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ENERGY EFFICIENCY AND RETROFITTING BUILDINGS FOR LOW CARBON FOOTPRINT; A PERISCOPE

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ABSTRACT

The United Kingdom government carbon goals will require UK's 27 million homes to be virtually zero carbon by 2050. This will be by a number of measures including a combination of energy efficiency strategies and retrofitting of buildings with smart technologies as well as moving to low carbon heat with a dedicated decarbonization fund to improve energy performance of homes. The home energy performance retrofit will include funding the installation of energy efficient technologies and low-carbon heating system in domestic properties. However, this is not the case everywhere because different strategies might be adopted at a completely different location with a different climatic disposition. While in a temperate climate heating might be the paramount consideration, cooling is the required option in a tropical climate. The intervention strategy will be the same where funding will be for governments or the private sector to decide. This paper delves into the ramifications of energy efficiency measures of retrofitting and decarbonization of buildings to achieved low carbon environment and optimize energy conservation devices and current technologies in all ramifications.

KEYWORD: *Energy Efficiency, Retrofitting, and Buildings*

1. INTRODUCTION

Energy efficiency and building energy consumption and performance is synonymous to global warming and climate change due largely to the proportion of GHGS coming from buildings and building operations including actual site construction. The effect of the later has become part of our daily experience irrespective of the geo-political coloration. This is as both our climate and ecosystem is precariously at near tipping point. Most countries are pursuing decarbonization of existing buildings by retrofitting old and existing buildings thus making retrofitting a key sustainable target. Building sector decarbonization was the focus and attracted enormous global attention in the lead-up to the COP26 submit in Glasgow, United Kingdom as it is well established that just in a decade the building sector is bound to expend geometrically and predicted to cover billions of square meters. And since 2021, all new buildings constructed in the European Union must be nearly zero carbon in energy footprint. Buildings are key to our daily lives and significantly impacting our health and wellbeing. Majority of the buildings have a substantial footprint in terms of land mass coverage employing heavy use of fossil fuels across their lifetime cycle, from construction, use and demolition phases. Buildings are presently responsible for about

47 percent of carbon dioxide emissions across the 25 nations of the European Union. And the race to reduce carbon emissions is in sharp focus and dominated previous climate summits like the Paris Agreement and most recently the COP26 in Glasgow, UK in 2021. The UK and most western nations have chosen decarbonization of homes to improve energy efficiency by retrofitting old and existing buildings to achieve net zero carbon status over a shorter period.

The environmental activist group Insulate Britain wants the government starting from social housing to fund insulation of all houses in Britain. This is line with commitments under the Paris Agreement to cut emissions from heating and powering homes reduced by 78% in less than 15 years and then to zero by 2050,". There were further commitments to cut deforestation by various countries after the COP26 held in Glasgow in 2021.

2. AIMS AND OBJECTIVES

The global trend is that of one headline news or breaking news displacing the other so that issues of great importance that poses as existential threat to humanity continued existence is quickly brushed aside and or forgotten with rapidity. The aim of this paper is to represent this fact and the need to tenaciously make it relevant at all times and proffer the route out of a looming global threat of uncontrolled emissions. The paper discusses the rudimentary principles of curbing the problem by energy efficiency measures and retrofitting of old and existing homes which contribute significantly to a large proportion GHG emissions due to continued and wasteful use of fossil fuels. This category of buildings perform poorly in energy performance and conservation and are wasteful throughout their continued use and thus require immediate and adequate intervention to curb the menace.

3. METHODOLOGY

The need to preserve living conditions on the only planet known to have all the requirements to sustain life of all the species of living creatures and ways this can be achieved is the reason there has been various submits in this direction. The Kyoto protocol, the Paris agreement and recently COP26 in Glasgow, United Kingdom. This study therefore demands a wide spectrum of interaction with stakeholders and their inferences, extensive literature surveys as well as electronic and print media sources to gouge varied opinions and postulations and to establish a solid framework to tackling issues of energy efficiency and retrofitting. This goes on to become a potent strategy to decarbonization of the built environment and at the same time address the complications of global warming and climate change.

4. RETROFITTING PROCESS

Essentially, the retrofitting process means improving a building to make it more energy efficient or particularly, updating of older systems in a building to increase its energy efficiency and to save energy and money and reduce its carbon footprint over time. In 2014, the worldwide building stock was 151.8 billion square meter and is expected to rise to 171.6 billion square meters by 2024 and residential buildings represented 75% of the existing building stock worldwide (Freas & Goldstein,

2015). In cities around the world, buildings occupy 50% or more of the land area and are responsible for 60% of electricity use, 12% of water use, 40% of waste and 40% of material resource use. With the sustainable development goals; which is “meeting the needs of the present without compromising the ability of future generations to meet their own needs” [4], it becomes obvious why curbing global emissions, Figure1 and decarbonizing buildings becomes an acceptable strategy including retrofitting.

