rooms but also harness the sun's energy to contribute to the building's warmth. In regions with cool temperate climates, Passive Houses feature triple-glazed window panes filled with noble gases and well-insulated frames. These high-quality windows, particularly in winter, allow more of the sun's thermal energy into the building than they release.

During warmer months or in climates closer to the equator, where the sun is higher in the sky, solar heat gains are naturally reduced when less needed. In most climates, it is optimal to orient large glazing areas toward the equator. Careful planning is essential for windows, and when necessary, appropriate shading should be implemented to prevent overheating and maximize overall solar gains during the heating period.



What is the purpose of constructing an airtight building? Isn't it essential for a house to have ventilation?

In a conventional building, air infiltration through gaps and joints is often felt as draughts, providing unreliable and uncomfortable "ventilation."

This method is inadequate for maintaining healthy indoor air quality, requiring frequent and prolonged window opening. An airtight building envelope ensures optimal efficiency of the ventilation system. Importantly, it prevents moisture damage and mold growth, as gaps in conventional structures allow cooling air to pass through, leading to condensation and potential risks. This concern is eliminated in Passive House buildings due to their high level of airtightness.

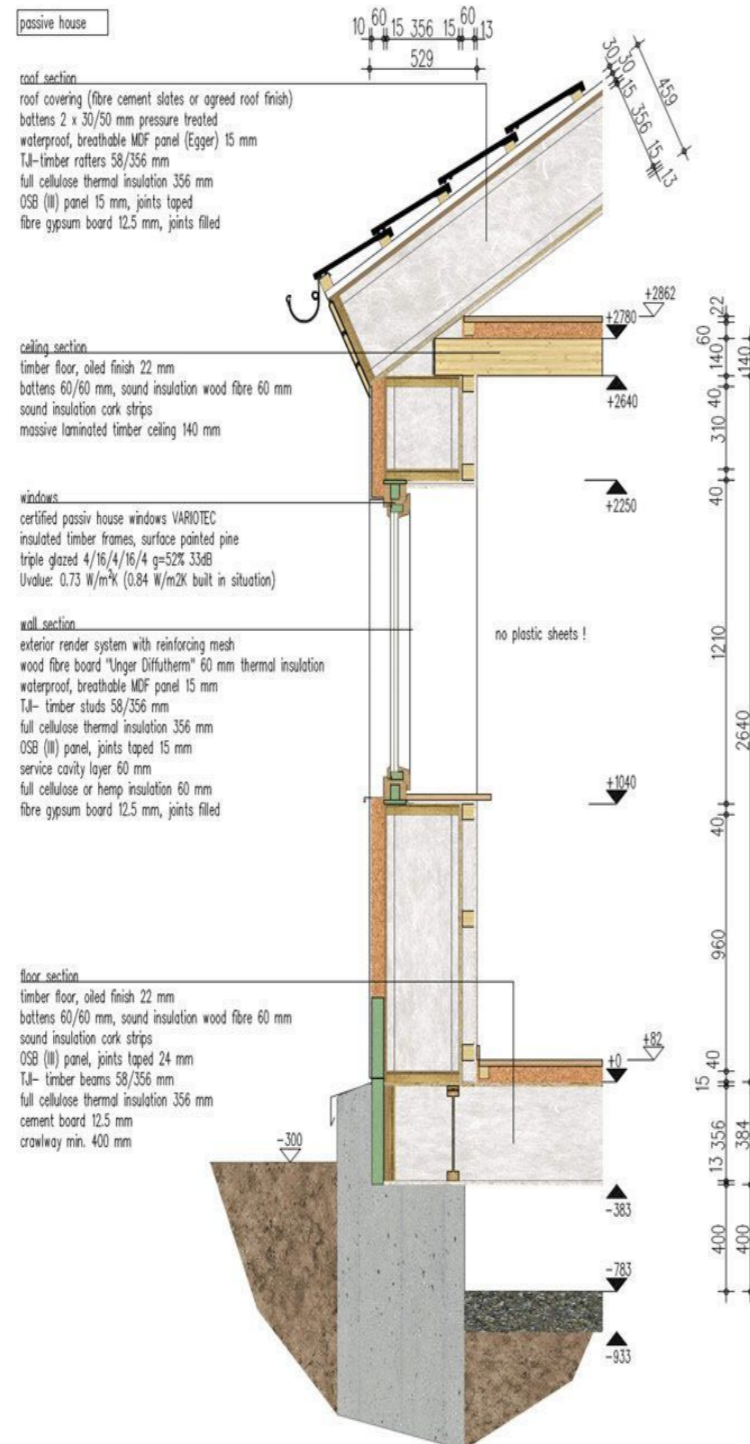
How comfortable are Passive Houses in a warm climate like the one in Crete, Greece?

In scorching summer conditions, a Passive House building's meticulously insulated walls and roof become invaluable shields against the relentless outdoor heat, ensuring a cool haven for its occupants. To fortify this defense, external blinds or sunscreens elegantly stand guard over windows, thwarting the sun's attempts to infiltrate.

The design ingeniously incorporates cross ventilation through strategically opened windows during cooler intervals, providing a passive means to cool the indoor space. During summer, when heat recovery is often unnecessary, ingenious ventilation systems with a summer-bypass step into action, preserving a refreshing ambiance indoors.

Passive House isn't confined to temperate climates; it seamlessly adapts to hot and humid environments. Here, the same foundational components and passive strategies, thoughtfully optimized for local conditions, come into play. Ventilation, coupled with energy recovery, emerges as a potent ally in curbing both heat and humidity within the building.

Even in regions where active cooling is imperative, the application of Passive House principles remarkably slashes cooling requirements, showcasing its versatile and efficient design in diverse climates.



Passive House windows stand out for their exceptional design and performance. These windows play a crucial role in achieving the high energy efficiency standards set by the Passive House concept. Here are some key features that make Passive House windows special:

High Insulation: Passive House windows are equipped with advanced insulation materials, reducing heat transfer between the interior and exterior. This insulation helps maintain a comfortable temperature inside the building.

Triple Glazing: Typically, Passive House windows feature triple-pane glass, providing an extra layer of insulation compared to standard double-pane windows. This design minimizes heat loss and enhances energy efficiency.

Airtight Seals: To prevent air leakage, Passive House windows incorporate airtight seals. This feature contributes to the overall airtightness of the building envelope, a critical aspect of Passive House construction.

Low-E Coating: Passive House windows often include a low-emissivity (Low-E) coating on the glass. This coating helps control the transfer of heat and improves the overall thermal performance of the window.

Argon or Krypton Gas Filling: The space between the glass panes in Passive House windows may be filled with inert gases like argon or krypton. These gases enhance insulation properties, further reducing heat exchange.

Solar Heat Gain: Passive House windows are designed to maximize solar heat gain during colder months while minimizing it in warmer months. This strategic design contributes to natural heating and cooling within the building.

