PASSIVE ENERGY :HOW NEW CONSTRUCTION METHODS AND MATERIALS CAN IMPROVE KURDISTAN'S ENERGY CONSUMPTION

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Executive Summary

In hot and cold climates like the Middle East, cooling and heating systems drive up electricity costs and levels of carbon emissions. The Kurdistan Region in Iraq faces growing residential demands and inefficient electricity production, along with a shortage of renewable energy resources. This paper explores how passive energy—designs that require minimal input energy—can improve energy efficiency in buildings, particularly through methods like passive cooling and heating. The implementation of Passive House principles, which prioritize energy efficiency via thermal insulation, the elimination of thermal bridges, and adequate ventilation, can significantly reduce energy usage. To promote sustainable growth, the government must actively establish a home finance system, support local manufacturing, provide different construction options, and prioritizing the development of a "Green Energy Department" to advocate for renewable energy and mitigate carbon emissions. These measures will promote economical housing and sustainable energy efficiency on a national scale.

Introduction

Buildings, residential and commercial, account for 40% of global energy consumption, with an annual growth of 2.2%.[1] Heating and cooling systems consume 50% of this energy.[2] In extreme climates such as that of the Middle East[3], cooling and heating devices are needed all year long, consuming a large amount of energy that not only raises electricity costs but also increases carbon emissions levels. This paper focuses on the Kurdistan Region in the north of Iraq, where the climate is relatively extreme in summer and winter seasons. The region has cold and dry winters, as well as very hot summers, especially from the months of June to September, where the temperature can reach above 50 degrees Celsius on some days.[4] The growing demand on residential areas and lack of electricity production due to economic

trouble, as well as the absence of refined renewable energy resources, necessitate new approaches that focus on using new and innovative construction methods and materials.

Passive Energy is a method of saving energy in which a design requires a small input of energy to reach an optimal outcome. Even such designs are not completely passive and require a little bit of energy, but the idea is using intelligent designs to achieve an energy-saving building that needs very little heating or cooling to reach a comfortable point in any season[5].

In modern urban societies, new methods of energy conservation in commercial buildings and residential households are used, which yield favorable results. In this sense, it is important to evaluate their applicability in the Kurdistan Region, given the already changing and rapidly urbanized environment.

Using construction methods and efficient materials, while applying passive energy methods of cooling and heating, can be an integral part of the urban structure and the key solution to combat climate change and extreme weather events.

Brief Historical Overview:

Iraq is the center of a rich cultural history and home to over 10,000 historical architectural sites of ancient civilizations such as Babylonian, Sumerian, and Akkadian[6]. However, many of these remains were destroyed because of continued wars and political crises such as the US-led invasion of Iraq to overthrow Saddam Hussein's regime in 2003. More recently, the barbaric attacks by the Islamic State of Iraq and Syria (ISIS) have caused irreversible damage to historical sites in places like Baghdad, Nineveh, Mosul, and Babylon.

Reconstruction efforts to restore and protect key sites, as well as creating settlements for the 5 million displaced citizens, have been underway since 2003. Following international

pledges of 33 billion dollars to support rebuilding Iraq. So far, progress has been slow, and Iraq continues to struggle with infrastructure progress.

The Effects of Climate Change:

Climate change, such as extreme weather and temperature shifts, can significantly impact the construction sector of a certain geographical location. For instance, it can accelerate structural deterioration and increase heating and cooling demands, resulting in increased carbon emissions. Yet, there is no system for integrating climate change impacts in environmental analysis such as life cycle assessments (LCAs) for infrastructures.

It is estimated that climate change can reduce the lifespan of houses and buildings by up to 20 years due to factors such as corrosion and extreme weather like heat, floods, earthquakes, and strong winds. There is a need for a shift towards more climate responsive building designs.[7]

As climate change introduces new environmental challenges, these must be factored into the construction of new buildings. The Kurdistan Region of Iraq (KRI) has witnessed increased temperature rise over the years; this is creating a massive energy demand for cooling. There are numerous construction methods and materials that can be used to create buildings that need less energy for cooling and heating without the need for constant renovations.

