
**School of Architecture**

**Delhi Technical Campus, Greater Noida**

**Affiliated to – Guru Gobind Singh Indraprastha University Delhi**

# EXPLORING REGENERATIVE DESIGN FOR RESIDENTIAL BUILDINGS IN CONTEXT OF COMPOSITE CLIMATE

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Submitted in partial fulfillment

Of the requirement for the Degree of

Bachelor of Architecture

**Batch: 2018 - 2023**

**Date: 04-05-202**

# CERTIFICATE OF ACCEPTIBILITY

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The work is acceptable for examination.

**EXPLORING REGENERATIVE DESIGN FOR RESIDENTIAL BUILDINGS IN CONTEXT OF COMPOSITE CLIMATE**



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# CANDIDATE'S DECLARATION

I hereby certify that the work, which is being presented in the Research Paper (AP-403), titled
EXPLORING REGENERATIVE DESIGN FOR RESIDENTIAL BUILDINGS IN CONTEXT OF COMPOSITE CLIMATE

For partial fulfillment of the requirement for the award of the Degree of BACHELORS OF ARCHITECTURE, submitted in the School of Architecture, Delhi Technical Campus, GGSIPU is an authentic record of my own work carried out during the period from July-December 2022 under the supervision of AR.SAMREEN SULTAN



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Date:04-052022

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Any other person

And also, my friends & colleagues who were always around to help me.

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## ABSTRACT

Regenerative architecture is the practice of engaging the natural world as the medium for, and generator of the architecture. It responds to and utilizes the living and natural systems that exist on a site that become the “building blocks” of the architecture. Regenerative architecture has two focuses; it is an architecture that focuses on conservation and performance through a focused reduction on the environmental impacts of a building. It is embodied in the material selection, reduced energy consumption, and intelligent design. The second, more profound piece of regenerative architecture is the treatment of the environment as an equal shareholder in the architecture. It is a practice that employs a full and comprehensive understanding of natural and living systems in the design of a structure. It is an architecture that embraces the environment and uses the millions of years of engineering and evolution as the foundation for a regenerative structure.

Regenerative structure is the practice of engaging the natural international because the medium for, and generator of the structure.

Regenerative structure has focuses; it is a structure that specializes in conservation and overall performance via a targeted reduction at the environmental effects of a constructing.

Regenerative structure is the practice of attractive the natural international because the medium for, and generator of the structure. It responds to and makes use of the dwelling and natural structures that exist on a website that grow to be the `` constructing blocks " of the architecture.

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# CHAPTER 1

# PREAMBLE

## 1.1 INTRODUCTION

### 1.1.1BACKGROUND

The modern-day paradigm inside the concern of structure nowadays is one in all degeneration and out of date building era. Regenerative structure is the practice of engaging the natural international because the medium for, and generator of the structure. It responds to and utilizes the residing and natural structures that exist o n a website that emerge as the “constructing blocks” of the architecture. Regenerative structure has focuses; it is a structure that specializes in conservation and overall performance via a targeted reduction at the environmental effects of a constructing.

Regenerative structure is the practice of attractive the natural international because the medium for, and generator of the structure. It responds to and makes use of the dwelling and natural structures that exist on a website that grow to be the “constructing blocks” of the architecture. Regenerative shape has focuses; it's miles an structure that makes a uniqueness of conservation and typical overall performance thru a cantered reduction at the environmental outcomes of a constructing. It is embodied inside the fabric selection, decreased strength consumption, and clever layout. The 2d, extra profound piece of regenerative structure is the treatment of the environment as an same shareholder inside the shape. It is a exercising that employs full and complete facts of herbal and living structures in the layout of a structure. It is an architecture that embraces the environment and uses the hundreds of lots of years of engineering and evolution as the foundation for a regenerative form.

Regenerative architecture gives a one-of-a-kind method to the improvement of human habitats, an method constructed on an possibility ecological worldview that sees human as a part of a larger community of lifestyles. Humans do no longer want to be best customers but that we can have a top notch feature inside the community of planets life structures. Regeneration design pursuits to merge nature, constructing and people. Regenerative layout is based totally on the idea that the entirety we construct has the ability for the combination of the natural global as an “equal partner” in structure, in step with Littman. By enticing the shape and co-habiting humans into the ecology of the website online, it does now not damage different residing communities.

The foundation of a hit realisation for a regenerative constructing are set in procurement and tendering of activities associated with the building (design, site and maintenance). Further a regenerative constructing does now not stop with commissioning, as its operation as well as what takes location after its primary use may be even more crucial. In this dissertation attempt is made to severely overview the modern technology in regenerative structure and applicability of identical in composite weather area. The essential purpose is to have techniques of such technologies in regenerative structure particularly in residential homes.

