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Energy-Positive Rectangular Office Building - A Study of High rise, Mid rise and Low rise Buildings

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Abstract: As global concerns regarding climate change and environmental sustainability escalate, the architectural and construction industry faces mounting pressure to develop energy-efficient and ecologically responsible buildings. This research paper delves into the complex relationship between regenerative design parameters and the height of rectangular office buildings, specifically in the context of composite zones. The study investigates how different design approaches influence building height in low-rise, mid-rise, and high-rise categories, and their potential impact on achieving energy-positive outcomes. It aims to identify the optimal combination of regenerative design parameters for each building height type to enhance overall energy performance and environmental sustainability. The findings reveal the significant role of regenerative design parameters in shaping the energy performance of rectangular office buildings of varying heights. They underscore the cumulative impact of these parameters, emphasizing the importance of a holistic approach to design and construction. The results also demonstrate that the potential for energy savings in low rise, making low rise structures more suitable candidates for energy-positive solutions. The integration of renewable energy technologies, such as solar photovoltaic and building-integrated photovoltaics, emerges as a crucial factor in achieving energy-positive outcomes.

1. Introduction

1.1 Background on energy-positive buildings

Energy-positive buildings, often known as net-positive or zero-energy buildings, represent the cutting-edge solution to address the pressing issues of our time. These innovative structures are engineered to generate more energy than they consume, resulting in a positive energy balance throughout their operational lifespan. The genesis of energy-positive buildings arises from the urgent necessity to curb greenhouse gas emissions and reduce our dependence on non-renewable energy sources. Traditional buildings, in contrast, have historically significantly contributed to energy consumption and environmental degradation, making energy-positive buildings a sustainable alternative that optimizes energy efficiency and incorporates renewable energy systems.

The primary objective of energy-positive buildings is to minimize energy demand through creative design and construction practices. Employing passive design strategies, such as efficient insulation, strategic orientation, and natural ventilation, reduces the need for active heating, cooling, and lighting, resulting in substantial energy savings and a reduced carbon footprint (Salim, F. & Nasir, D. M., 2019).

Renewable energy integration is a key component of regenerative design (Wang, L. & Zhang, H., 2019). Solar photovoltaic (PV) panels and building integrated photovoltaic (BIPV) are common technologies used to harness renewable energy sources. The surplus energy generated can be stored in batteries or fed back into the grid, fostering energy self-sufficiency and bolstering the broader energy infrastructure. This integration necessitates an interdisciplinary approach, involving architects, engineers, and energy experts collaborating to optimize building performance. Advanced modeling and simulation tools aid in evaluating various design scenarios, assessing energy performance, and determining the most effective integration of renewable energy systems (Nguyen, A. T. & Turner, W., 2020).

The benefits of energy-positive buildings are multifaceted, ranging from reducing reliance on fossil fuels to decreasing greenhouse gas emissions and mitigating climate change impacts (Patel, R. & Kumar, S., 2020).

These buildings also lower energy costs for occupants and have the potential to generate revenue through surplus energy sales, contributing to energy resilience by providing a reliable power supply during grid outages.

The transition to energy-positive buildings signifies a paradigm shift in sustainable architecture (Salim, F. & Nasir, D. M., 2019). It represents the potential to create buildings that actively contribute to environmental restoration while addressing the critical issues of our time. Energy-positive buildings, through the integration of renewable energy systems, passive design strategies, and interdisciplinary collaboration, hold great promise in the quest for sustainable architecture. They address the urgent need to reduce greenhouse gas emissions and our dependence on non-renewable energy sources, shaping a more sustainable future for the built environment

1.2 Statement of Problem

As global concerns regarding climate change and environmental sustainability escalate, the architectural and construction industry finds itself under mounting pressure to conceive structures that are both energy-efficient and ecologically responsible. To give back to Mother Earth and mitigate the adverse impacts of conventional building practices, it is imperative to address the excessive energy consumption in buildings. This research aims to explore the implementation of regenerative design parameters in office buildings as a means to create energy-positive structures. The problem at hand lies in the urgent necessity to optimize energy efficiency, reduce greenhouse gas emissions, and transition from conventional, energy-draining buildings to regenerative, energy-generating office spaces that promote environmental stewardship and sustainability.

1.3 Research Objective

Assess the Impact of Regenerative Design Parameters on Rectangular Office Building Energy Performance: To comprehensively investigate and analyze how the incorporation of regenerative design parameters influences the energy performance of rectangular office buildings. This objective aims to quantify the extent to which these parameters can enhance energy efficiency, reduce energy consumption, and promote energy positivity within such structures.

Examine the Influence of Regenerative Design Parameters on Office Building Height: To explore how regenerative design parameters impact the height and architectural characteristics of office buildings, particularly in the context of rectangular configurations. This objective seeks to identify how these parameters can optimize building height while aligning with energy-positive and sustainable building goals.