The Nature of KRI's Construction Sector:

The construction sector is crucial to the economy of KRI due to its large size and influence on other sectors, such as materials industries and employment. Iraq's local material production cannot keep up with the overwhelming demands of this rapidly growing sector, which has led to the domination of the industry by private sector firms. The construction sector is valued at $2.8 Billion, and Turkish companies dominate 65% of the sector. This has created

dependence on the importation of vital construction materials such as cement, bricks, glass, gypsum, pipes, tiles, windows, and doors.[8] Dependency on imports from countries like Turkey and Iran has made it difficult for KRI's construction sector to rely on itself to produce construction materials suitable for the Region's environment, as there is a lack of study on the suitable materials.

Some of the challenges KRI's construction sector faces, include:

1. Lack of experienced construction workers in the Region. A lot of the engineers, site officers, and technicians are from Turkey or Iran. They use techniques and methods that are popular in their own countries without trying to create suitable approaches that work well in KRI.
2. Locally produced materials are of poor quality, creating a need to import materials from outside for a much higher price. However, these imported materials lack proper quality control measures tailored to Kurdistan's environment, resulting in low-quality buildings that age quickly.
3. There is a lack of funding for restoring old factories or building new ones to produce construction materials locally. Most of the allocated budget for the construction sector is spent on importing materials at high prices; there is no focus on trying to create opportunities to develop factories to produce suitable local material for affordable prices.
4. There is a continuous urgent need for affordable housing because of immigration and the return of displaced families. This puts a strain on resources, leading to rising material costs and a decline in quality.
5. Construction companies are tending to the wealthy by focusing on building luxury homes instead of providing affordable housing for all income levels.

Adapting Passive House Principles

One of the most popular methods for energy efficiency through construction is the Passive House standard. Passive House buildings are known for their ability to drastically reduce energy consumption by minimizing heating and cooling needs using insulation, internal heat sources, and heat recovery. This approach makes conventional heating and cooling systems unnecessary, even during the coldest winters and hottest summers. According to the Passive House Institute, the annual energy demand for heating and cooling in a Passive House is only 15 kWh compared to the average house that spends 100-150 kWh. Buildings in Kurdistan do not use the same materials used in an average house in developing countries, resulting in a poorly insulated house that requires 300 kWh.[9] The rest of the Passive House performance requirements are shown below:

Passive House Criteria	Requirements
Heating Demand	15 kWh/m²a
Heating Load	10 W/m²
Cooling Demand	15 kWh/m²
Cooling Load	10 W/m²
Frequency of over heating	< 10%
Airtightness Form factor	0.6 acph

Credit: The Architectural Science Association[10]

This method of building houses can be particularly beneficial for the KRI, where energy conservation is crucial due to fluctuating electricity and steadily increasing summer temperatures. By reducing reliance on active heating and cooling systems, this method offers

a sustainable solution for Kurdistan, helping to lower energy costs while providing comfortable living spaces year-round. The Passive House standard, originating in Germany, emphasizes the following five key principles the building must follow:

1. Thermal Insulation
2. Eliminating Thermal Bridges
3. High-Performance Glazing
4. Airtightness and Ventilation
5. Optimized Orientation

These principles work together to create an energy-efficient and comfortable living environment. Here's a closer look at each one in detail:

1. Thermal Insulation: A Passive House building must be very well insulated using proper insulation materials on each of its surfaces. The building walls, roof, and floor must be enveloped in continuous insulation materials that limit heat transfer to a thermal transmittance (U-value) of no more than 0.15 W/m^2K. This helps in keeping the inside warm when the temperature is low outside and cool when the temperature is high outside, to reduce the energy needed for cooling and heating devices.