## 1.2 NEED OF THE STUDY

Benefits of modern settlements (which include housing, employment, education, health care etc) are undeniable; but, the construction and exploitation of facilities and infrastructure lead to considerable resource intake, emissions of dangerous gases and era of massive volumes of waste. Having in thoughts that natural resources are constrained and that the manufacturing of materials and the exploitation of buildings and infrastructure are accountable for growing bad influences at the environment which is not able to soak up all emissions and pollution.

All the issues discussed above can be alleviated by incorporating regenerative architecture in residential buildings as well as it's technologies in composite climate. Regenerating our buildings with the help of modern technologies helps us in reducing waste and damage to the environment and helps in conserving the environment. We need to adopt an expertise that everything is connected through the net of together supportive relationships and reintegrate ourselves with the surroundings.

Regenerative architectural technologies are widely adopted to harness both the environmental benefits as well as maintaining a connection between human and nature. It means constructing homes that maintain human existence in a time of doubtlessly coming near monetary, social and environmental fall apart. It is feasible to layout a shape that could produce its own meals, strength, heating, cooling, water seize and purification, the usage of substances which can be derived locally and in a surely sustainable way. Architecture is innately furnished with seemingly countless quantity of possibilities to have interaction the natural world in layout and existence.

## 1.3 AIM

The aim of this paper is to identify regenerative architecture on residential buildings that is entirely based on contemporary technologies in a composite climate.

## 1.4 OBJECTIVES

1.4.1 To understand the concept of regenerative architecture and its contemporary technologies.

1.4.2 To identify and compare cotemporary regenerative architecture technologies used in residential buildings.

1.4.3 To analyse the potential benefits, implementation and applicability of regenerative architecture on residential buildings in composite climate.

1.4.4 To determine how modern regenerative architecture technologies can benefit the operation of residential buildings in a composite climate.