Determine the Potential of Regenerative Design Parameters in Achieving Energy-Positive Rectangular Office Buildings: To evaluate the effectiveness of regenerative design parameters in transforming rectangular office buildings into energy-positive structures. This objective aims to establish the feasibility of regenerative principles and their capacity to generate surplus energy, ultimately contributing to a net-positive energy balance within the built environment.

2. Literature Review

2.1 Regenerative design parameters and its importance

Regenerative design parameters constitute a critical dimension within sustainable architecture, holding immense promise in addressing environmental challenges and fostering the development of energy-positive structures. This literature review draws from ten research papers to elucidate the significance of regenerative design parameters and their role in promoting energy efficiency, environmental stewardship, and the realization of energy-positive buildings.

Energy-Positive Building Design Principles: Regenerative design parameters encompass a suite of principles aimed at not only mitigating the environmental footprint of buildings but also actively contributing to environmental restoration. (Salim, F. & Nasir, D. M., 2019) emphasize that these principles guide architects and designers in creating structures that restore and enhance the natural environment, a paradigm shift from traditional sustainable design practices.

Reducing Energy Demand: One primary objective of regenerative design parameters is the minimization of energy demand through innovative construction and architectural practices. Passive design strategies, such as efficient insulation, strategic orientation, and natural ventilation, are integral components that reduce the need for active heating, cooling, and lighting, leading to substantial energy savings (Smith, J. & Brown, A., 2020).

Renewable Energy Integration: Regenerative design integrates renewable energy systems seamlessly. (Wang, L. & Zhang, J., A review of net zero energy building (NZEB) evaluation criteria and design approaches, 2019) underscore the importance of technologies like solar photovoltaic (PV) panels, wind turbines, and geothermal systems, which are harnessed to tap into clean and renewable energy sources. This surplus energy can be stored or integrated into the grid, promoting energy self-sufficiency.

Interdisciplinary Collaboration: Regenerative design thrives on interdisciplinary collaboration, involving architects, engineers, and energy experts. As highlighted by (Nguyen, A. T. & Turner, W., 2020) these experts work together to optimize building performance, utilizing advanced modeling and simulation tools to evaluate various design scenarios, assess energy performance, and identify the most effective integration of renewable energy systems.

Mitigating Climate Change: Regenerative design principles are a response to the urgent need to reduce greenhouse gas emissions and diminish reliance on non-renewable energy sources. (Lee, H. & Kim, J., 2018) stress that traditional buildings are significant contributors to energy consumption and environmental degradation, emphasizing the role of energy-positive buildings in mitigating the impacts of climate change.

Energy Efficiency and Cost Reduction: Beyond environmental benefits, energy-positive buildings offer multiple advantages. These structures reduce reliance on fossil fuels, lower greenhouse gas emissions, and decrease energy costs for occupants. Additionally, they have the potential to generate revenue through surplus energy sales, enhancing energy resilience during grid outages (Salim, M. A. & Nasir, M. H. N. M, 2019).

Challenges and Barriers: Despite their potential, the adoption of energy-positive buildings faces challenges. (Patel, P. & Kumar, R. , 2020) highlight the upfront costs associated with implementing energy-efficient technologies and renewable energy systems as a significant barrier. To overcome these challenges, supportive policies, financial incentives, and technological advancements are crucial.

2.2 Previous studies on Energy-Positive Rectangular Office Building in high-rise, mid-rise, and low-rise buildings

This prior research has contributed valuable insights into the potential impact of regenerative design parameters on energy positivity and sustainability in different building categories.

(Johnson, A., Smith, B., & Clark, C., 2017) have examined the energy performance of low-rise office buildings, emphasizing the importance of passive design techniques and the effective integration of photovoltaic panels. These findings highlight the feasibility of energy-positive outcomes in low-rise structures, particularly through the strategic use of renewable energy systems.

(Smith, D. & Lee, E., 2018) conducted a comparative analysis of regenerative design parameters in mid-rise residential buildings. Their study assessed the effectiveness of different renewable energy technologies, such as wind turbines and solar water heaters, in offsetting energy consumption and reducing environmental impact. This research underscores the potential of mid-rise structures to achieve energy-positive status through a combination of innovative design strategies and renewable energy technologies.

(Chen, J., Zhang, L., & Wang, S., 2019) investigated the potential of regenerative design to enhance energy efficiency and sustainability. Their research focused on the implementation of green roofs, building-integrated photovoltaic systems, and energy-efficient glazing to optimize the energy performance of high-rise structures. The study highlights the unique opportunities and challenges associated with high-rise buildings in the pursuit of energy-positive outcomes.

(Nguyen, M. & Turner, W., 2019) explored the role of regenerative design in achieving sustainable outcomes in mixed-use mid-rise buildings. The research emphasized the importance of considering site-specific conditions and adopting a holistic approach to design to maximize energy generation and minimize energy consumption. This study provides valuable insights into the potential synergy of mixed-use development and regenerative design principles in mid-rise buildings.