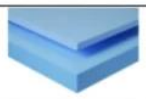
Many buildings in the KRI are built with bricks (U-value = 2.0 W/m^2K) or cinder blocks (U-value = 1.75 to 2.25 W/m^2K). Sometimes a layer of insulation material is added for more protection, but even so, there is a big amount of energy loss through the walls. Passive House standard recommends the following insulation materials be added to the structure for more protection. The materials can be divided into three groups[11]:

a . Mineral insulation (made from natural materials)

Materials	Picture	Manufacturing	Thermal conductivity (W/m.K)	Properties	Conditions of use
Foam glass		Sand/limestone	0,038 to 0,055	- Non-combustible - Resistant to T°C > 430°C - Waterproof - Dimensional stability - Resistant to rodents, insects, acids	Suitable for flat roofs, walls, foundations Available in sheets, panels or granules Not recommended for irregular surfaces
Glass wool		Silica and glass recovered by melting, then fibering and polymerization	0,03 to 0,04	- Resists up to 260°C - Non-flammable in the presence of a vapour barrier - Resistant to rodents - Root proof but blows over when humid	Suitable for sloping roofs, attics, attics, wall partitions, ceilings Available in semi-rigid panels, flakes or rolls Wearing gloves and glasses
Rock wool		Basalt, fondant and coke	0,032 to 0,04	- Fire/heat resistant - Excellent compressive strength - Moisture resistant and vapour permeable (possibility of respiratory discomfort)	Suitable for sloping roofs, attics, walls, ceilings Available in semi-rigid panels, flakes or rolls Wearing gloves and glasses
Perlite		Volcanic silica rock crushed and heated to 1200°C	0,05 to 0,06	- Hydrophilic (so it must be combined with a water repellent) - Durable and ecological but expensive - High compressive strength - Effective against bacteria, rodents - Non-combustible	Suitable for ceilings, roofs and attics Available in panels or granules
Vermiculite		Magnesium silicate, a natural and abundant resource	0,06 to 0,08	- Expanded under the action of extreme heat (1000°C) or water vapour => water repellent treatment required - Non-combustible and rotproof - Not irritating - Resistant to rodents/insects - Good mechanical resistance	Suitable for attics and roofs Available in bulk or in panels
Expanded clay		Raw dried clay, reduced to flour, mixed with water and then heated	0,10 to 0,16	- Non-combustible and fire-resistant - Permeable to steam and water resistant but must dry to regain its properties - Rot-proof and resistant to corrosive/insect products	Available in bulk in granules and bead-based building blocks

Credit : ecopassivehouses .com

b . Synthetic insulation (made from fossil fuels)

Materials	Picture	Manufacturing	Thermal conductivity (W/m.K)	Properties	Conditions of use
Expanded Polystyrene (EPS)		Crude oil - balls compression-bonded during molding	0,029-0,038	- Fragile in the face of fire: requires associating it with plaster, for example - Releases CO2, H2O and CO in case of fire - Unstable over time - Sensitive to the action of corrosives and rodents	Recommended on regular surfaces for roof, wall and floor insulation In the form of plates
Extruded Polystyrene (XPS)		Crude oil - balls compression-bonded during molding	0,029-0,037	- Compression-resistant - Waterproof, cold, heat resistant - Fragile in the face of fire (combine it with plaster)	Basements, flat roofs, floors, heated underfloor, double walls Panels with smooth or flush edges
Polyurethane (PUR)		Polyurethanes are produced by the reaction of an isocyanate and a polyol of various types.	0,022-0,030	- Good compression support - Moisture does not alter it - Micro-porosity of its structure: allows water vapour to migrate from the inside to the outside => no need for a vapour barrier - Dangerous in case of fire: releases toxic gases	Roofs, flat roofs, floors, wall lining Suitable for renovation and construction Foam or panels
Phenolic foam		Phenol-formaldehyde resin	0,018-0,035	- Fireproof and low smoke emission during combustion - Sensitive to moisture: requires water repellent	Roofs, walls, floors Panels
Thin insulating		Lightweight and thin material Aluminum layers + other layers (felt, wadding, foam...) => multi-layer or reflective insulation	0,1-1 Prevents heat losses	- Lightweight - Low thickness - No health risk - Water vapour tight	Handy, flexible On all surfaces Not irritating to the skin, so wearing a glove is not necessary
Vacuum insulating panels (VIP)		Composed of a central material (= aerogels) confined in a sealed film and placed in a vacuum	0,0042-0,0050 1 cm VIP = 6 cm EPS and 9 cm of mineral wool	- Water vapour permeable (installation of a vapour barrier recommended) - Good compressive strength	Suitable for flat surfaces Disadvantage: must not be drilled and the panels cannot be cut out