Table 1

OBJECTIVE MATRIX

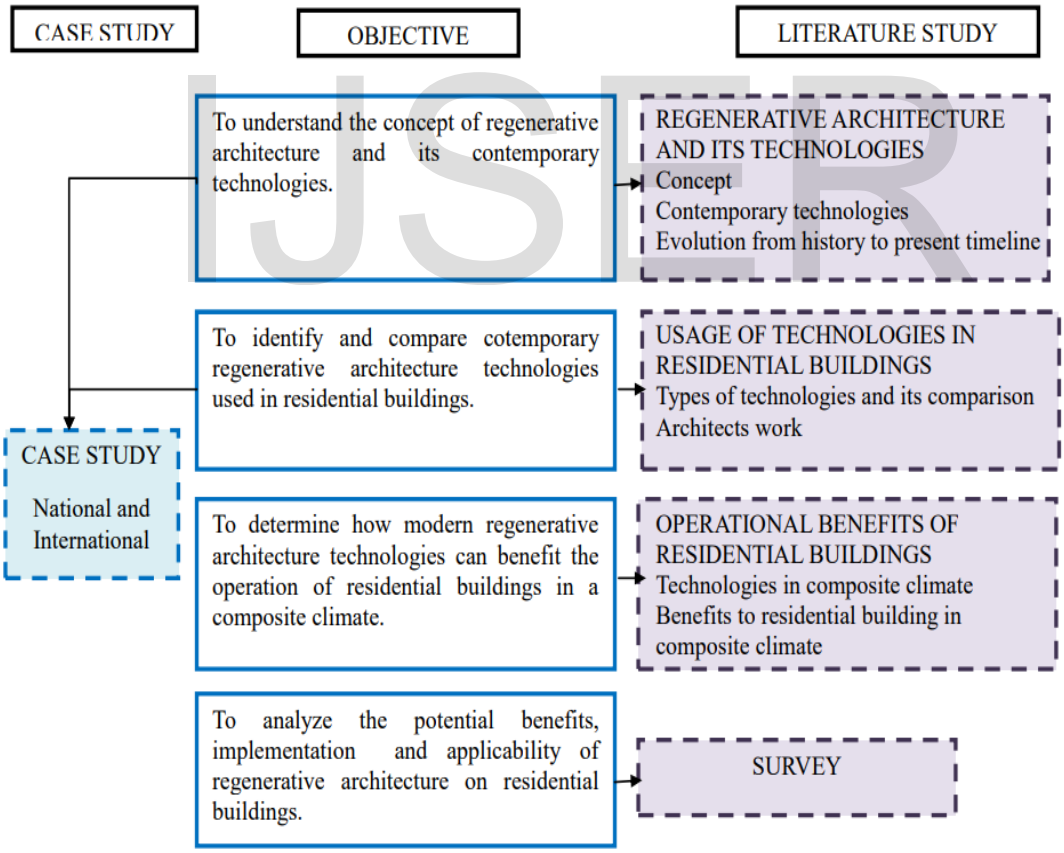


Table 2

| OBJECTIVE | SCOPE | LIMITATION |
|---|---|---|
| Regenerative architecture and its contemporary technologies. | Understanding of regenerative architecture<br>Timeline generation | Scenarios mainly from mid-20th century onwards. |
| Cotemporary regenerative architecture technologies used in residential buildings. | Comparison between technologies in composite climate | Address only usages for buildings |
| Regenerative architecture technologies can benefit the operation of residential buildings in composite climate. | How these technologies benefit the operational use of building. | International case studies only. |
| Benefits, implementation and applicability of regenerative architecture on residential buildings. | Survey via questionnaire from architects and occupants. | In composite climate only. |



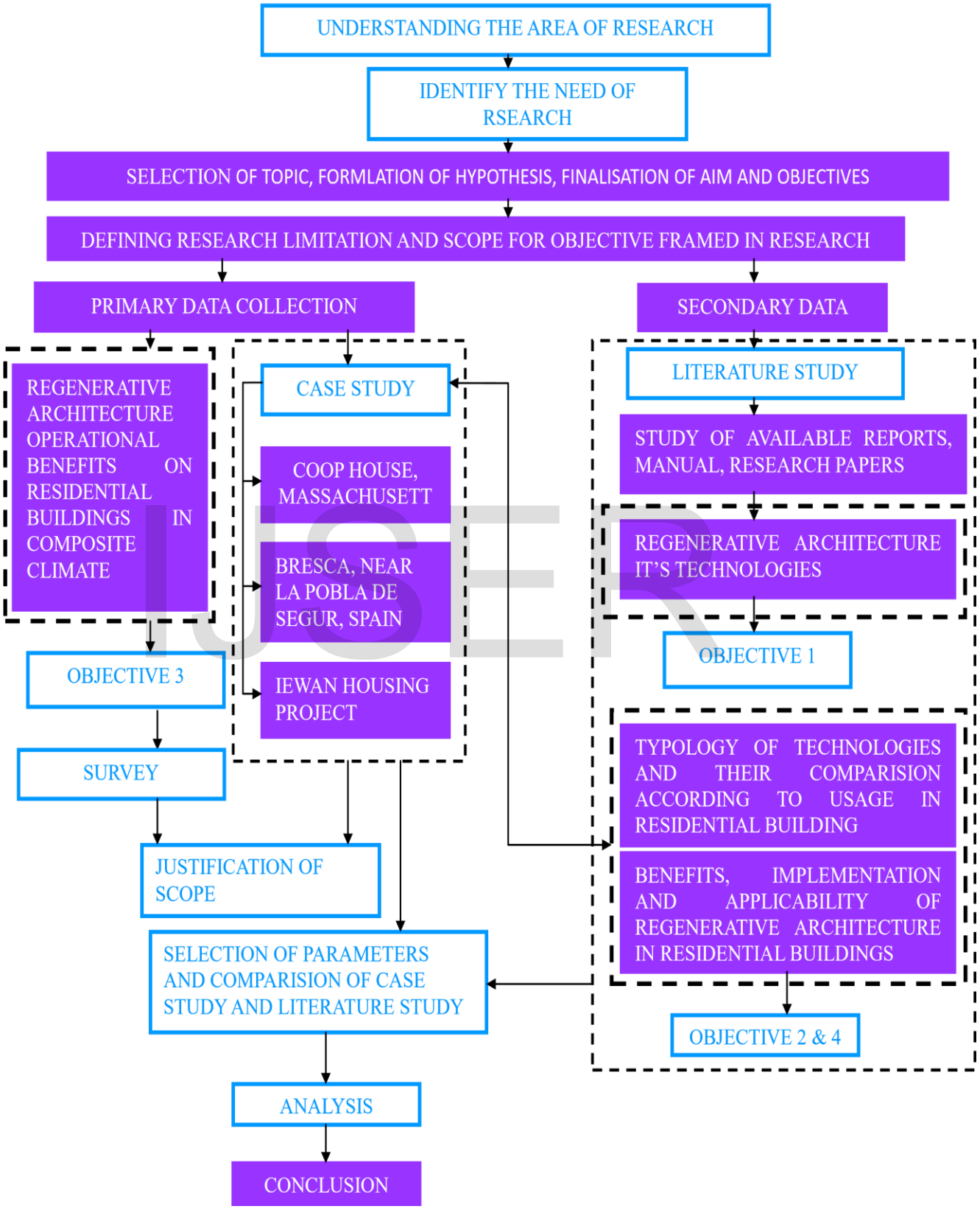
## 1.5 HYPOTHESIS

Regenerative architecture and its technologies will lower the impact on environment in terms of carbon footprint

## 1.6 SCOPE

This study is produced from the evaluation of contemporary regenerative architecture technologies in a composite climate particularly for residential buildings. The dissertation discusses approximately numerous contemporary regenerative architecture technologies of residential buildings and their advantages may be highlighted and the way regenerative design strategies are applied to these technologies that increase capability and do much less damage to building.