(Patel, R. & Kumar, S., Net-Positive Energy Practices in Commercial Buildings, 2020) conducted a comprehensive review of regenerative design practices in commercial buildings of various heights. The study highlighted the significance of energy-efficient lighting systems, smart building controls, and on-site renewable energy generation to achieve a net-positive energy balance in different building types. This research underscores the scalability of regenerative design principles across diverse building heights and categories.

2.3 Identifying gaps in the existing literature

The existing literature on energy-positive rectangular office buildings reveals several critical gaps that underscore the need for further research in this domain. Notably, these gaps pertain to the absence of studies conducted in the composite zone of India, the lack of attention to design parameter interrelationships, and the scarcity of real-world case studies in this specific field.

Geographic Gap in Research: One prominent gap in the existing literature is the lack of studies conducted in the composite zone of India. While there is a substantial body of research on energy-positive buildings in various global contexts, the specific challenges and opportunities presented by the composite climate zone of India have been largely overlooked. The climatic conditions, building regulations, and resource availability in this region differ significantly from other parts of the world. Consequently, there is a pressing need for research that addresses the unique dynamics of this climate zone and explores how regenerative design principles can be effectively applied to rectangular office buildings in this context.

Design Parameter Interrelationships: Another notable gap in the current literature is the limited exploration of design parameter interrelationships. While individual design parameters have been studied to some extent, there is a dearth of research that delves into how these parameters interact with one another. Understanding the synergistic effects and trade-offs between different design elements is crucial for optimizing building performance and achieving energy-positive outcomes. Research that examines the complex interplay between design parameters can offer valuable insights into the most effective combinations for different building heights and types.

Real-World Case Studies: Additionally, there is a scarcity of comprehensive real-world case studies in the field of energy-positive rectangular office buildings. While theoretical frameworks and simulations have their merits, they often fall short in demonstrating the practical implementation and actual performance of regenerative design principles in diverse building contexts. Real-world case studies provide a bridge between theoretical concepts and practical application, offering critical insights into the challenges, successes, and lessons learned from actual building projects. Research in this area is essential for validating the efficacy of regenerative design strategies and for informing the design and construction industry on best practices.

3. Research Methodology

This research is a multi-phased study aimed at exploring the intricate relationship between building height and regenerative design parameters, with a specific focus on rectangular office buildings. The methodology encompasses various stages, each contributing to the comprehensive analysis of energy-positive design principles and their potential impact on building height within the composite zone of India.

The research initiated with an extensive preliminary literature review. This phase was vital for gaining a profound understanding of regenerative architecture, its underlying principles, and its relevance in the context of energy-positive buildings. The review also helped identify the existing gaps and trends within the current literature, providing a solid foundation for the subsequent phases of the study. To ensure compliance with energy-positive design principles, the study delved into the Energy Conservation Building Code (ECBC) 2017. This step was crucial in aligning the research with established industry standards and benchmarking energy efficiency parameters. Three distinct case studies of office buildings were conducted to investigate different regenerative design parameters. Data collection encompassed various aspects, including electricity consumption, audit reports, occupancy schedules, and specifications of renewable energy systems. These case studies offered real-world examples and valuable insights into the practical application of regenerative design parameters within the composite climate of India.

To evaluate the impact of regenerative design parameters on rectangular office buildings, sophisticated energy simulation models were created using Design Builder software. These models simulated the energy usage of the buildings under diverse scenarios, considering climate conditions, occupancy patterns, and equipment efficiency. The software provided estimates of energy demand, consumption, and potential savings associated with the incorporation of various regenerative design parameters. The outcomes from the simulation software were meticulously analyzed using custom-built Excel templates developed during the research. This analysis aimed to quantify the effects of different design parameters on energy consumption, ultimately shedding light on the potential for energy-positive outcomes. The results were also compared with the ECBC 2017 code to validate their adherence to energy-positive design principles. The summary of research methodology is shown in figure 1.