Credit : ecopassivehouses .com

c. Organic insulation (made from plant or animal materials)

Materials	Picture	Manufacturing	Thermal conductivity (W/m.K)	Properties	Conditions of use
Cork		Made of cork and 96% air	0,032-0,049 depending on the packaging Good thermal shift	- Resists to compaction - Stable against differences in humidity and T°C - Rot proof - Self-extinguishing (burns on contact with a flame but extinguishes on its own when removed) - Does not emit toxic fumes - Not attacked by rodents and insects	Suitable for attics, roofs, floors, walls and foundations Expanded cork available in plates or in bulk (granules) Agglomerated cork available in plates, slabs and rolls Required thickness from 20 to 100 mm
Wood fiber (wool wood)		Obtained from the defibration of fir scraps.	0,037-0,049 Good thermal shift	- Ageing very well - Low flammability - Does not emit toxic fumes - Hygroscopic = can store moisture - Cleanses the air in the house and regulates humidity	Available in rigid or semi-rigid panels and in bulk Panels: exterior roof insulation, slabs and floors, exterior walls under cladding, wood framing, interior walls and partitions Bulk: empty filling of sloping roofs, partitions and floors
Hemp		Made from natural fibers from the fibrous part of the hemp tree	0,04-0,046	- Rot proof - Anti-fungal - Antibacterial - Resistant to insects and rodents - No chemical toxicity - Flammable - Addition of synthetic binders necessary to guarantee its resistance over time	Suitable for walls, roofs, attics, partitions Available in panels, rolls, mattresses or in bulk
Linen		Made from linen fibers too short to be used in the textile industry	0,037-0,040	- Very good longevity - Impregnated with boron salt to resist mould, insects and fire - May blow over -Rot proof - Ability to absorb and release moisture	Suitable for insulating walls, roofs, floors, attics Available in panels, rolls, bulk or felt
Sheep's wool		After mowing: soaking, degreasing, rinsing, treatments + boron salt to protect against fire, moulds and insects + moth control treatment	0,035-0,042	- Low flammability and tends to self-extinguish - Vertical settlement - Not suitable for wet areas	Suitable for roofs or attics Available in bulk, rolls, felt
Wool based on duck feathers		Made of 70% duck feathers and other binders (polyester fibers, sheep wool...)	0,33-0,42	- Permeable to water vapour but retains insulating properties after drying - Treatment allows it to resist fungi and insects - Possible settlement	Suitable for attic spaces, separately applied ceilings, walls, wooden frame houses, floating floors Available in rolls and panels

Credit: ecopassivehouses.com

A Passive House constructed in Qatar, an area known for its high temperatures, used Thermostone for the wall structure instead of hollow concrete bricks (which is commonly used for buildings in the KRI); this led to a 25% energy reduction and a 30% decrease in costs due to using the Thermostone. The production of better-quality raw materials can offer not only energy efficiency advantages but also economic advantages if given proper research and study.

Local Sample:

An experimental study was conducted on a residential building in the city of Kirkuk, where two models (1.8 x 1.8 x 2) m were built, one following local building standards and the other was based on the insulation principles of Passive House. The experiment took place during the months of August and September to examine the effects of the heat on the buildings without the use of cooling devices. The model based on the Passive House insulation principles showed better air quality and a comfortable indoor temperature of 32 degrees Celsius compared to the other building that experienced an indoor temperature of 42 degrees Celsius. While the Passive House model only implemented one of the principles, it still showed a significant improvement in heat resistance, alongside an 80% reduction in energy consumption.[12]

The table below shows the construction materials used for a standard house in the KRI, in Ashti City 2 in Erbil, according to the Iraqi construction code.[13] As shown, the current U-value is very high, resulting in significant heat transfer. To address this, stronger insulation materials, such as EPS or XPS foam, should be used, alongside improved reinforcement for the roof, which is the most prone to heat leaks. Applying a liquid Polyurethane solution over the roof construction materials, will insulate the area effectively.