1.7... METHODOLOGY



# CHAPTER 2

# 2. LITERATURE STUDY

Brief: - The literature study states theories and principles of regenerative architecture concept and contemporary technologies that have less damage to environment and increase capability. The study analysis the data and establishes the relationship between human and nature.

## 2.1 LITERATURE READINGS

Table 3
Literature readings

| RESEARCH PAPER | AUTHOR | PUBLICATION | YEAR | OBJECTIVE | METHODOLOGY | HYPERLINK |
|---|---|---|---|---|---|---|
| Regenerative Architecture: A Pathway Beyond Sustainability | Jacob Alexander Littman | ScholarWorks@UMass Amherst | 2009 | Nine Principles of Regenerative Architecture and Place Analysis Criteria, | To analyse the process and applications of nine principles of architecture. | https://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1389&context=theses |
| Development of a regenerative design model for building retrofits | W. Crafta , L. Dinga , D. Prasadb , L. Partridgea , D. Elsec | Elsevier Ltd. | 2017 | Development of a regenerative methodology by Regenesis which provides a set of guiding principles and concepts grounded in this regenerative worldview | Process of identifying and extracting the key interactions between physical, human and natural systems | https://pdf.sciencedirectassets.com/ |
| Assessment of Regenerative Architecture Principles in Nigeria; A Case Study of Selected Research Institutes in Nigeria | Ukaegbu Chidinma and Fulani Omoyeni | Journal of Physics | 2019 | The principles of regenerative architecture and place analysis criteria utilized in buildings and sites | The main objectives of the study were to identify the principles of regenerative architecture and place analysis criteria utilized in buildings and sites and to examine the compliance level of institutional buildings | https://iopscience.iop.org/article/10.1088/1742-6596/1378/4/042074/pdf |
| Implementing Regenerative Design Principles: A Refurbishment Case Study of the First Regenerative Building in Spain | Aleksandar Atanas Petrovsk Emmanuel Pauwels Aránzazu Galán González | MDPI | 2021 | The objective is to examine the design process as well as the underlying challenges that arise in the implementation of regenerative principles on the example of the case-study building | In order to achieve the research aims, a site visit and a semi-structured survey was conducted with the project manager and owner of the case-study building—the most knowledgeable and competent member of the project team, responsible for the execution of the project throughout its life-cycle, and the most respected stakeholder to describe the entire process. | https://www.mdpi.com/2071-1050/13/4/2411 |
| Beyond sustainability – biophilic and regenerative design in architecture | Bruno Duarte Dias | European Scientific Journal | 2015 | the limits of Sustainable concept and looks at Biophilia and Regenerative Design, two emerging concepts that appear to have a more appropriate answer to the environmental problems that we face today and in the future. | This paper will give an overview of each concept and design framework, trying to interpret the way they operate, the differences, similarities and goals. | https://core.ac.uk/download/pdf/236408788.pdf |

Table 4

| OBJECTIVE AND LITERATURE PARAMETERS | | | |
|---|---|---|---|
| OBJECTIVE | LITERATURE REVIEW | PARAMETERS | INFERENCES |
| To understand the concept of regenerative architecture and its contemporary technologies. | Evolution of regenerative architecture | 1906 - 2021 timeline study of regenerative architecture | The study will help in understanding the conceptual evolution of regenerative architecture |
| | | Conceptual evolution | |
| | Contemporary technologies | Change in usage of technologies in accordance with timeline (sustainable growth evolution) | Changes in usage of technologies will be analysed according to the timeline |
| To identify and compare cotemporary regenerative architecture technologies used in residential buildings. | Types of technologies in residential buildings | Study about technologies in regenerative architecture | The study will increase the understanding on how contemporary technologies in regenerative architecture benefit environment in composite climate. |
| | | How do these benefit the environment in composite climate. | |
| To analyze the potential benefits, implementation and applicability of regenerative architecture on residential buildings in composite climate. | Study of regenerative architecture technologies on residential buildings in composite climate. | Applications on buildings and their empirical outcomes towards environment | The study will help in analysing the benefits based upon implementations and applicability of technologies in residential buildings in composite climate. |
| | | Implementations | |
| | | Benefits | |
| To determine how modern regenerative architecture technologies can benefit the operation of residential buildings in a composite climate. | Study of operational benefits | Technologies in composite climate | Technologies used in composite climate will help in making us understand operational benefits of contemporary technologies |
| | | Operational benefits of contemporary technologies | |