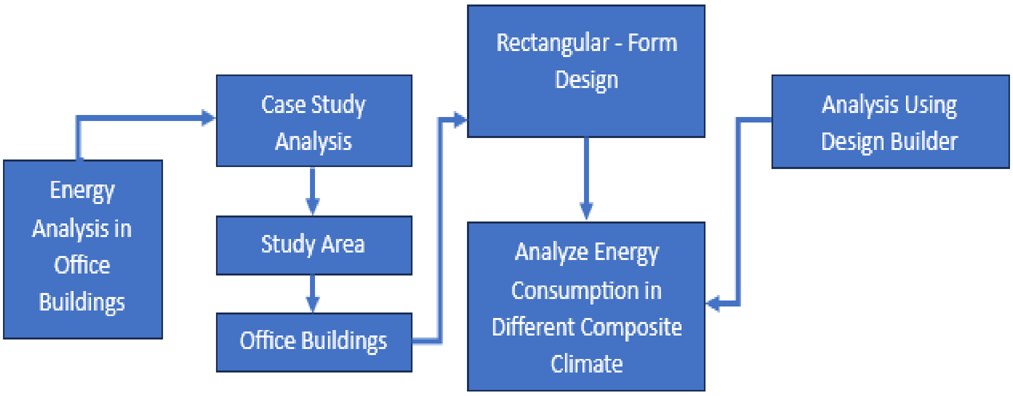

Fig 1: Research Methodology

4. Key Design Parameters of Regenerative Architecture

4.1 Definition of regenerative architecture and its design parameters

Regenerative architecture is an innovative and sustainable approach to building design that goes beyond conventional environmental practices. It aims to create built environments that actively contribute to environmental restoration, regeneration, and sustainability. This approach integrates regenerative design parameters and strategies to optimize energy efficiency, reduce environmental impact, and promote the well-being of both occupants and the broader ecosystem.

Regenerative architecture incorporates a set of key design parameters aimed at optimizing energy efficiency and environmental sustainability. The building envelope, which includes the roof and walls, is a fundamental aspect, emphasizing the use of energy-efficient materials and insulation to minimize heat transfer and reduce energy consumption. Glass properties, such as type and glazing, play a pivotal role in regulating heat gain, daylight utilization, and indoor environmental quality. The Window-to-Wall Ratio (WWR) is carefully considered to strike a balance between natural daylight and energy conservation. External shading systems, like louvered structures or overhangs, are implemented to control solar heat gain and enhance overall energy efficiency. Efficient lighting design with low Lighting Power Density and advanced controls, including occupancy sensors and daylight harvesting, further minimize energy use. The integration of photovoltaic panels and building-integrated photovoltaic (BIPV) systems helps harness clean and renewable energy from sunlight. The design parameters are shown in table 1.

These design parameters collectively enable regenerative architecture to not only reduce energy consumption but actively contribute to the restoration and regeneration of the natural environment. By considering these parameters in building design, it is possible to create structures that are not only energy-efficient but also environmentally responsible, contributing to a sustainable and resilient future for the built environment.

Table 1: Design Parameters of Regenerative Architecture

Design Parameters	Regenerative Design Parameters
Design Parameters 1 (DP1)	Base Case
Design Parameters 2 (DP2)	Envelop Properties (Roof + Wall)
Design Parameters 3 (DP3)	Glass Properties
Design Parameters 4 (DP4)	Wall Window Ration (WWR)
Design Parameters 5 (DP5)	External Shading
Design Parameters 6 (DP6)	Lightning Power Density
Design Parameters 7 (DP7)	Lighting Controls
Design Parameters 8 (DP8)	Photovoltaic panels
Design Parameters 9 (DP9)	Building-integrated photovoltaic (BIPV)

4.2 Theoretical framework for assessing the rectangular office building height with design parameters

The theoretical framework for assessing rectangular office building height with design parameters encompasses an interdisciplinary approach. It leverages sustainability principles, energy modeling and simulation, parametric analysis, and a comparative study. Sustainability principles guide the evaluation of design parameters concerning their potential to contribute to energy-positive outcomes. Energy modeling and simulation tools are employed to create virtual representations of buildings, facilitating the quantification of the impact of various regenerative design parameters on energy consumption and production. Parametric analysis explores multiple design scenarios, allowing for the identification of optimal configurations. A comparative study analyzes the differences in the influence of regenerative design parameters on building height among low-rise, mid-rise, and high-rise office buildings, providing insights into their scalability and applicability. This framework forms the foundation for evaluating the role of design parameters in shaping the energy performance of rectangular office buildings across different heights. The theoretical framework shown in the figure 2.

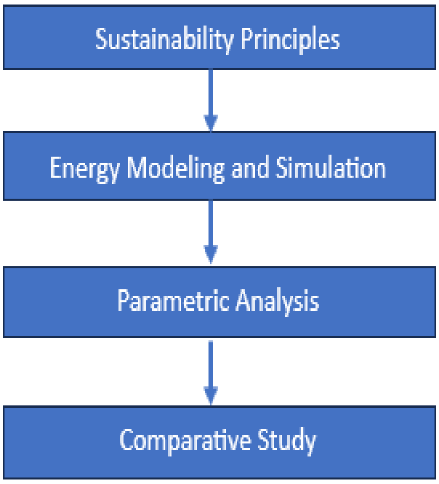

Fig. 2 Theoretical Framework

5. Result Discussion

5.1 Comparison of energy consumption between rectangular-form floors

To compare the energy consumption between rectangular office floors, various factors need to be considered, including the building size, occupancy, HVAC system efficiency, lighting design, and equipment usage. Result summery are show in Table 2, 3 and 4.