House module	Construction details	U value W/m^2 k
External wall	2 cm Cement & sand render+ 20 cm hollow concrete block + 2 m Gypsum	2.719
Internal partitions	2 cm Gypsum + 20 cm hollow concrete block + 2 m Gypsum	2.544
Roof	20 cm reinforced concrete with %1 steel bars + 2 cm Gypsum	3.645
Ground floor	Soil + 10 cm gravel + 10 concrete + 2.5 cm Terrazu Tile.	2.61
Internal floor	2.5 cm Terrazzo tile + 5 cm sand &cement mix + 20 cm reinforced concrete with %1 steel bars + 2 cm Gypsum	1.119
Windows	PVC (polyvinyl chloride) with one single pane of 6 mm	5.77
Façade or direction	Not considered	–

Credit: ScienceDirect[14]

An improved example of wall construction should incorporate a concrete block paired with a layer of EPS foam, a cement layer covered by a protective mesh layer and a final protection layer of cement, to significantly enhance insulation. As shown in the figure below:

Credit: roofingoutlet.co.uk

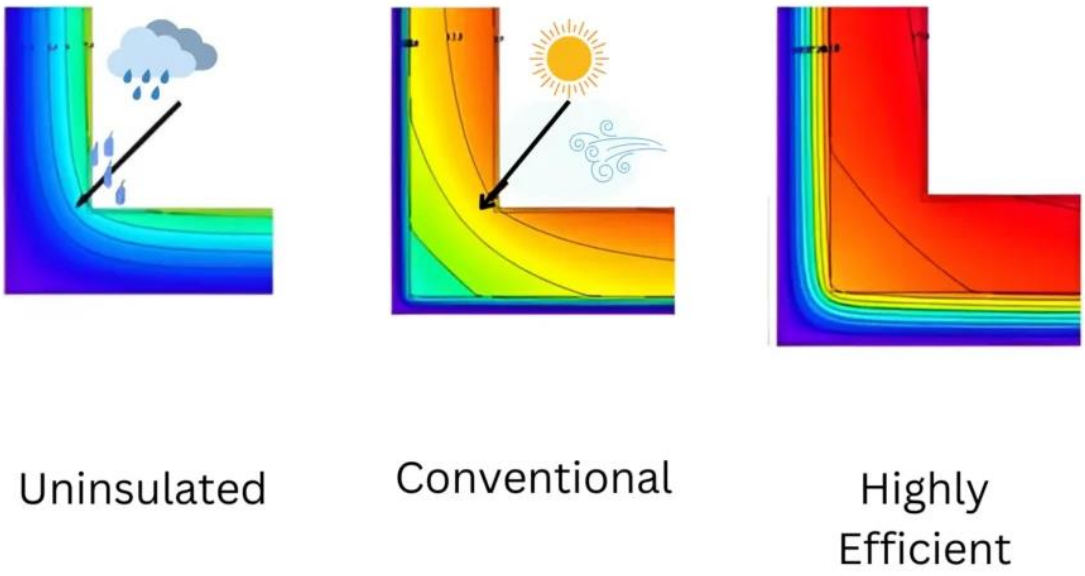
2. Eliminating Thermal Bridges: A building does not consist of one continuous layer of construction, but it also has edges, turns, corners, connections, and penetrations. These points in a building are called thermal bridges. A thermal bridge is a weak point in the building envelope that allows heat to pass through more easily.