## 2.3 REVISIT

Table 5
Revisit

| OBJECTIVE | TOPIC AND SUB TOPIC | PARAMETERS |
|---|---|---|
| To understand the concept of regenerative architecture and its contemporary technologies. | Regenerative architecture concepts understanding | 1. Introduction<br>2. Evolution (1906 – 2021 )<br>3. Theories and principles |
| | Regenerative architecture contemporary technologies | 1. Methods<br>2. Contemporary technologies<br>3. Examples |
| To identify and compare cotemporary regenerative architecture technologies used in residential buildings | Types of technologies | 1. Introduction<br>2. Types |
| | Comparison of technologies | 1. Contemporary technologies comparison<br>2. Examples |
| To analyse the potential benefits, implementation and applicability of regenerative architecture on residential buildings in composite climate. | Applications on buildings and their empirical outcomes towards environment | 1. Introduction<br>2. Applications<br>3. Empirical outcomes |
| | Implementation<br>Benefits | 1. Methods of implementation<br>2. Benefits on environment |
| To determine how modern regenerative architecture technologies can benefit the operation of residential buildings in a composite climate. | Study of operational benefits | 1. Technologies in composite climate<br>2. Operational benefits |

## 2.4 LITERATURE REVIEW

### 2.4.1.1 INTRODUCTION

Table 6

| 1. 1906 – 2021 EVOLUTION OF REGENERATIVE ARCHITECTURE | |
|---|---|
| Introduction | After the era of sustainable development emerges, many concepts and new methodologies such as biophilia, cradle-to-cradle, resilience planning, natural step, permaculture, living buildings, eco-districts, transition cities, and integrative and biomimetic design, etc |
| Methods | Timeline chart , Variations in them |
| Body | History , timeline chart , conceptual evolution |
| Discussion & conclusion | The emergence of diverse standards and methods discussed is a wave of thoughts to acquire sustainability. Concepts and tactics have emerged, even though actually separate, both technological sustainability, ecological sustainability, and residing system is co-associated and all needed. |
| Reference list | https://www.researchgate.net/publication/329971013_What_is_the_sustainable_method_enough_for_our_built_environment<br>https://issuu.com/kadk/docs/regenerative_design_in_digital_practice_lowres |

These issues cannot be fully addressed with the concept of sustainable design and construction, which is based on causing less harm to the environment, at the current rate of development of contemporary society. As a result, the regenerative concept is gaining traction as it shifts the construction paradigm toward the delivery of a human-centric environment, which, when combined with the circular economy, aims to allow the natural environment to evolve. To increase the frequency with which regenerative buildings are delivered, knowledge of regenerative design must be expanded.

Regenerative design, like natural processes, aims to create resilient systems that try to self-optimize rather than maximise. It is defined as the return to nature and its cyclical flows at sources, consumption centers, and sinks, replacing current linear systems and throughput flows. Climate change has far-reaching consequences for Earth's living systems.
Some of the consequences can be large or small, positive or negative, and have a direct or indirect effect. Since the early twentieth century, world-renowned architects have attempted to incorporate environmental concepts into their designs.

Bioclimatic Architecture (1906-19), Environmental Architecture (1963-1972), Energy Conscious Architecture (1972-1983), Sustainable Architecture (1980-1993), Green Architecture (1990-2006), Carbon Neutral Architecture (2006-2015), and the last, Regenerative Architecture is a series of concepts and approaches in connection with the environmentally friendly concept .

The regenerative approach seeks to improve the living quality and community equity by promoting a healthier and more resilient way of life. Regenerative aspects, it is hoped, will be accepted by society and used to accelerate the transformation of the built environment. This modification can make the built environment more adaptable and resilient in the face of climate change.