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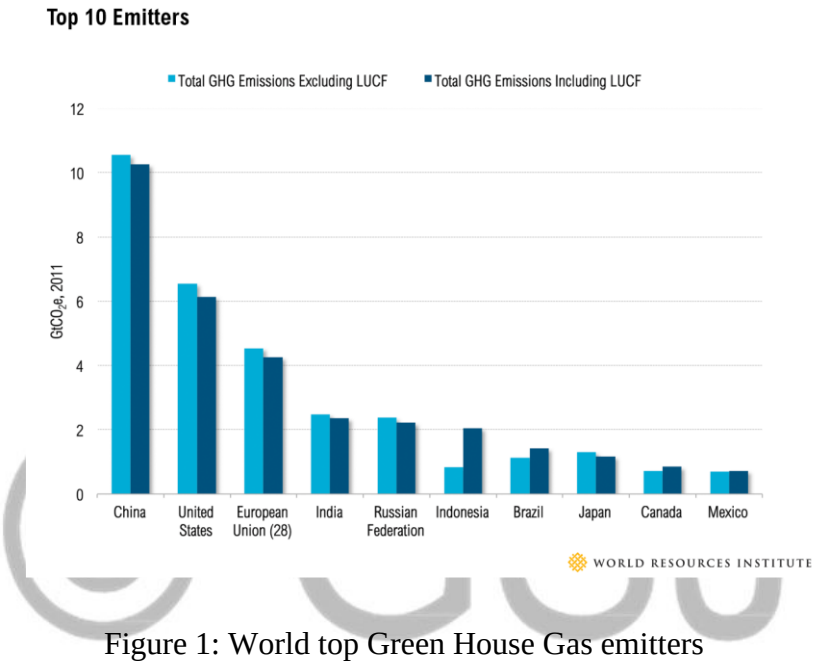

Figure 1: World top Green House Gas emitters
Source: www.wri.org.

Retrofit can reduce carbon emissions, energy use and utility bills depending on the efficiency of some variables as appliances and technology. An excellent retrofit can improve indoor air quality and thermal comfort and going as far as boosting local job creation. Across Europe, the environmental, economic and social impacts of retrofit programs is being assessed for standardization in collaboration with experts across the construction industry. This is steered towards developing suites of measurable indicators and to determine what reductions in a city’s carbon emissions can be attributed to retrofit work across board. The pursuit to meet net zero target by 2050 in the UK. has created the need for buildings to be retrofitted to tackle energy poverty and energy waste. The following strategies of repurposing buildings will include;

ADAPTIVE REUSE

Repurposing buildings is primarily the sustainable way to meet new needs through careful repair and creative adaption of buildings enhancing functionality and performance. This include turning aging offices into flexible workplaces, derelict yards into shopping districts and industrial structures into homes enhancing the life of the buildings and upgrading their performance in energy consumption and efficiency thus reducing their carbon footprint.

EXPANSIVE REUSE

This strategy of retrofitting upgrades and add new space to existing buildings in creative ways to maximize their values through sustainability innovations. The reuse of existing structure and fabric will be saving more carbon in design and construction than the building will produce in operations.

PROACTIVE REUSE

When buildings require repairs, upgrades can unlock new possibilities and inclusion of new technologies and repair areas in poor condition such as investigation of structure and façade, material testing, appraisals, structural and seismic retrofit and alterations, vibration analysis and remediation, reviews and improvements to acoustic performance. Assessments and upgrading building services, energy efficiency, service life prediction, building physics upgrade and return on investment are some of the aspects that require special considerations.

FABRIC FIRST

This form of retrofit means maximizing the performance of the materials that a house is built from, such as insulation and draught-proofing, while still maintaining breathability. This will involve checking that front doors do not have an inch of airway under it, that letter boxes close fully, that windows fit, and are, if possible, double glazed. Front door issues are remediable by attaching a brush strip to the bottom of the door frame and installing a rotating metal disc over the keyhole using an 'escutcheon plate'). Windows can be significantly more expensive, especially if you have sash windows.

5. ENERGY EFFICIENCY AND RENEWABLE TECNOLOGIES

Retrofitting to reduce energy use within buildings now encompasses the energy ratings of appliances and the energy source like renewable energy alternatives Figure 2 and Figure 3 respectively. This refers to the domestic air source heat pumps, ground source heat pumps and biomass boilers on which future hopes of steering away from damaging fossils are founded. Whether solar, wind, hydro, or biomass boiler, the later fed by pellets, reducing energy use within a building is of course the main focus of a retrofit vision.