Durable Frames: The window frames in Passive House construction are carefully selected for their durability and thermal resistance. High-quality materials ensure longevity and contribute to the overall energy efficiency of the building.



The way forward

Five key parameters for a healthy and resilient passive house ecosystem

Passive Houses, characterized by superior insulation, airtight construction, high-performance windows, and ventilation with heat recovery, represent a groundbreaking approach to sustainable and energy-efficient building design. By strategically harnessing solar energy, incorporating advanced ventilation systems, and eliminating thermal bridges, Passive Houses maintain optimal indoor temperatures while minimizing energy consumption. These eco-friendly dwellings, adaptable to various climates, prioritize holistic sustainability, connecting architectural design to positive social and environmental outcomes. From meticulous construction techniques to the integration of energy-efficient appliances, Passive Houses exemplify a harmonious

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- 2 Passive House Windows**
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1 Thermal Bridge Free and Airtight

Eliminating Energy & Air Leaks

Halting energy leaks is a crucial aspect of constructing energy-efficient buildings, and this involves addressing thermal bridging—a phenomenon where energy easily escapes through points like edges, corners, connections, and penetrations in the building envelope. Preventing thermal bridges is an effective measure for energy conservation.

For instance, extending a concrete ceiling to form a balcony can lead to increased heat losses, but incorporating a thermal break element can mitigate this effect. Passive House underscores the importance of thermal bridge-free construction, aiming to make these effects negligible to the point where they don't significantly impact calculations.

Airtightness is also paramount, achieved through meticulous planning, intelligent solutions, and quality workmanship, ensuring the building envelope minimizes the risk of structural damage.

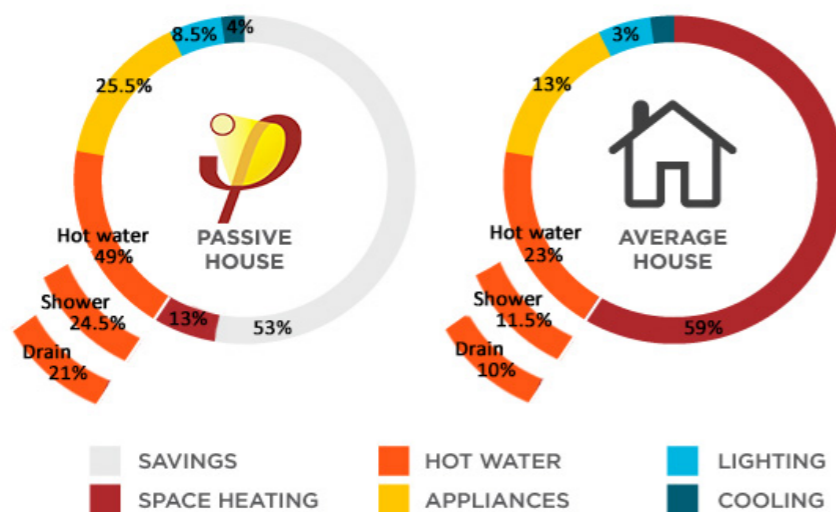
Airtight Building

In an airtight building, the movement of air is not arbitrary through the walls of the building envelope.

This is crucial because relying on wind-driven or temperature-induced air flow alone is insufficient to consistently maintain good air quality. Random air movement can be uncomfortable, providing either too much or too little air, and it may lead to structural issues when leaks in the building envelope permit the passage of warm, moist air through the walls.

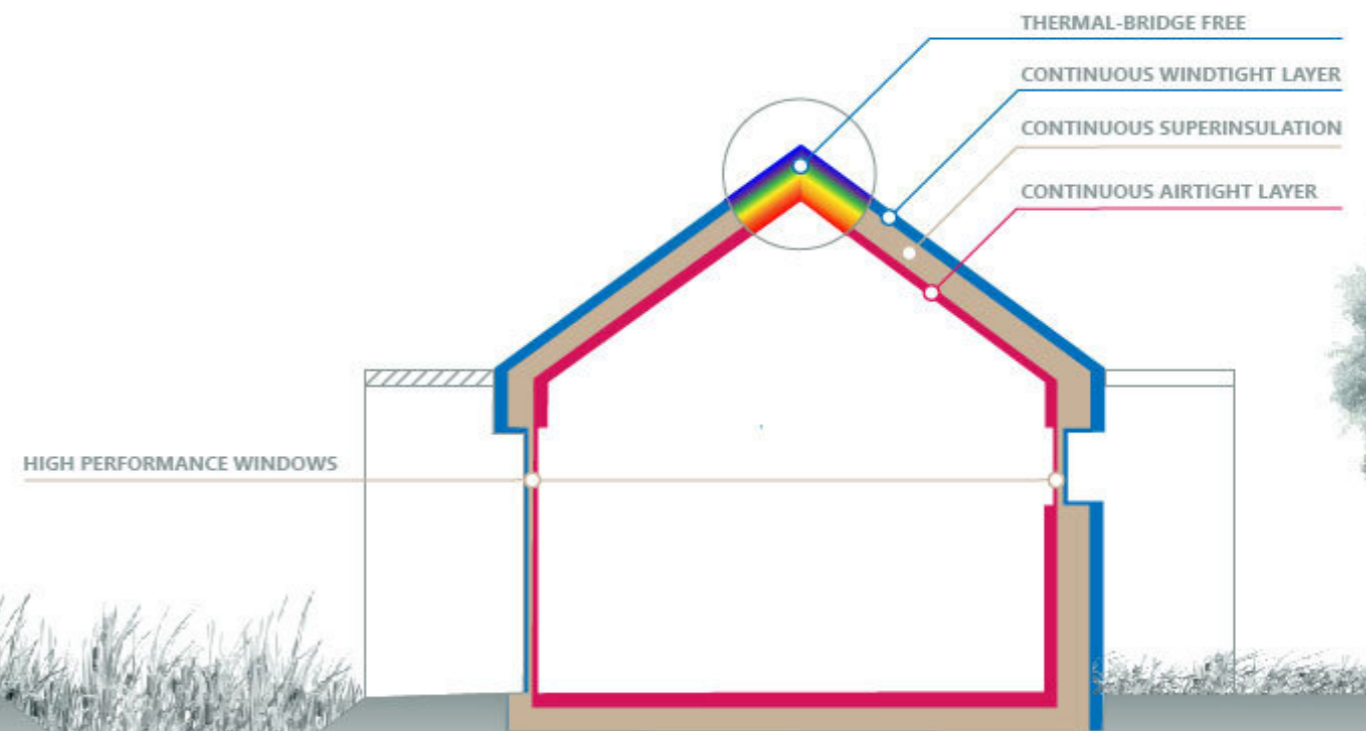
This, in turn, can result in condensation, fostering mold growth and structural damage. Leaky buildings also suffer from poor acoustic insulation and significant heat losses.