2.4.1.2TIMELINE

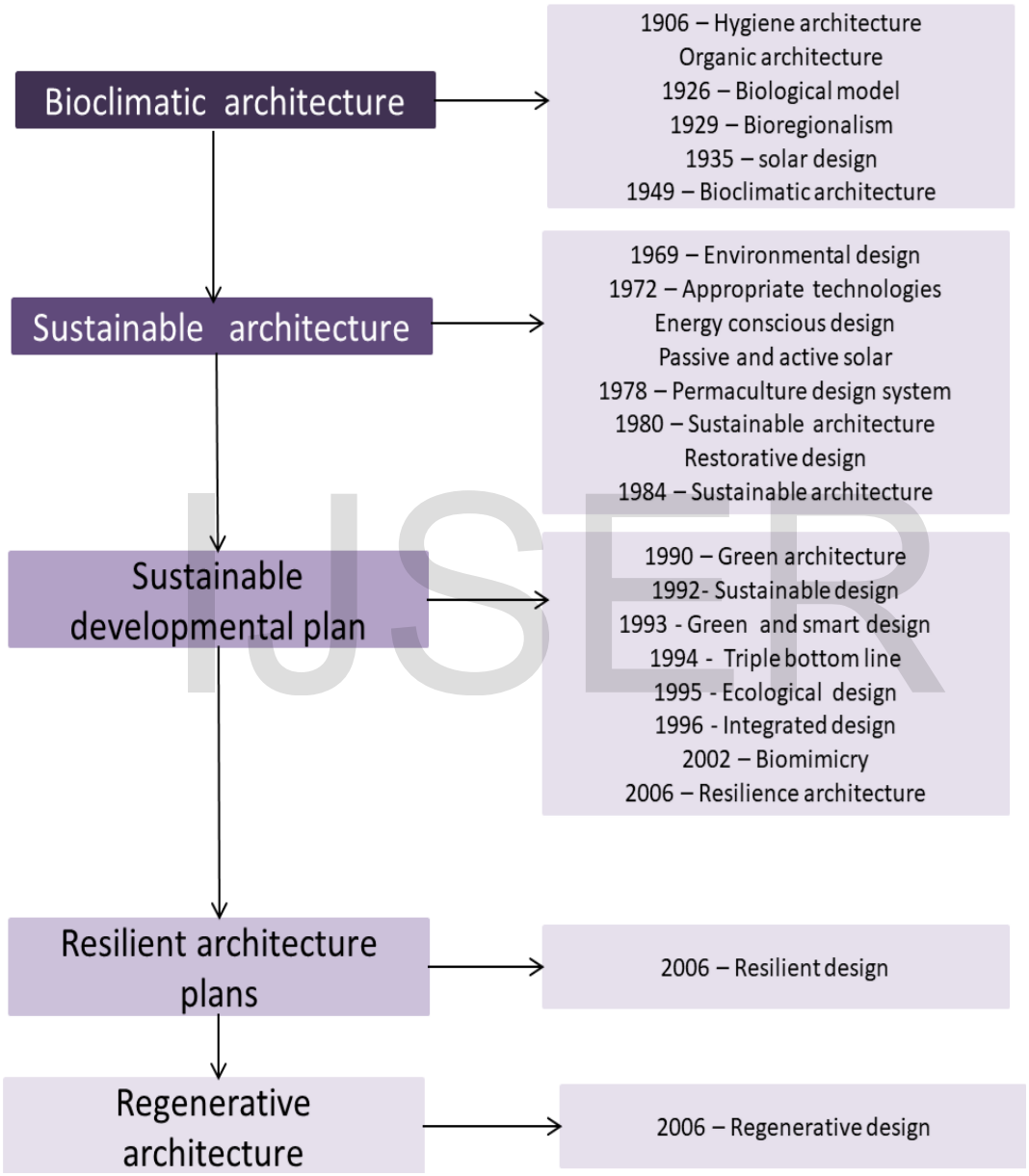



Figure 1 –Timeline

Source - IOP Conf. Series: Earth and Environmental Science 213 (2018) 012016

Since the early twentieth century, world-renowned architects have attempted to incorporate environmental concepts into their designs. Bioclimatic Architecture (1906-19), Environmental Architecture (1963-1972), Energy Conscious Architecture (1972-1983), Sustainable Architecture (1980-1993), Green

Architecture (1990-2006), Carbon Neutral Architecture (2006-2015), and Regenerative Architecture (2006-2015) are all concepts and approaches related to the environmentally friendly concept.

Bioclimatic is a response to environmental and climate problems, whereas Green Building and Sustainable Development are solutions to more complex and integrated technical-environmental issues. Given the deterioration of environmental conditions as evidenced by an increasing number of disasters, the concept of resilience emerges. Natural conditions that are unfavourable are addressed by emphasising the significance of the presence of natural elements. Bioclimatic is a response to environmental and climate problems, whereas Green Building and Sustainable Development are solutions to more complex and integrated technical-environmental issues. Given the deterioration of environmental conditions as evidenced by an increasing number of disasters, the concept of resilience emerges. Natural conditions that are unfavourable are addressed by emphasising the significance of the presence of natural elements.

2.4.1.3 DISCUSSION AND CONCLUSION

Conservation is an attempt to produce a product as efficiently as possible while using as few resources as possible. However, this still suggests that all of those resources will be depleted one day. However, renewing resources is difficult, especially given entropy, which states that energy transfer processes are one-way due to recovery time issues. It takes millions of years to return one litre of gasoline for a motorcycle. In response, another thought occurs to me. This concept assumes that the balance will always shift. Balance, as Heraclitus stated in the Ancient Greek Era, is dynamic (dynamic equilibrium). The balance tends to be dynamic and moving forward, never stopping at one point, so change is the only permanent cause by the life activities on the planet.