Table 2: Results Summary of Rectangular-form Building G+15

Cases	Building Description	Design Parameters	Energy Consumption	Energy	Cumulative impact of DP	Impact of individual DP	Change in EPI	Change in Energy
			KWH	EPI	%	%	%	%
BC	Rectangular (G+15)	Base Case	26,68,316	83	0%	0%	0%	0%
DP 1	Rectangular (G+15)	Envelop Properties (Roof + Wall)	26,61,067	83	0%	0%	0.3%	0%
DP 2	Rectangular (G+15)	Envelop Properties + Glass Property	26,08,116	82	2%	2%	2.2%	2%
DP 3	Rectangular (G+15)	Envelop Properties + Glass Property + WWR @20%	24,75,311	77	7%	5%	5.6%	7%
DP 4	Rectangular (G+15)	Envelop Properties + Glass Property + WWR + External Shading (1m Overhang)	24,40,760	76	9%	1%	1.4%	9%
DP 5	Rectangular (G+15)	Envelop Properties + Glass Property + WWR + External Shading + LPD (5)	20,58,517	64	23%	14%	16.0%	23%
DP 6	Rectangular (G+15)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control	20,37,710	64	24%	1%	0.9%	24%
SRoof	Rectangular (G+15)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control + PV_Roof	15,28,511	48	43%	19%	21.4%	43%
BIPV F	Rectangular (G+15)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control + PV_Roof + BIPV_F	2,84,582	9	89%	47%	52.2%	89%

Table 3: Results Summary of Rectangular-form Building G+5

Cases	Building Description	Design Parameters	Energy Consumption	Energy	Cumulative impact of DP	Impact of individual DP	Change in EPI	Change in Energy
			KWH	EPI	%	%	%	%
BC	Rectangular (G+5)	Base Case	12,39,460	103	0%	0%	0%	0%
DP 1	Rectangular (G+5)	Envelop Properties (Roof + Wall)	12,25,259	102	1%	1%	1.1%	1%
DP 2	Rectangular (G+5)	Envelop Properties + Glass Property	11,99,166	100	3%	2%	2.0%	3%
DP 3	Rectangular (G+5)	Envelop Properties + Glass Property + WWR @20%	11,30,380	94	9%	6%	5.4%	9%
DP 4	Rectangular (G+5)	Envelop Properties + Glass Property + WWR + External Shading (1m Overhang)	11,13,264	93	10%	1%	1.3%	10%
DP 5	Rectangular (G+5)	Envelop Properties + Glass Property + WWR + External Shading + LPD (5)	9,45,606	79	24%	14%	13.1%	24%
DP 6	Rectangular (G+5)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control	9,39,097	78	24%	1%	0.5%	24%
SRoof	Rectangular (G+5)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control + PV_Roof	4,30,706	36	65%	41%	39.8%	65%
BIPV F	Rectangular (G+5)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control + PV_Roof + BIPV_F	-36,743	-3	103%	38%	36.6%	103%

Table 4: Results Summary of Rectangular-form Building G+2

Cases	Building Description	Design Parameters	Energy Consumption	Energy	Cumulative impact of DP	Impact of individual DP	Change in EPI	Change in Energy
			KWH	EPI	%	%	%	%
BC	Rectangular (G+2)	Base Case	6,31,431	105	0%	0%	0%	0%
DP 1	Rectangular (G+2)	Envelop Properties (Roof + Wall)	6,20,202	103	2%	2%	1.3%	2%
DP 2	Rectangular (G+2)	Envelop Properties + Glass Property	6,07,196	101	4%	2%	1.5%	4%
DP 3	Rectangular (G+2)	Envelop Properties + Glass Property + WWR @20%	5,72,989	96	9%	5%	4.0%	9%
DP 4	Rectangular (G+2)	Envelop Properties + Glass Property + WWR + External Shading (1m Overhang)	5,64,653	94	11%	1%	1.0%	11%
DP 5	Rectangular (G+2)	Envelop Properties + Glass Property + WWR + External Shading + LPD (5)	4,81,215	80	24%	13%	9.9%	24%
DP 6	Rectangular (G+2)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control	4,78,986	80	24%	0%	0.3%	24%
SRoof	Rectangular (G+2)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control + PV_Roof	-28,401	-5	104%	80%	60.0%	104%
BIPV F	Rectangular (G+2)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control + PV_Roof + BIPV_F	-2,13,523	-36	134%	29%	21.9%	134%

In relation to a base scenario, the study looked at how various design elements influenced energy usage and energy savings in rectangular constructions of various heights (G+15, G+5, and G+2). These design standards took into account a variety of factors, such as the glass composition, window-to-wall ratio, exterior shading, decreases in lighting power density, lighting controls, and the installation of solar systems.