Airtightness, conversely, mitigates issues like draughts, cold pockets, and structural damage associated with gaps in the façade. Combining airtightness with a ventilation system ensures a controlled supply of the right amount of fresh air.



“Passive House design emphasizes thermal bridge-free construction and airtightness—essential elements ensuring superior energy efficiency and year-round comfort.”

Maria Gkika - Certified Passive House Engineer



2 Passive House Windows

High Quality Glazing & Frames

Windows, being the most susceptible element of the building envelope, demand special consideration in Passive House construction, requiring the installation of exceptionally high-quality windows. The choice of windows is climate-dependent, with varying degrees of frame insulation and distinct glazing characteristics needed to fulfill thermal comfort requirements for both living and working spaces.

A critical guideline mandates that the average temperature of internal window surfaces should not dip below 17°C on cold days, even without radiators beneath the windows, ensuring optimal thermal comfort in close proximity to windows. In cool temperate climates, the emphasis is on highly insulated frames and triple low-e glazing, achieving U-values below 0.85 W/(m²K) for installed windows.

The window frame's role is pivotal, constituting 30 to 40 percent of the total window area, favoring slimmer frames and larger glass surfaces for enhanced solar gains. Slim and insulated frames are imperative to reduce heat losses, with additional considerations for minimizing losses at the edges of glazing through thermally improved edge seals.

This meticulous approach ensures high-quality windows with triple low-e glazing and insulated frames being indispensable in cool temperate climates, double low-e glazing and moderately insulated frames sufficing for warmer climates, and colder climates necessitating quadruple glazing and further advancements in frame insulation.

Minimizing Thermal Bridges for Optimal Comfort

Substantial thermal bridges may arise when a window is improperly integrated into the wall. In Passive House constructions, it is crucial to strategically position windows within the insulation layer of the wall to mitigate the impact of thermal bridges.

This commonly involves extending the insulation to cover connections in the window frame. In colder climates, this approach aids in preventing heat losses and elevating internal surface temperatures at these junctions. Conversely, in warmer climates, the extended insulation assists in maintaining a cooler building environment by minimizing internal surface temperatures.

Harnessing Solar Energy

The natural illumination and warmth brought into a building through its windows via solar radiation play a dual role. Especially crucial during winter, the effectiveness of retaining this warmth within the building is intricately linked to the quality of the installed windows. Passive House-grade windows excel in minimizing heat losses, facilitating the ideal utilization of passive solar energy for enhanced energy efficiency and comfort.

This not only results in energy conservation but also contributes to creating appealing and health-promoting living environments. The quantity of passive solar gains entering a building, however, hinges on the building's geographical position, as well as the layout and orientation of its glazed sections. Seasoned designers possess the expertise to optimize these factors in their designs, enabling the construction of Passive Houses even in areas with limited sunlight exposure.

Reducing or Eliminating Overheating

In warm periods across all climates, the primary focus is on minimizing solar gains to maintain a comfortably cool indoor environment. Given the prevalence of large windows in modern architecture, effective shading becomes imperative. In regions where heating is not a concern but solar heat poses a challenge, solar protective glazing proves to be highly efficient.

This specialized glazing permits visible light to enter the building while effectively filtering out infrared and ultraviolet waves through a phenomenon known as "spectral selectivity." For Passive Houses situated in warmer climates, it is advisable to incorporate windows with a selectivity rating of 2 or higher.

According to our research overheating in Passive house constructions can be eliminated by:

Optimal Window Design: Choose high-quality windows with appropriate glazing and shading systems.

Orient windows to minimize direct sunlight penetration during peak heat periods. External shading devices like awnings, shutters, or shades can be effective.

Ventilation Strategies: Utilize natural ventilation during cooler periods, such as evenings and nights, to flush out accumulated heat. Cross-ventilation and stack ventilation can be effective strategies to cool down indoor spaces.

Thermal Mass: Incorporate thermal mass, such as heavy materials like concrete or stone, into the building design. Thermal mass helps absorb excess heat during the day and release it during cooler periods, stabilizing indoor temperatures.

Insulation: Ensure proper insulation to prevent overheating from external sources. Insulate the roof, walls, and floors to minimize heat gain from the external environment.

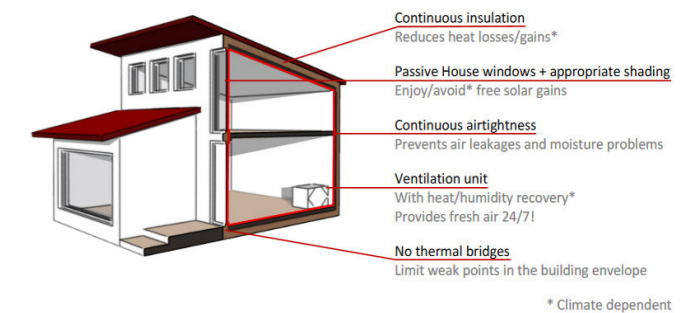


Image Retrieved from: © Passive House Institute

3 Superior Ventilation

Fresh Air and Pleasant Indoor Climate

In the majority of climates, even in the context of Passive Houses, a minimal amount of heating is occasionally required. However, the demand for heating is so marginal that the ventilation system can serve a dual purpose by efficiently distributing heat across the entire house.

To address any remaining heating needs, heating coils are employed to warm the incoming fresh air. A noteworthy innovation in this regard is the integration of compact heat pump units, seamlessly combining heat recovery ventilation with heating, hot water supply, and storage within a single, space-saving apparatus. These units, pre-engineered for optimal performance, boast ease of installation. Additionally, alternative heating solutions such as gas, oil, district heating, or wood can also be explored to fulfill heating and hot water requirements.

Maximising potential of local assets

The utilization of solar collectors to meet the demand for domestic hot water presents an intriguing avenue that can yield additional reductions in energy consumption. In temperate seasons characterized by warmth and mildness, the necessity for heat recovery diminishes as its application could confine heat within the building.

To address this, ventilation systems incorporate a feature known as a summer bypass, which deactivates heat recovery, allowing the direct introduction of cool outdoor air indoors. With the implementation of automated control for the bypass, the potential for maximizing heat recovery is extended across different climates throughout the year.

Intelligent Design

To ensure optimal functionality, the overall design of the ventilation system must be meticulously planned. The air intake should be directed into the living room and bedrooms, while extraction occurs in areas prone to moisture and odors, such as kitchens and bathrooms.

Connecting these spaces are air transfer zones, including hallways, allowing fresh air to circulate seamlessly throughout the entire building. To prevent closed doors from impeding air circulation, it is essential to incorporate appropriate air transfer openings, such as covered panels with acoustically optimized vents, into the doors or door frames.