2.4.2.1 INTRODUCTION

Table7

| 2. SUSTAINABLE GROWTH EVOLUTION IN CONTEMPORARY TECHNOLOGIES | |
|---|---|
| Introduction | The sustainable movement has grown and developed rapidly inside the 21st century. This movement is a reaction to the diverse issues of the connection among human beings and the earth that seem extra disruptive and apparently intractable troubles. |
| Methods | Technological change with time |
| Body | Construction technologies in 21st centaury , their changes in accordance with time |
| Discussion & conclusion | The technologies changed mostly in 21st centaury which in turn had sustainable reaction towards environment. |
| Reference list | https://www.researchgate.net/publication/335568554_REGENERATIVE_DESIGN_AS_AN_APPROACH_FOR_BUILDING_PRACTICE_IMPROVEMENT<br>https://issuu.com/kadk/docs/regenerative_design_in_digital_practice_lowres |

Cole identified eight sustainable building attributes that are commonly addressed in sustainability standards or certifications:

I. Lessens the impact on natural or sensitive areas.
II. Reduces the requirement for new infrastructure.
III. Minimizes the effects of construction on natural features and site ecology.

IV. Minimizes the potential environmental damage caused by emissions and outflows
V. Contributes less to global environmental damage.
VI. Reduces resource consumption (energy, water, and materials).
VII. Reduces building occupants' discomfort
VIII. Reduces the presence of harmful substances and irritants in building interiors.

The following attributes of a truly sustainable building would imply a net-positive and holistic approach to sustainable building:

I. Increases the value of natural and sensitive sites
II. Creates new ecological infrastructure
III. Enhances natural features and site ecology during
IV. Construction Repairs environmental damage from emissions and outflows
V. Contributes to global environmental regeneration
VI. Creates new energy, clean water, and materials by circular approaches
VII. Increases the comfort and well-being of building occupants Creates beneficial substances within the building

This net-positive and holistic approach represents a radical shift in perspective, best described as "less bad to more good." This is the fundamental tenet of regenerative design. Regenerative design is based on the understanding that humans and the built environment coexist with natural systems. As such, Regenerative Design aims to undo past damage by restoring ecosystems and allowing them to thrive and evolve.

Given the urgency and magnitude of the predicted impacts, today's responses to climate change and biodiversity issues are insufficient. Current targets tend to aim to reduce the negative impact, or at the very least to achieve 'neutral' operational energy use. However, it is becoming clear that newly constructed and renovated buildings must do more than just reduce environmental impact; they must also provide positive environmental benefits. A comprehensive approach that considers carbon, resource use, waste, and water is required. The practise of regenerative design seeks to not only mitigate but also reverse the causes of climate change and ecosystem degradation.
Businesses, their buildings, and how they are designed, constructed, and used are finding new meaning as a result of the Sustainable Development Goals. Indeed, when it comes to building sustainability, we must broaden our discussion to include issues of social justice and regenerative economy, in addition to climate change and resource considerations. Our built environment has an impact on almost every industrial, commercial, and residential sector, influencing those sectors' ability to be sustainable. We must recognise this influence and act responsibly through sound governance. The Sustainable Development Goals serve as a framework for this comprehension.

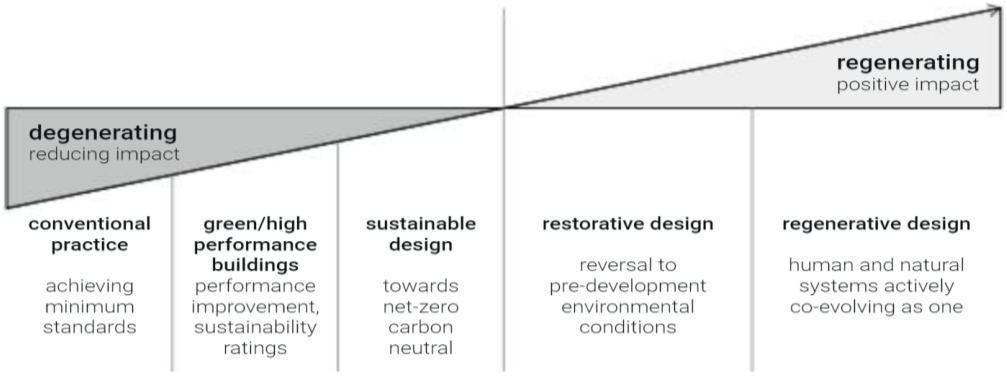



Figure 2 – negative and positive impact

SOURCE: A Handbook for the Built Environment Edited by Emanuele Naboni and Lisanne Havinga Emanuele Naboni

## 2.4.2.2 DISCUSSION AND CONCLUSION

Designers must therefore create and retrofit cities and buildings to act as positive change agents. Design can no longer be limited to creating artefacts that have limited environmental impacts within a specified target or that have limited health impacts within a certain emission threshold. Instead, buildings must be designed with the long-term goal of improving the relationships between global natural systems, the built environment, and the inhabitants in mind.