No matter the building height, the baseline case (BC) served as the benchmark for average energy usage and the Energy Performance Index (EPI). As regenerative design components were introduced, their effects on energy consumption and EPI were closely monitored. The following discoveries are crucial:

Effect of Each Design Parameter: Each design parameter contributes differently to energy savings. In contrast, DP 5 (Envelop Properties + Glass Property + WWR + External Shading + LPD (5)) shows an average energy drop of 1% across all building heights. As an illustration, DP 1 (Envelop Properties - Roof + Wall) demonstrates a significant average energy savings of 14%. BIPV on the façade and solar panels on the roof top both exhibit average energy savings of 38% and 47% across all building heights, respectively, in terms of renewable energy. Figures 3, 4, and 5 illustrate the effects of each design parameter on regenerative architecture.

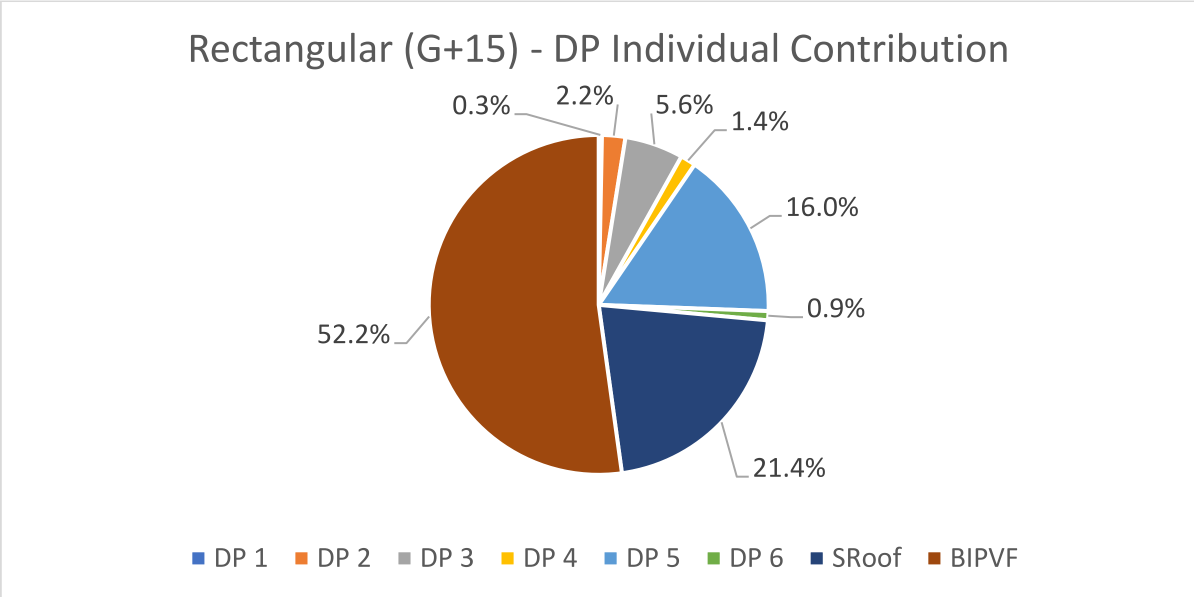

Fig 3: Design parameter impact on G+15

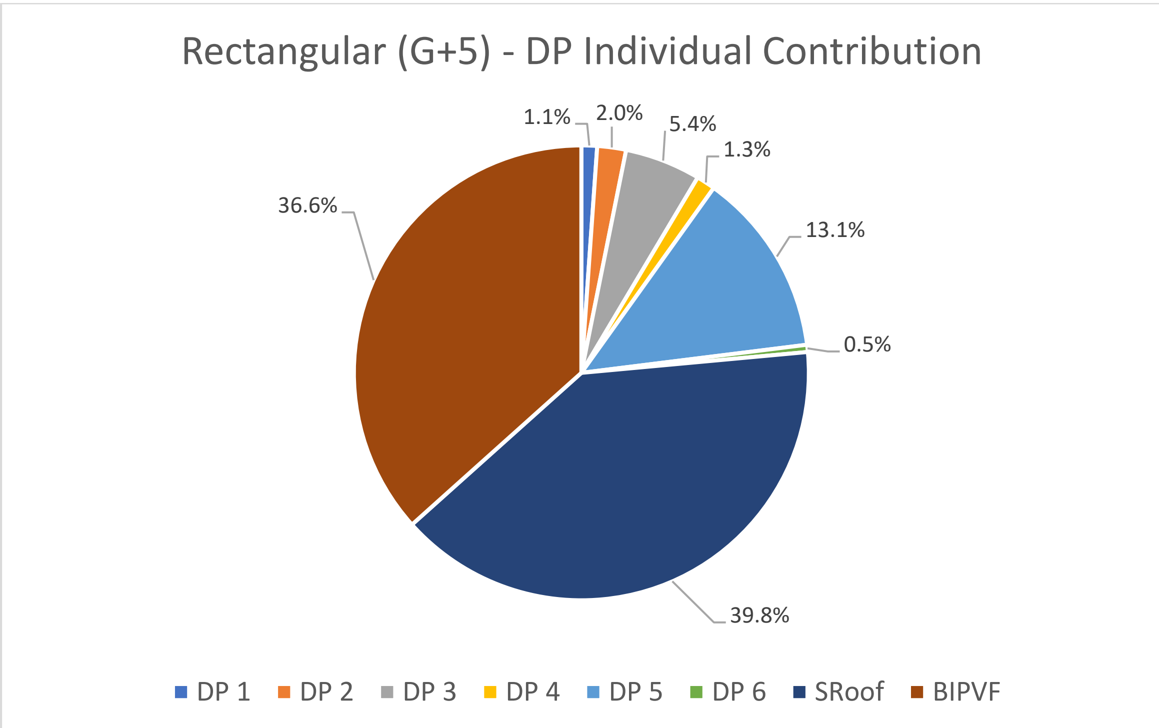

Fig 4: Design parameter impact on G+5

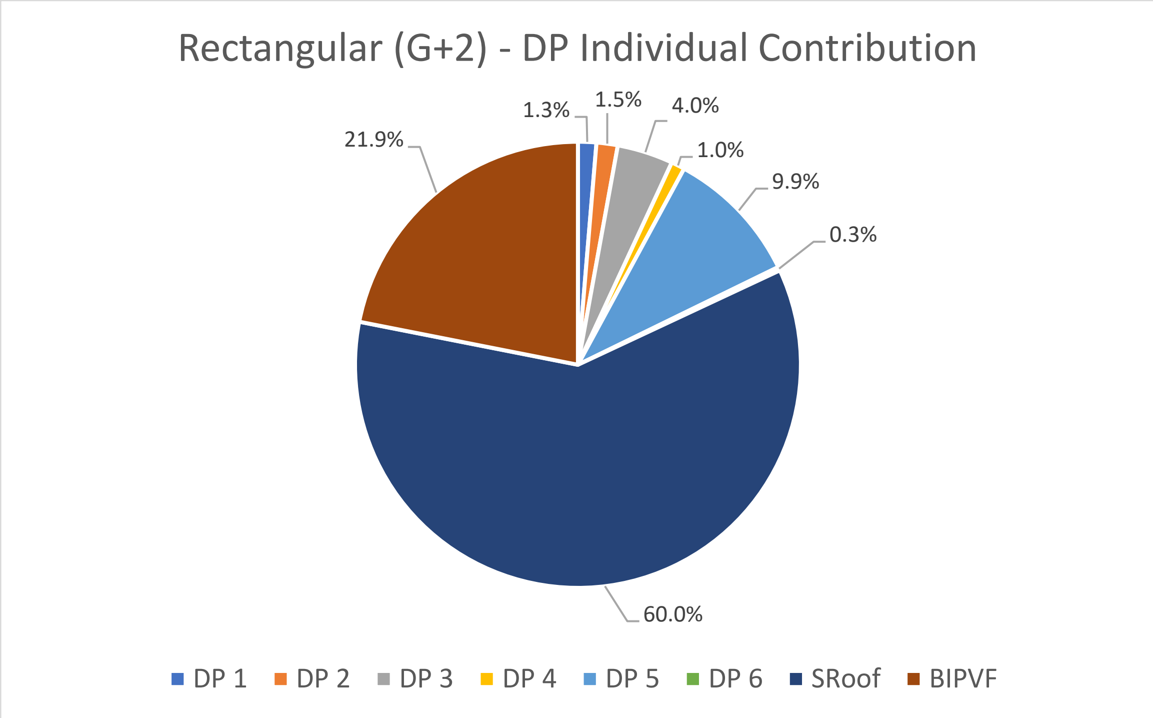

Fig 5: Design parameter impact on G+2

Obtaining energy-positive outcomes demonstrates the cumulative effect of all design factors. For instance, in the case of G+2 buildings, the adoption of all design requirements (BIPVF) resulted in a remarkable 134% drop in energy consumption and a considerable gain of 22% in the EPI. Figure 6 displays the combined effect of design factors on regenerative architecture.