A high-quality Passive House ventilation system operates incredibly quietly, maintaining sound levels below 25dB(A). This adherence to the noise limit is achieved by equipping supply and exhaust air ducts. By integrating these intelligent design paradigms, Passive Houses can achieve optimal fresh air retention while maintaining energy efficiency and a comfortable indoor environment:

Strategic Placement of Windows and Ventilation Openings:

Position windows strategically to encourage cross-ventilation and natural airflow.

Integrate operable windows and vents in key areas to facilitate the entry of fresh air.

Innovative Air Transfer Zones:

Design air transfer zones, such as hallways and open-plan spaces, to allow for seamless air circulation.

Ensure these zones act as conduits for fresh air to reach all living spaces.

Balanced Airflow Distribution:

Ensure a balanced distribution of fresh air throughout bedrooms, living rooms, and other essential spaces.

4 Insulation Matters

Move from Insulation to Intelligent Insulation

Insulating exterior walls stands out as the most effective choice, demanding thorough exploration of all viable avenues. However, certain constraints, such as those imposed by historical or listed buildings, may render external insulation impractical. In such cases, meticulously planned and executed interior insulation emerges as a preferable alternative to forgoing insulation entirely.

Unlike its external counterpart, interior insulation introduces unique challenges, necessitating a meticulous approach to airtightness and the minimization of thermal bridging to eradicate potential cold spots susceptible to moisture damage. Insulation strategies diverge in new Passive House constructions, allowing for underfloor applications.

Conversely, retrofitting existing structures involves creative solutions, such as insulating above the floor slab or incorporating an insulation skirt—an external insulation extending from the entire exterior wall to the foundation. Addressing thermal bridges in existing basements.

The Challenges

In the realm of new Passive House constructions, the application of insulation beneath the floor slab is a standard practice, optimizing thermal efficiency. However, this approach becomes impractical when retrofitting existing structures. In such cases, a pragmatic alternative involves applying insulation above the floor slab or adopting an insulation skirt—an external insulating layer extending comprehensively from the entire exterior wall down to the foundation.

Removing barriers

In instances where new constructions feature basements situated outside the thermal envelope, a strategic thermal barrier is typically integrated to maintain the continuity of the insulation layer. Retrofitting existing structures with thermal barriers in basement walls to mitigate thermal bridging can prove costly.

A more economical alternative entails the application of flanking insulation along basement walls that traverse existing insulation, particularly at junctures like where they connect to the basement ceiling. This versatile strategy seeks a balance between effectiveness and cost efficiency in retrofit scenarios.

True Airtightness, Insulation and Mould Elimination

Mitigating the risk of mould growth, especially in cold climates, stands as a crucial objective achieved through optimal combinations of airtightness, insulation, and strategic prevention of condensation. External insulation emerges as the premier strategy, elevating temperatures on internal surfaces like walls, roofs, and basement ceilings. This approach effectively curtails condensation, even at residual thermal bridges, thereby thwarting the conditions conducive to mould proliferation. The significance of this lies not only in the noticeable enhancement of comfort resulting from increased surface temperatures but also in the substantial reduction of mould-related risks.

Complementarily, airtightness plays a pivotal role by curbing energy transfer through walls and safeguarding against moisture damage originating from the transit of warm, damp air. While well-insulated and airtight structures, including energy retrofits, exemplify these preventive measures, it is imperative to incorporate ventilation systems to counteract the potential build of excessive moisture in the air and on building surfaces. This holistic approach ensures a harmonized balance between energy efficiency and mould prevention.

5 Efficiency – the Key to Green Building

Optimal insulation, highly efficient windows, a ventilation system incorporating heat or energy recovery, and a meticulously sealed building envelope collectively stand as proven methodologies to curtail heating and cooling requirements.

The Passive House concept adeptly harnesses these elements, demonstrating a paradigm shift wherein heating and cooling demands, which often constitute over 80 percent of energy consumption in traditional structures, align with the energy outlay for domestic hot water in Passive Houses. With such minimal energy needs for temperature control, formerly secondary considerations gain prominence.

Hot water production assumes significance, and judiciously implementing water-saving fixtures for showers and sinks becomes instrumental in achieving substantial reductions in hot water requirements, directly translating into energy savings. In regions with elevated heating demands, the adoption of waste water heat recovery devices proves beneficial.

Electricity emerges as the predominant contributor to overall energy consumption in Passive Houses. Enhancing energy efficiency extends beyond architectural facets to include lighting choices, where the integration of LEDs, renowned for their lower energy consumption compared to conventional "low-energy" bulbs, results in cost-effective energy savings. LED technology not only guarantees improved light quality, instantaneous illumination, and extended bulb lifespans but also aligns with the broader commitment to sustainability.

Likewise, energy-efficient IT and communication devices play a pivotal role in reducing electricity consumption, with contemporary laptops requiring a mere 25 percent of the energy expended by standard desktop computers.

Efficiency, first

Efficiency takes precedence in a Passive House building, and this prioritization is well-founded. Efficiency represents an inherently straightforward "source" of energy, as energy that is not consumed in the initial phase eliminates the need for subsequent generation. T

he reduction of overall energy consumption offers the prospect of utilizing available sources in a sustainable and cost-effective manner. This approach not only mitigates the consequences of energy price fluctuations but also contributes to the preservation of social, economic, and environmental well-being. In essence, the emphasis on efficiency in Passive House construction aligns with a forward-looking strategy that fosters resilience and harmony across various facets of our interconnected world.

“**Embracing Passivhaus as our foundational approach is a strategic decision rooted in the ability to substantially diminish energy consumption through intentional design, all while ensuring optimal comfort.**”



Bringing it together through a Passive House components approach

Passive House components play a crucial role in achieving the high standards of energy efficiency and comfort associated with the Passive House concept.

These components are carefully selected and integrated into the building design to ensure optimal performance. Here are key components commonly found in Passive House buildings:

High-Quality Insulation:

Description: Effective insulation is fundamental to minimizing heat transfer through the building envelope.

Purpose: Prevents heat loss in cold weather and minimizes heat gain in warm weather.

Triple-Glazed Windows:

Description: Windows with three layers of glass and insulated frames.

Purpose: Provides excellent thermal performance, reducing heat loss or gain through windows.

Airtight Building Envelope:

Description: The building envelope is sealed tightly to prevent air leakage.

Purpose: Reduces energy loss, ensures better control over indoor air quality, and prevents moisture-related issues.

Ventilation System with Heat Recovery:

Description: Mechanical ventilation system with a heat exchanger.

Purpose: Supplies fresh air while recovering heat from outgoing air, improving energy efficiency and maintaining indoor air quality.

Thermal Bridge-Free Design:

PASSIVE HOUSE COMPONENT & PERFORMANCE CRITERIA



TRIPLE-GLAZED WINDOWS

U-values: 0.80W/(m²K) or less. Low-E glass with argon or krypton gas between panes



THERMAL INSULATION

All opaque surfaces must be sufficiently insulated to achieve U-values of 0.15 W/(m²K) or less.