Thermal bridges also give opportunities for moisture to be trapped, which can lead to mold generation. Thermal bridges occur when the continuous layer of insulation is interrupted because of a change of direction in the building, such as a corner of the wall, a connection between the wall and the roof, and added balconies.[15] This creates a "bridge" between the inner and outer faces of the building for heat to escape or get in. To eliminate the chances of creating thermal bridges, detailed planning is essential to create a straightforward architectural design with a small number of corners and turns, as complex shapes are more prone to thermal bridges. For example, if a balcony is added to a house, the structure will penetrate the insulation layer where the balcony floors and walls connect to the building,

creating a big thermal bridge. A better design would be to connect a free-standing balcony to the exterior face or front of a building as to not interrupt the continued layer of insulation, as shown in the image below:

Credit: bradfabs.co.uk

Additionally, extra layers of insulation should be added to areas where thermal bridges are likely to occur, reinforcing these vulnerable spots. The figure below shows how an uninsulated corner loses notable energy, while adding more layers of insulation reduces heat loss and enhances the building's thermal protection.



Credit: International Passive House Association

3. High-Performance Glazing: When creating a highly insulated enveloped building, the windows and doors must not be forgotten. Due to their function (providing light, visibility, and access) windows and doors cannot be insulated as effectively as a wall, resulting in being the weakest areas of the envelope in terms of resisting heat loss. Yet, windows are very necessary in a Passive House as they are very useful in utilizing the sun. Daylight can provide natural heating in cold seasons as well as proper lighting to reduce electrical lighting energy.

Window placement is a very important part of the building planning process; windows facing east or west can lead to overheating. It is important to consider window orientation, as well as installing window shades if needed, to receive the most amount of sun during cold seasons and the least amount during warm seasons. According to Passive House standards, the temperature of the surface of the window should not be below 17 degrees Celsius in cold temperatures without the help of heating devices.

It is very important to use high-performance Passive House-certified windows and doors. The windows must be either double or triple paned, depending on the location's atmosphere and

orientation of the house, with argon or krypton gas between the panes to further increase insulation. Passive House requires a window with a U-value of no more than 0.85 W/m^{2}K. The slimmer the window frame the better, as the insulation of the glass is higher than the frames, which is why the amount of frame should be no more than 40% of the entire window. It is also important to invest in highly insulated doors, preferably certified by the Passive House Institute.

Credit: modernize.com

4. Airtightness and Ventilations: Passive Houses must have a balance of airtightness and ventilation. To achieve an airtight building, every air leakage point should be addressed and sealed properly to prevent winter heat loss and summer heat gain through gaps and joints. This not only saves heating energy, but it also creates a comfortable home that experiences healthy indoor air quality and prevents moisture damage and mold growth that can lead to structural damage.

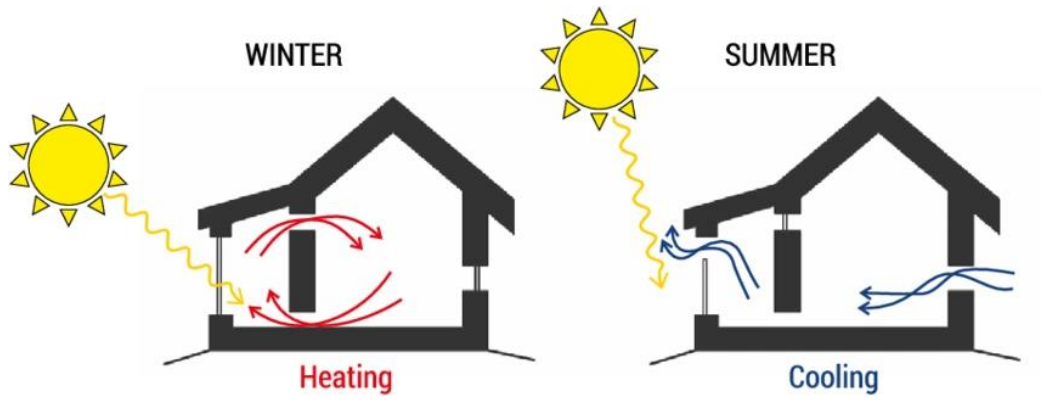
However, as buildings become more airtight, the need for good ventilation grows. Ventilation provides the house with clean, controlled air, eliminating any unwanted pollutants, odor,

moisture, and outside pollen. This creates a sufficient level of oxygen and helps remove pollution such as carbon dioxide and other contaminants in the air of the house.