However, there are also energy use and pollution impacts during the extraction and processing of materials, and at their eventual disposal. Using natural building materials therefore makes sense as part of a really low impact eco retrofit. Carbon sequestration' is of prime importance in material

choices as growing plants absorbed carbon from the atmosphere, and this carbon then stays locked up for decades.

In a tangible retrofit, problems may arise if energy efficiency measures are taken one by one without attention to how they'll interact. It's particularly important in older buildings, because they were designed to be open to absorbing and releasing moisture. Sealing an old house up with cement render and non-breathable insulation tends to cause damp problems. Using natural materials therefore helps to protect buildings from damage as well as leading to a low environmental impact. The 'whole house retrofit' approach is intended to avoid these pitfalls.

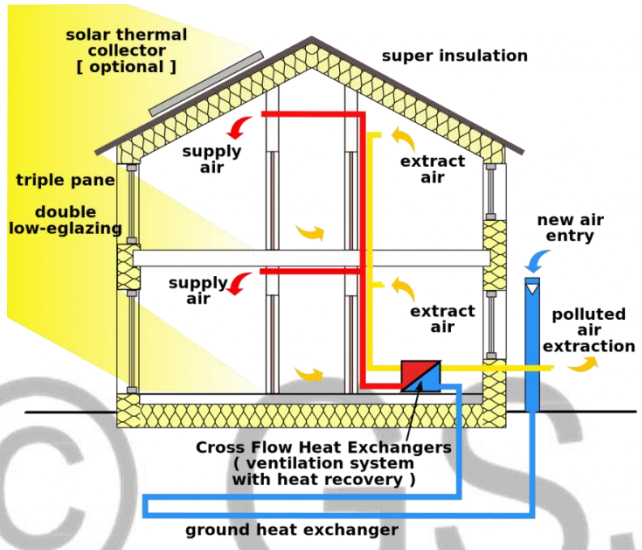

Figure2; Renewable Energy in building
Source: https://ecobnb.com/

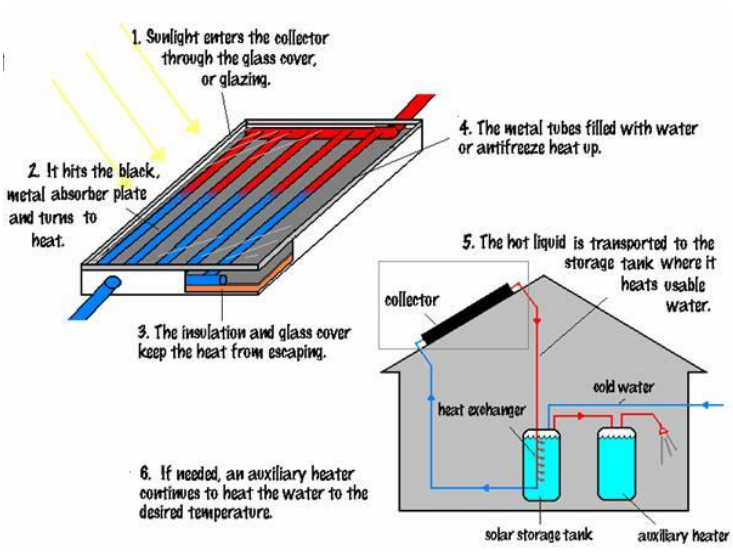

Figure 3: Solar Collector Source: https://www.humboldt.edu/

Retrofitting largely depends on choice of materials and energy use. Concrete for instance typically contains 8-15% cement, 2-5% water, about 80% aggregates (e.g. gravel, sand, limestone filler) and less than 0.1% chemical admixtures. The major global impact of cement production is global warming Figure 4. Humphreys and Mahasenan (2002) [1] estimate that the cement industry is responsible for 3% of global anthropogenic greenhouse gas emissions and 5% of global anthropogenic CO2 emissions. About half the CO2 is released by limestone decomposition in the kiln – "cement process and the other half is due mainly to fuel burning. However, there is impressive effect in moderating indoor temperatures by using high thermal
mass where indoor temperatures is being lowered by fully 10 degrees especially in hot-humid climate. [5][6] Thermal comfort as a retrofit target is an important parameter since it impacts on both the health and wellbeing of occupants and the potential energy consumption of buildings [7] Building energy use has become the main driver of global growth in energy consumption and CO2 emissions. [8]