VENTILATION

A ventilation system with heat recovery (MVHR) circulates fresh, room temperature air through the building.



AIRTIGHTNESS

Air leakage must be less than 0.6 of total house volume, per hour, at 50 Pascals pressure (0.6 ACH or less).



THERMAL BRIDGING ELIMINATED

Detailed planning is required to eliminate thermal bridging wherever possible.

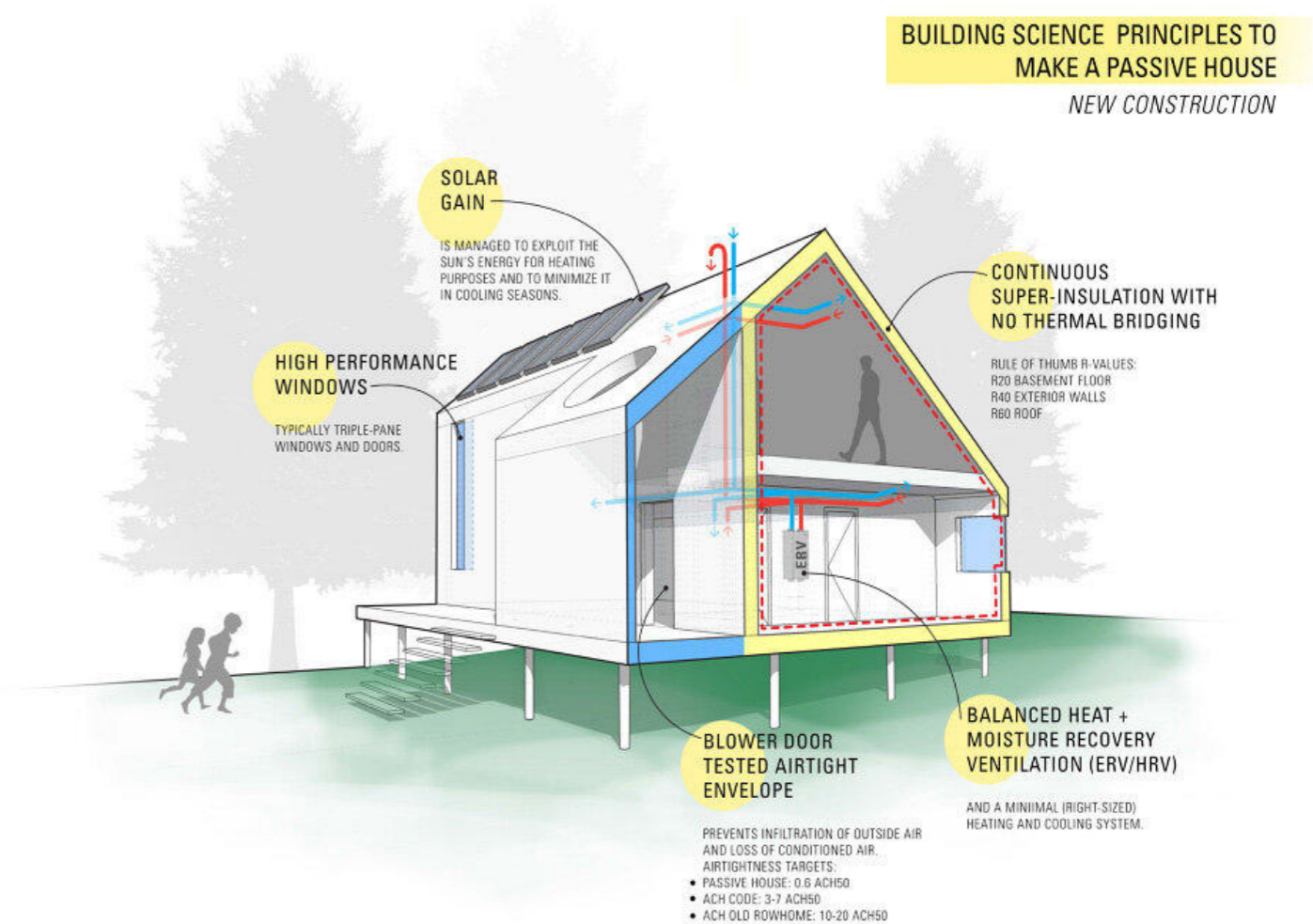


Image Retrieved: ovo-design.co.uk

Renewable Energy Applications and Passive House Constructions

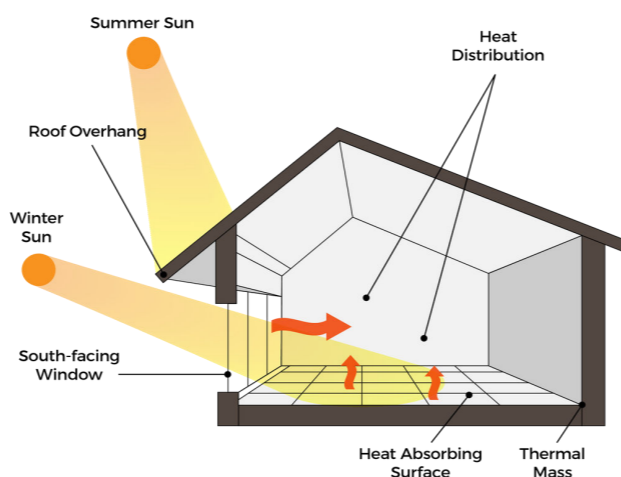
1 Integrated wind, solar and hybrid technologies

In regions characterized by the non mature nature of the Passive House itself, such as the island of Crete, Greece, and significant parts of the South East Europe, meeting all energy demands in a building through renewable energy sources poses a formidable challenge.

The winter season, marked by lower temperatures and reduced daylight, intensifies the need for heating and artificial lighting. In these areas, solar energy becomes less abundant, and hydroelectric output diminishes due to the transformation of rainfall into snow. While cold days may bring stronger winds, they fall short of compensating for the scarcity of sunlight and water power amid heightened heating demands. Achieving sustainability in the building sector through renewable energy hinges on a strategic reduction in overall energy consumption.

The Passive House approach excels in this regard, attaining remarkable energy efficiency levels that enable economical coverage of the minimal remaining energy demand with a diverse range of stable and sustainable sources. Prioritizing energy use reduction, Passive House stands as a pragmatic solution, offering a robust alternative to an exclusive focus on renewables, which, while potentially yielding "net zero" or "energy plus" buildings, may fall short in addressing the winter energy deficit.

<https://www.arenecos.com/net-zero-building-design/>



2 Passive House and Wind Energy

Integrating wind energy into Passive House design represents a strategic approach to enhance sustainability and achieve greater energy autonomy. While Passive House principles focus on minimizing energy demand through superior insulation, airtightness, and efficient ventilation, the addition of wind energy systems contributes to a holistic and renewable energy strategy.