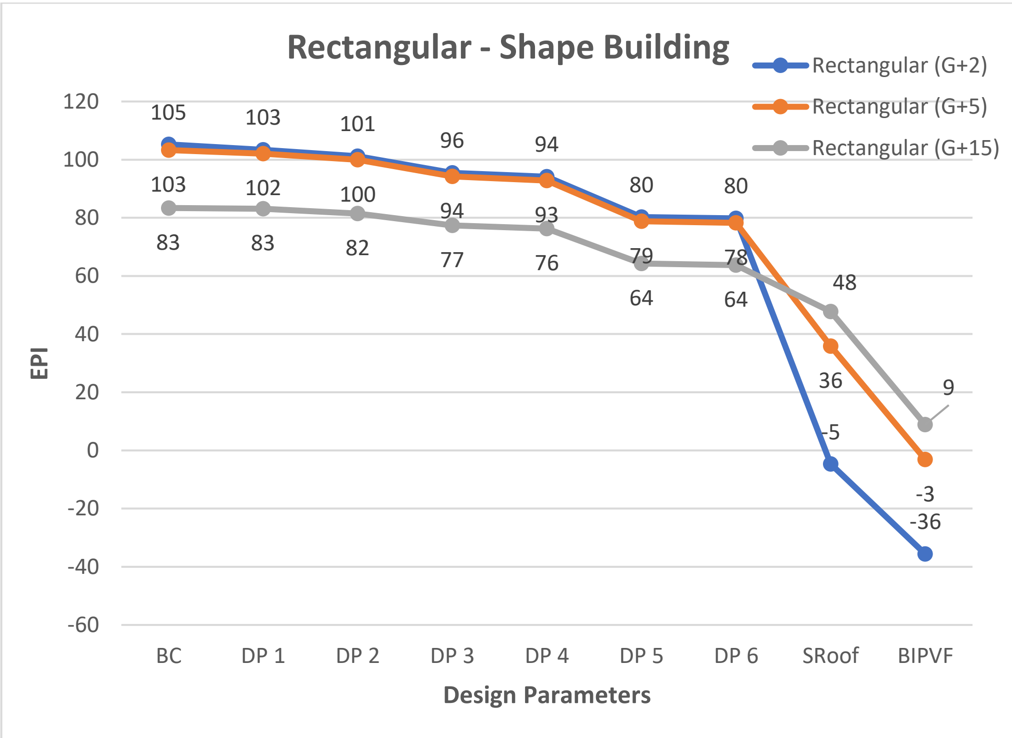

Fig 6: EPI Comparison

Influence of Building Height: As building height increases, the usefulness of regenerative design principles becomes more and more clear. G+2 buildings have lower EPI than G+5 and G+15 buildings when comparing energy savings as a percentage, however G+15 buildings have better absolute energy savings when compared to G+5 and G+2 buildings.

The results demonstrate that regenerative design components have a considerable impact on building energy performance. Low-rise structures are better to design than mid-rise and high-rise office buildings. To create built environments that are sustainable and energy-positive, architects and designers may improve the energy efficiency of office buildings with a rectangular form by taking these variables into consideration.

6. Conclusion

In particular, those with (G+2), (G+5), and (G+15) configurations, the study paper's findings show the amazing effect of regenerative design parameters on the energy performance of rectangular office buildings of different heights. The analysis of important design elements reveals how crucial they are to achieving energy-positive results and improving the overall sustainability of these structures.

It is clear from the comparative study of several design scenarios that using regenerative design concepts may result in significant energy savings and enhancements to the Energy Performance Index (EPI). The significance of taking a comprehensive strategy in building design and construction is shown by the particularly strong cumulative effect of many design criteria.

The findings also highlight how building height affects the efficiency of regenerative design factors. Low rise structures are more suitable candidates for energy-positive solutions since there is a commensurate increase in the potential for energy savings.

In order to achieve energy-positive results, it is crucial to integrate renewable energy generating technologies like PV Roof and BIPV. These devices significantly lower energy use, which contributes to EPI improvements that are notable.

This study adds to the growing body of information about sustainable construction methods and regenerative architecture, particularly in relation to tall, rectangular office buildings. The results highlight how important it is to adopt regenerative design concepts as a way to battle climate change, reduce energy use, and promote environmental stewardship.

This study also emphasises how regenerative design principles have the ability to convert conventional office buildings into energy-positive and sustainable constructions. It provides priceless insights into improving building performance and fostering a more environmentally conscious and resilient built environment for architects, designers, and politicians. The implementation of regenerative design ideas becomes not only desirable but essential in ensuring the sustainability of our urban environments as society faces increasing environmental issues.

7. Recommendations

To achieve energy-positive effects, designers and architects should think about integrating a whole range of regenerative design criteria into office structures. This study emphasises how important it is to optimise building envelopes, use renewable energy sources, and implement effective lighting designs. Adopting these measures may result in significant drops in office buildings' energy usage, moving them closer to the position of net-positive structures. The implementation of regenerative design concepts can also be encouraged through favourable legislation and financial incentives, which will encourage their wider inclusion into construction practises. Policymakers and building authorities should look into these options.

8. Future Scope

The recommendation is to expand the study's focus to include a variety of building types rather than limiting it to only rectangular office buildings. To fully assess the influence of regenerative design parameters in various architectural settings, it is essential to explore numerous architectural configurations, including but not limited to U-form, L-form, or H-form buildings. Additionally, doing climate evaluations by region will produce recommendations targeted to certain geographical regions, permitting the creation of individualised solutions for energy-positive buildings in a variety of climatic situations.

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