Choosing the appropriate type of ventilation system depends on the local climate of the house. The KRI faces a very high level of air pollution, yet many houses and buildings do not invest in proper ventilation systems. Mechanical ventilation systems such as heat recovery ventilators and energy recovery ventilators are the most popular types of mechanical ventilators. The only difference between the two systems is that while heat recovery ventilator recovers heat only, the energy recovery ventilator recovers both heat and humidity, helping to control indoor moisture levels[16]. Which makes it more efficient to get an energy recovery ventilator if the building or house faces very dry winters and moist summers to ensure the utmost indoor comfort.

Having an airtight building with a proper ventilation system controls the flow of clean air and effortlessly removes moisture, drafts, and cold corners, ensuring high-quality indoor air and comfort.[17]

5. Optimized Orientation: Orientation is the position of your house relative to the direction of the sun. Optimized orientation is important to reduce cooling and heating needs by relying on the sun. Ideally, the building must be receiving the most amount of sun in winter when the sun is the lowest in the sky, and the least amount of sun in the summer when the sun is the highest in the sky and vice versa, as shown in the figure below[18].



Credit: Research Gate

For optimal orientation, it is necessary to review the building's climate zone. For instance, the Kurdistan Region aligns with the principles of the Northern Hemisphere; the sun is southward, which means it is the most optimal to orient the house facing the south direction for the most sun in winter and the least sun in the summer. It is better to avoid having windows facing the east and west sides because they can receive intense sunlight during the summer.[19]

Retrofitting Existing Buildings

For existing buildings, it is much more difficult to adhere to Passive House standards because of the existing structure. Which is why the Passive House Institute introduced the Enterphit standard. Passive House cannot always be achieved to an existing building because of factors like house orientation, unavoidable thermal bridges such as basement walls, added balcony, construction with many turns and interruptions in the insulation layer, and more. For those who want to retrofit their house to save as much energy as possible, following the Enterphit standard is recommended. Enterphit follows many principles of Passive House design. Such as insulating walls and replacing doors and windows with those approved by Passive House. Finally, implementing a high-quality ventilation system is essential for optimal performance.

More energy is required to reach a comfortable temperature level inside a house following the Enterphit standard, but it can still save up to 75% energy compared to non-retrofitted or even new local houses. It is guaranteed that the reduced energy demand will ensure the return of the investment in the retrofit process. There will also be an uplift in property value thanks to the modern modifications.

The standards a building must meet to adhere to Enterphit are as follows:[20]

Enterphit standard	Requirements
Heating Demand	25 kWh/m²a
U-value for windows (cool areas)	0.85 W/m2K
U-value for windows (cold areas)	0.65 W/m2K
U-value for windows (warm areas)	1.05 W/m2K

Credit: The Enterphit Standard

Net Zero Energy House

Another energy-saving construction method is the net zero energy house design. This is a house or building that produces as much energy as it uses yearly, making it a zero energy-cost house. The net zero energy house follows green energy principles to reduce emissions by using renewable energy methods, the most popular being solar energy, where solar panels are added to the roof of the house. This helps the house create as much energy as the household spends. Adapting net zero energy in the KRI can also be beneficial against power outages that are commonly experienced in the area. Combining the principles of Passive House and net zero energy houses can create a very comfortable, energy-efficient, and sustainable house. By integrating the airtight construction and thermal insulation of Passive House with the energy generation capabilities of net zero energy houses, it becomes easy to

reach net zero energy. In fact, the application of all the Passive House principles is not necessary for significant changes in energy efficiency to become noticeable.[21]

The Impact of Cultural Needs on Housing Development:

Cultural traditions have shown to influence house occupancy, comfort level, and energy usage. Research shows that introducing foreign concepts and new technology without coordinating with the local cultural, societal, and gender norms, may lead to an increase in energy usage and the need for future renovations.[22]

A lot of the modern construction designs in the KRI are modeled after western designs. However, adapting to more western designs is not preferred culturally, as they do not provide households with much privacy. While Kurdish families value privacy and a large number of rooms in a house, western model designs are wider and have more open floor plans, which are not favored in the Middle East. These factors should be taken into consideration while designing.