Wind turbines, strategically positioned to harness prevailing winds, can generate electricity to power Passive House buildings. This synergy allows for the utilization of clean and sustainable wind power to supplement the minimal energy needs of a Passive House, particularly during periods of increased demand or when renewable sources like solar energy may be less abundant.

By combining the energy efficiency of Passive House design with the renewable power generated by wind turbines, the overall environmental impact is further reduced. This integration promotes a balanced and resilient energy system, reinforcing the commitment to sustainable living while mitigating the reliance on conventional energy sources. In summary, Passive House with wind energy integration exemplifies a forward-thinking approach that leverages both energy-efficient building practices and renewable power generation to create environmentally conscious and self-sufficient living spaces.

<https://arenecos.com/what-we-do/wind-energy-engineering/>

4 Passive House and Solar Energy

Passive House design, with its emphasis on energy efficiency, can be seamlessly integrated with solar energy systems to create environmentally sustainable and self-sufficient buildings. The core principles of Passive House, including high-quality insulation, airtight construction, and efficient ventilation, work synergistically with solar energy solutions to optimize overall energy performance.

Solar panels, typically photovoltaic (PV) or solar thermal systems, can be strategically incorporated into Passive House buildings to harness the power of the sun. Here's how Passive House and solar energy integration can be achieved:

Photovoltaic (PV) Panels: Installing solar panels on the roof or walls of a Passive House allows the building to generate electricity from sunlight. This clean energy source can contribute to meeting the minimal energy demands of the Passive House, especially during daylight hours.

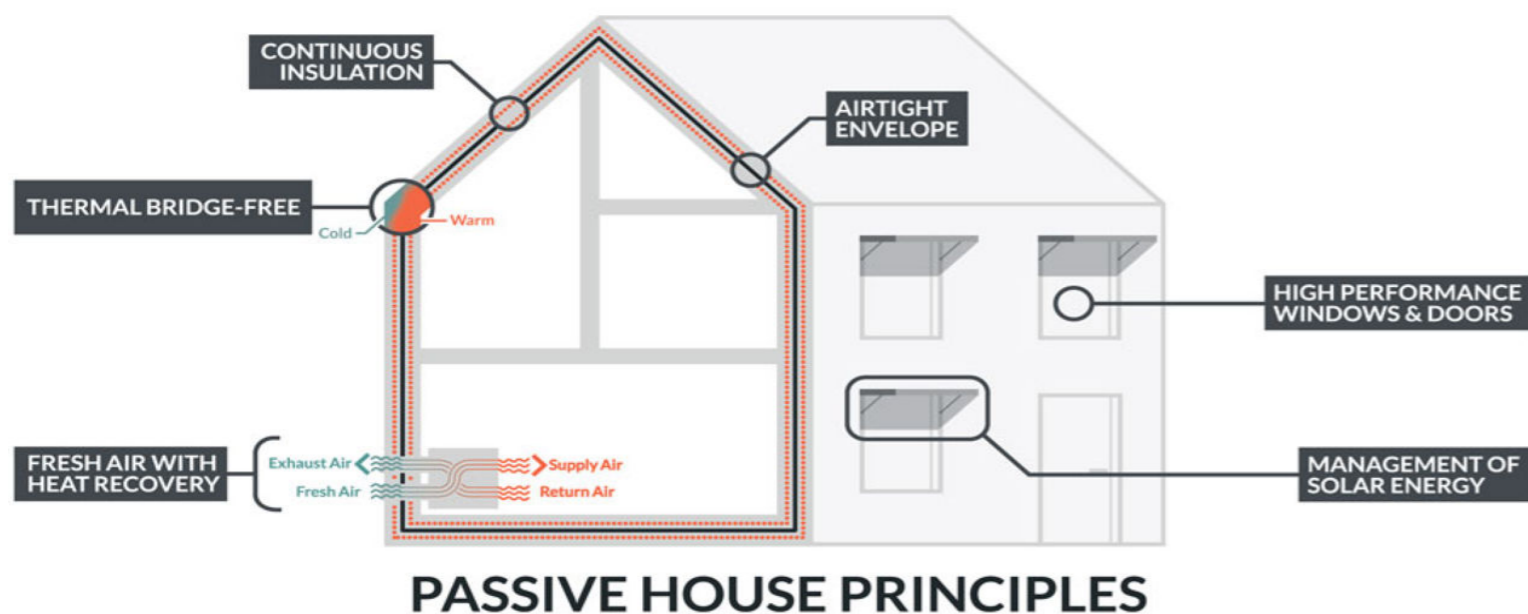
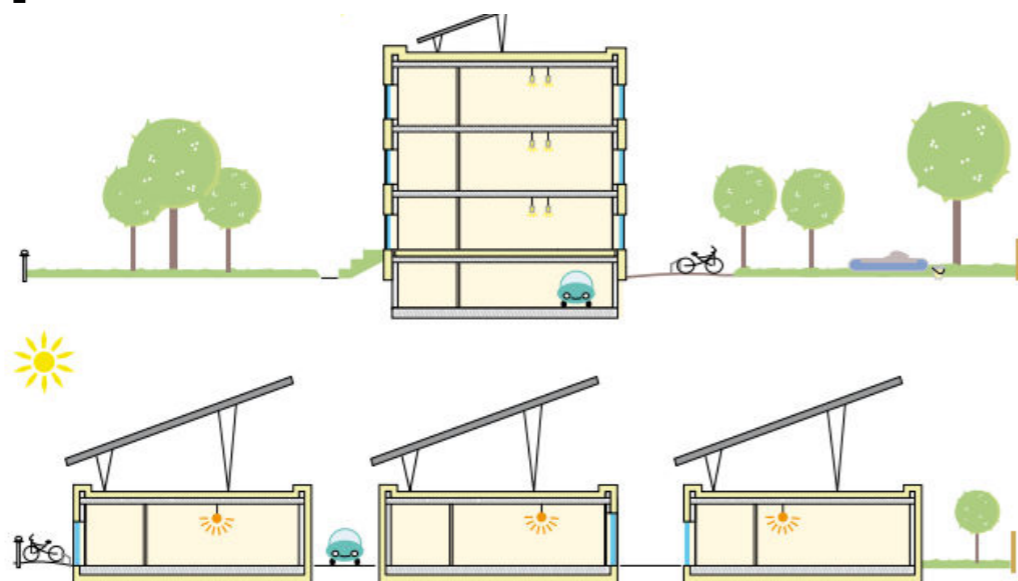
Passive House and a Mediterranean Approach

Passive House Plus

Highly efficient buildings require smaller photo-voltaic systems resulting in sustainable buildings and reduced land use.