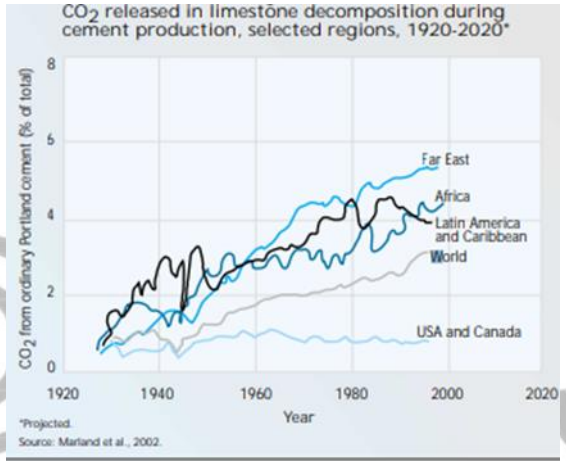

Figure 4: CO2 Released in limestone decomposition
Source: Marland et al; 2002

6. DISCUSSION

The decarbonization of buildings to achieve a zero carbon footprint also includes thermal comfort as a target as this has a huge impact on the health and wellbeing of the occupants and the energy consumption of the buildings. Energy efficiency of a building is a cocktail of parameters that keeps the energy consumption at the minimal thus reducing the emission levels considerably and improve energy performance of homes.

Energy retrofit of residential buildings is an approach designed to reduce global energy consumption [9] thus, existing residential buildings are expected to remain a large proportion of the future stock requiring retrofitting. For this reason, energy retrofit strategies play a crucial role in meeting 2030 and 2050 climate and energy targets, included in the European Green Deal [10] Retrofit can reduce carbon emissions, energy use and utility bills depending on the efficiency of variables as appliances, building fabrics and renewable technologies. An excellent retrofit can improve indoor air quality and thermal comfort. This will entail installation of new building systems as heating or cooling systems and can also involve the fabrics of the building, both

insulation and double glazing. The process will involve careful balancing of different elements and their effects or impact on the overall performance of the building. Airtightness for instance can result in condensation problems if the sealing process is not handled with the meticulousness it deserves during the sealing. Insulating a roof without ventilation considerations can result in decay of the timber trusses.

In pursuing the zero carbon goals, energy audit might be necessary on the performance of the building envelope and existing systems which can paint a picture of inefficiencies inherent in the building and so search for better sustainable retrofitting options to deal with the variant issues and emanating problems.

7. CONCLUSION

The aim of having a building is that people spend majority of their life in these spaces and this can be homes, offices and commercial outlets. They live in them, work or shop and do business and efforts are made to ensure that they are healthy for people and for the planet. This encompasses human health and comfort with the ecological goals of minimal operational and embodied energy use and emissions. Retrofit can reduce carbon emissions and energy use depending on the efficiency of some variables as appliances and technology but the process will involve careful balancing of different elements and their effects or impact on the overall performance of the building and other environmental considerations. However, it is worthy to note that decarbonization of building through retrofitting is not the ultimate silver bullet that solves all the problems here envisioned with respect to emissions, the people, governments and the private sector must choose a different way of living; lifestyle changes, respect for the ecosystem and environmental protection strategies that guarantees a healthier planet for all humanity and this is paramount and now.

REFERENCES

1. Humphreys, K. and M. Mahasenan (2002) “Climate Change” in Toward a Sustainable Cement Industry. Battelle – World Business Council for Sustainable Development.
2. Freas, B., & Goldstein, N. (2015). *Global Building Stock Database*. Retrieved April, 2022, from Navigant Research: http://www.navigantresearch.com/research/global-building-stock-database
3. WRI. (2016). *Initiative 20x20.* Retrieved April, 2022, from World Resources Institute: http://www.wri.org/our-work/project/initiative-20x20
4. Brundtland Commission. (1987). *Our common future: Report of the World Commission on Environment and Development.* UN Documents: Gathering a Body of Global Agreement.
5. Givoni, Baruch; (2011) -*Indoor temperature reduction by passive cooling systems*. Solar Energy, vol. 85 pg1692–1726.
6. Chirarattananon, S. & Vu Duc Hien, (2011) Thermal performance and cost effectiveness of massive walls under Thai climate. Energy and Buildings vol. 43 pg 1655–1662.
7. M. Singh, S. Mahapatra & J. Teller, (2014) Relation between indoor thermal environment and renovation in Liege residential buildings, Therm. Sci. 18 (3) 889–902.
8. Abdallah, R., Natsheh, E., Juaidi, A., Samara, S. and Manzano-Agugliaro, F., 2020. A Multi-Level World Comprehensive Neural Network Model for Maximum Annual Solar Irradiation on a Flat Surface. Energies, 13(23), p.6422.
9. Jia, L., Qian, Q. K., Meijer, F., & Visscher, H. (2021). Exploring Key Risks of Energy Retrofit of Residential Buildings in China with Transaction Cost Considerations. Journal of Cleaner Production, 126099.
10. European Parliament resolution of 15 January 2020 on the European Green Deal (https://oeil. secure. europarl. europa. eu/oeil/ficheprocedure. 2019/2956 (RSP) (accessed 4 April 2022).