There are many ways to involve the residents of the building in the design process to create a more satisfactory result for everyone. For example, educating them on how energy flows within their house and how everything is affected. Additionally, introducing a transparent and flexible billing system will provide residents with more accurate bills, making them feel more secure and confident in their energy usage. Most importantly, when conducting energy audits, it is important to help the residents in identifying sources of energy losses and maximizing energy savings through detailed, ongoing assessments.[23]

Financial Challenges

The cost of each different project can vary depending on the size, complexity of the design, materials used, the engineers and workers involved, and many other variables. According to the Passive House Institute, building a Passive House style house can cost about 5-10% more than an average modern house, although sometimes it reaches 7-15 %, this rate will increase for buildings in the KRI as the average houses built here are much cheaper than the average modern houses in first world countries.

While the construction cost of energy efficient houses is a lot higher than the average ones, significant savings can be gained in the long run through energy conservation and reduced future renovation needs. To save even more energy, a lot of houses build solar panels on their roof and sell it back to the grid to make the extra income. One family in Massachusetts, USA had done just that. They have built an energy saving house with solar panels creating a zero net energy house. They spend around $400 a year on energy usage,[24] compared to the average energy spent in a Massachusetts household recorded at $1,520.64.[25] Ultimately, investing in energy-efficient construction pays off both financially and environmentally.

Today, many countries encourage green building practices and the reduction of carbon emissions nationwide. For instance, in Ireland, by building or retrofitting a house that receives a Passive House certificate, the country's sustainable energy authority will fund 50% of the cost of retrofit. Similarly, in many states in the US, homeowners who implement energy saving techniques and insulation materials are eligible for government grants and tax breaks. These incentives not only encourage sustainable living but also make it more accessible and affordable for homeowners.

Policy Recommendations

To have comprehensive governmental polices for creating more energy-efficient houses, the following are recommended[26]:

1. **Clear Government Role**: Define a clear and concise role for the government in the housing sector, focusing on setting standards, regulations, and providing oversight to ensure energy efficient construction practices.
2. **Housing Finance System**: Establish a strong housing finance system to offer affordable loans, grants, and incentives that encourage homeowners and engineers to adopt energy saving construction methods and technologies.
3. **Broad Choices**: Provide KRI developers and home builders with a wider range of construction options, including energy efficient materials and sustainable construction techniques, to meet different needs and budgets.
4. **Support for Local Factories**: Create opportunities and provide financial support for establishing local materials factories, ensuring affordable access to high-quality, energy-efficient building materials that are suitable for the Region's climate.
5. **Green Energy Department**:Establish a Green Energy Department to supervise energy efficient housing policies, promote renewable energy, and coordinate efforts to reduce carbon emissions in buildings and households. This department will also provide guidance and financial support to individuals trying to implement energy saving construction methods but face high costs or lack knowledge of where to begin. By leading these initiatives, the Region will gain international recognition for its progress in going green, opening the door for expanding this success to the rest of Iraq.

These policies will foster sustainable development, reduce environmental impact, and ensure more affordable, energy efficient housing for the Region.

Conclusion

- In regions like the Middle East, cooling significantly increases electricity costs and carbon emissions, The Kurdistan Region of Iraq (KRI) faces challenges from growing housing demands, economic struggles, and a lack of sufficient renewable energy resources.
- Passive energy designs, which require low energy input, improve building efficiency. A passive house is a building designed to maintain a comfortable indoor temperature year-round with minimal energy consumption, using new construction methods and materials. It follows five main principles; thermal insulation, thermal bridge elimination, airtight construction and effective ventilation systems, high-performance glazing, and optimized orientation.
- The government should support the housing industry by establishing a clear role for it in national planning, implementing financial initiatives to fund sustainable housing, and fostering the growth of local industries dedicated to producing energy-efficient materials. Additionally, the creation of a Green Energy Department would be essential in advancing renewable energy and promoting sustainable development across the sector.

ENDNOTES

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