Plus Energy:

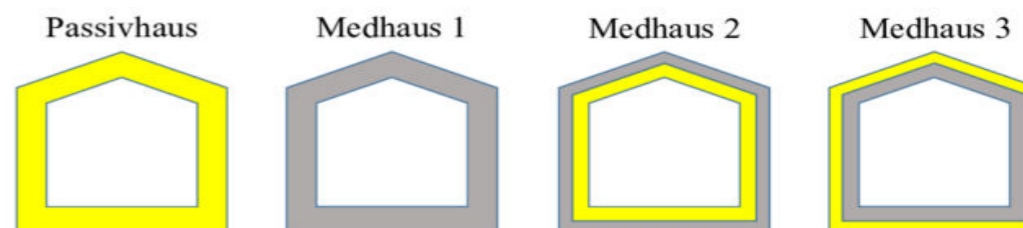
this approach often requires large surface areas if buildings are not highly energy efficient.



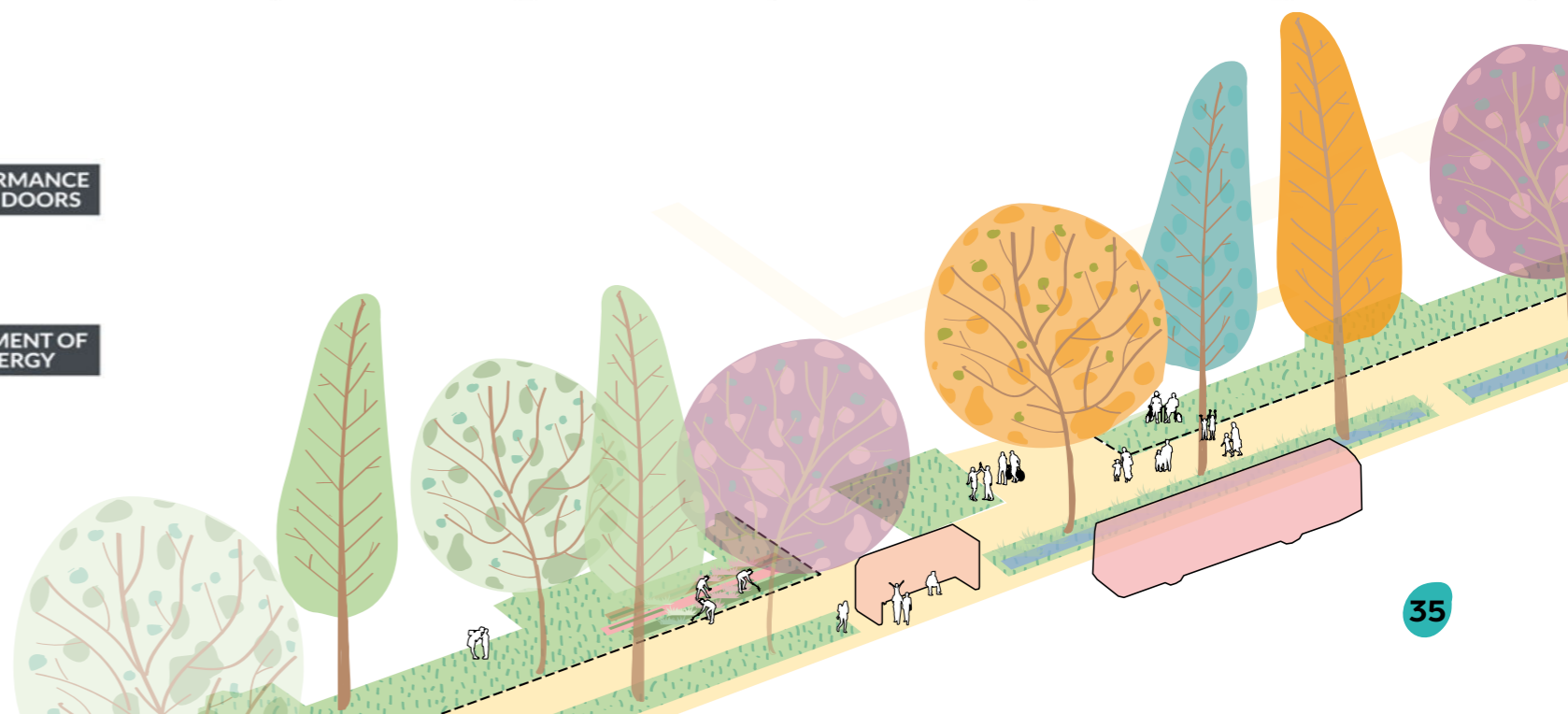
Passive House in the Mediterranean Climate

Passivhaus and three options for Mediterranean Passive House (Medhaus), including design principles and possible drawbacks

www.arenco.com



	Passivhaus	Medhaus 1	Medhaus 2	Medhaus 3
Design principles	<ul style="list-style-type: none"> Thermal insulation Airtight Mech. ventilation 	<ul style="list-style-type: none"> Airtight Mixed-mode Ventilation Solar shading Thermal mass Smart control 	<ul style="list-style-type: none"> Thermal insulation Airtight Mixed-mode Ventilation Solar shading Thermal mass Smart control 	<ul style="list-style-type: none"> Thermal insulation Airtight Mixed-mode Ventilation Solar shading Thermal mass Night-time ventilation
Possible drawbacks	<ul style="list-style-type: none"> Overheating 	<ul style="list-style-type: none"> Cold discomfort Heating energy need 	<ul style="list-style-type: none"> Lack of heat gain passive control Interstitial condensation 	<ul style="list-style-type: none"> Heating system performance



Making it happen



Immediate next steps

ARENCOS Making it Happen Strategy

Passive House Construction: Make it Happen" serves as a comprehensive guide to implementing Passive House principles in building projects. This section is a roadmap for professionals and stakeholders in the construction industry, providing practical insights and actionable steps to bring Passive House concepts to fruition. It encompasses a range of critical aspects, including high-quality insulation, airtight construction, efficient ventilation systems, and the integration of renewable energy sources.

Within this section, architects, engineers, builders, and decision-makers will find valuable information on overcoming challenges and achieving optimal results in Passive House construction. The emphasis is on translating theoretical knowledge into practical applications, ensuring that the principles of energy efficiency and sustainability are effectively implemented in real-world building projects.

Key elements covered in "Passive House Construction: Make it Happen" may include design considerations, material selection, construction techniques, and the integration of cutting-edge technologies to meet Passive House standards. The section aims to empower professionals with the knowledge and tools needed to navigate the complexities of construction while adhering to the stringent requirements of Passive House certification.

Emerging Technologies

Passive House construction continues to evolve with the integration of emerging technologies, fostering innovation and pushing the boundaries of energy-efficient building practices. The incorporation of cutting-edge technologies enhances the performance, comfort, and sustainability of Passive House structures, reflecting the industry's commitment to staying at the forefront of environmental design.

One notable emerging technology is the use of advanced building materials that offer superior insulation properties, durability, and environmental sustainability. Innovations in insulation materials, such as aerogels and vacuum insulation panels, contribute to achieving higher levels of thermal efficiency, ensuring that Passive Houses maintain their energy performance standards while utilizing materials that align with sustainable principles.

Smart building automation systems are also making their mark in Passive House design. These systems optimize energy usage by monitoring and adjusting lighting, heating, and ventilation based on real-time environmental conditions. Integrating sensors, smart controls, and artificial intelligence allows Passive Houses to adapt dynamically to occupant behavior and changing weather patterns, further reducing energy consumption without compromising comfort.

Renewable energy technologies play a crucial role in the quest for net-zero energy consumption. Passive Houses increasingly incorporate solar panels, wind turbines, and other renewable energy sources to generate clean and sustainable power on-site. Energy storage solutions, such as advanced batteries, enable efficient utilization of renewable energy, ensuring a stable power supply even in periods of low natural resource availability.

Looking further forward

Passive House Constructions in Crete

Collaborate, cooperate and coordinate

Looking ahead to the future of Passive House construction in Crete, Greece, there is a promising trajectory marked by advancements in sustainable building practices, increased awareness of environmental considerations, and a growing emphasis on energy efficiency. Greece, with its diverse climatic conditions ranging from coastal areas to mountainous regions, presents a unique opportunity to tailor Passive House designs to specific local contexts.

One key aspect of the future of Passive House construction in Greece involves the integration of indigenous architectural elements and materials. Drawing inspiration from traditional Greek building techniques, Passive House designs can blend seamlessly with the local aesthetic while incorporating modern energy-efficient principles. This fusion of tradition and innovation contributes not only to energy savings but also to the preservation of Greece's rich architectural heritage.

As environmental awareness continues to rise, there is a growing demand for sustainable and energy-efficient housing solutions. The Passive House standard, with its focus on minimizing energy consumption and providing superior indoor comfort, aligns well with the evolving preferences of homeowners and developers in Greece. This increased demand is likely to spur the growth of Passive House projects across the country.

Government incentives and regulations aimed at promoting energy-efficient construction are anticipated to play a crucial role in shaping the future of Passive House construction in Greece. As policymakers recognize the importance of reducing the carbon footprint of buildings, initiatives supporting Passive House principles may be introduced to encourage widespread adoption. Financial incentives, tax breaks, and streamlined permitting processes could further accelerate the integration of Passive House technologies in the Greek construction landscape.

Collaboration between architects, builders, and policymakers will be instrumental in driving innovation and setting new standards for Passive House construction in Greece. The exchange of knowledge and best practices within the industry can foster a community committed to sustainable building practices, ensuring that Passive House projects become increasingly prevalent and accessible.

Looking further into the future of Passive House construction in Greece, technological innovations are expected to play a pivotal role in enhancing the performance and versatility of Passive House designs. The integration of smart building technologies, such as advanced sensors, automated shading systems, and intelligent HVAC (Heating, Ventilation, and Air Conditioning) systems, can further optimize energy efficiency and indoor comfort in Passive House buildings. These innovations enable real-time monitoring and adaptive control, allowing for dynamic responses to changing environmental conditions.

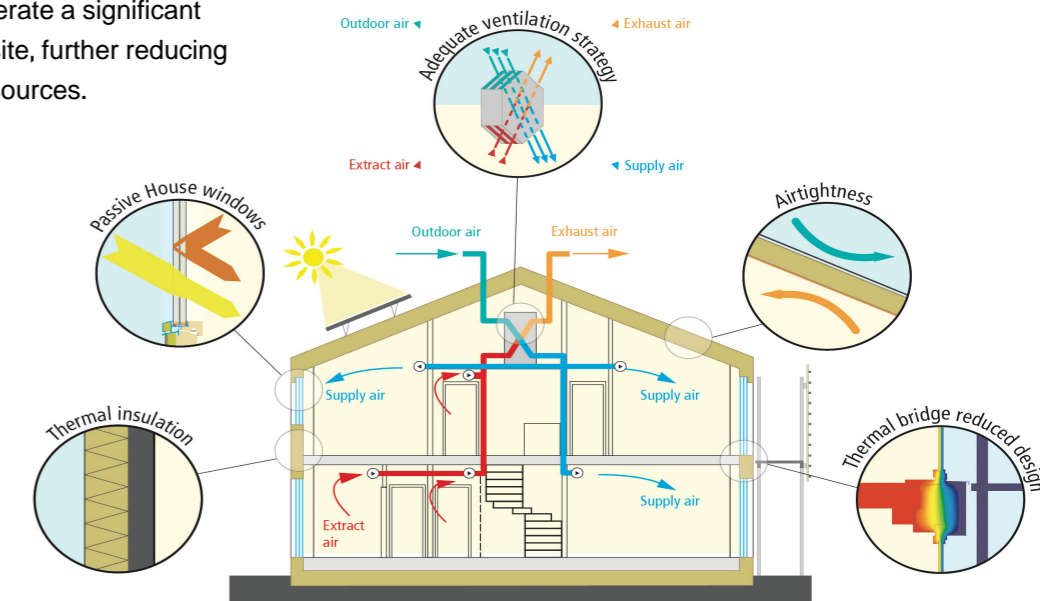
Moreover, the incorporation of renewable energy sources, particularly solar power, is poised to become increasingly integral to Passive House projects in Greece. Advancements in solar panel technology, energy storage solutions, and grid integration can empower Passive Houses to generate a significant portion of their energy needs on-site, further reducing reliance on conventional energy sources.

Spaces that matter the most

Collaborative research initiatives and academic partnerships focused on Passive House construction are likely to contribute to the development of region-specific guidelines and best practices. Tailoring Passive House principles to the unique climate challenges and architectural traditions of Greece will enhance the adaptability and effectiveness of these energy-efficient building standards.

The evolution of Passive House construction in Greece also aligns with the broader global movement toward sustainable urban development. Concepts such as eco-districts and green building certifications may become integrated into urban planning strategies, promoting a holistic approach to sustainability that extends beyond individual buildings to entire neighborhoods and communities.

In summary, the future of Passive House construction in Greece is characterized by a convergence of cutting-edge technologies, increased emphasis on renewable energy integration, and a collaborative approach among stakeholders. As Greece positions itself at the forefront of sustainable building practices, Passive House construction is likely to emerge as a key contributor to the nation's energy resilience, environmental stewardship, and the overall well-being of its inhabitants.





Research Division

ARENCOS Digital Ecosystem

66, Apokoronou Street, 73134, Chania,
Crete, Greece

UpData



Maria Gkika

Civil Engineering & Passive House Design

Maria directs our civil engineering research programs. She has a background in civil engineering and structures with a focus on sustainable building design.



Stavros Thomas

Research Leader, ARENCOS Foresight, Research + Innovation

Stavros manages the research programs of ARENCOS. He has a background in computer science, wind energy engineering and strategy with focus on business digitalization.

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