## 2.4.3.1 INTRODUCTION

Table 8

| CONTEMPORARY TECHNOLOGIES USED IN COMPOSITE CLIMATE IN RESIDENTIAL BUILDINGS | |
|---|---|
| Introduction | Due to technological advancement, we have the available tools and methodologies to transform our architectural practice from sustainable to regenerative. However, the lack of knowledge and inefficient coordination between stakeholders are hindering this endeavor. The integrated design process, with its wide application and positive impact in the built environment, can become a reality |
| Methods | Study of technologies in composite climate. |
| Body | Types of new technologies used , their advancement in residential buildings in accordance with composite climate. |
| Discussion & conclusion | The integrated process of technologies and their wide application on buildings can become a reality. |
| Reference list | https://cpwd.gov.in/CPWDNationBuilding/InaugurationPM25.02.2014/architectural_design.pdf |

Regenerative Design adapts to, harmonises with, and improves microclimates in a harmonious relationship to larger climatic flows (e.g. thermal and water flows) through designs that are a part of nature rather than 'apart from nature.' The energy generation and use balance is positive.

Because the climate, ecosystems, and human life have a synergistic relationship, strategies to address the causes and impacts of climate change may be found in managing local microclimates as a way to reduce and produce energy, eliminate and absorb emissions, combat biodiversity loss, and promote people's lives in outdoor spaces. This would imply restoring or creating ecosystem services at the

same time, thereby increasing the overall resilience of the built environment and creating favourable climatic conditions for people to spend more time in public spaces. Substantially, people must design with the climate, the environment, and the people in mind. New cities and buildings should provide ample opportunities to initiate and demonstrate this change.

Professionals must "Design with Climate." This is also the title of a book published in 1963 that was considered one of the most ground-breaking books in the field of climate adaptation. It is still a point of reference today that climate change is an emergency. It incorporates principles from ecology, biology, engineering, climatology, and physics, and demonstrates how an aesthetically sound approach to climate change can be achieved.

We are inundated with statistics about the future of cities, such as the fact that half of humanity—3.5 billion people—lives in cities today, and that this number will rise to 5 billion by 2030. These figures make for compelling headlines in stark reports on the effects of urbanisation, but they are meaningless unless action is taken to transform cities into inspiring healthy environments with outdoor comfort, clean air, connections to nature, and energy positive buildings linked by a green energy network. Cities, while at the heart of the problem, also provide dynamics that can be used to develop solutions. Cities are hubs for commerce, culture, science, productivity, social development, and new ideas, all of which must be harnessed to address some of humanity's most pressing issues, such as climate change.



2.4.4.1 INTRODUCTION

Table 9

| METHODS IN REGENRATIVE ARCHITECTURE | |
|---|---|
| Introduction | Concept of regenerative architecture and testing materials' effectiveness (thermal, availability, waste, and toxicity) and impacts on shifting towards regenerative architecture. |
| Methods | To study how material selection plays a significant role in reducing energy consumption and toxicity levels . |
| Body | After the study of materials , impacts on shifting towards regenerative architecture |
| Discussion & conclusion | The regenerative architecture concept goes beyond "less bad" or even "net-zero" design approaches to sustainability and aims at "net positive" design in architecture. |
| Reference list | International Journal of Technology (Towards Regenerative Architecture: Material Effectiveness) |

Environmental issues arose with the rise of human civilization, and they have grown in magnitude with the advancement of technology's contribution to human life. Architects believe that regenerative approaches are systems based on aligning architectural design with natural resources to produce positive results. Regenerative design has a lot of potential for a new theory of sustainable architecture. Regenerative architecture (which extends beyond the scope of sustainable design) is regarded as the highest architectural design concept in terms of positive productivity toward the environment, whereas sustainability

aims to be neutral, implying less harm to nature and the environment. These objectives can be met by putting some theories into practise, such as place-based theory, co-evolutionary system theory, and whole and living system theory.

Buildings consume a large amount of resources, which is why material selection between biodegradable, recycled, and sustainable materials makes a significant difference. Material selection is critical because it has the potential to transform a building from sustainable to regenerative. Green building materials can be used to construct a sustainable building. Likewise, using regenerative material-construction results in a regenerative building.

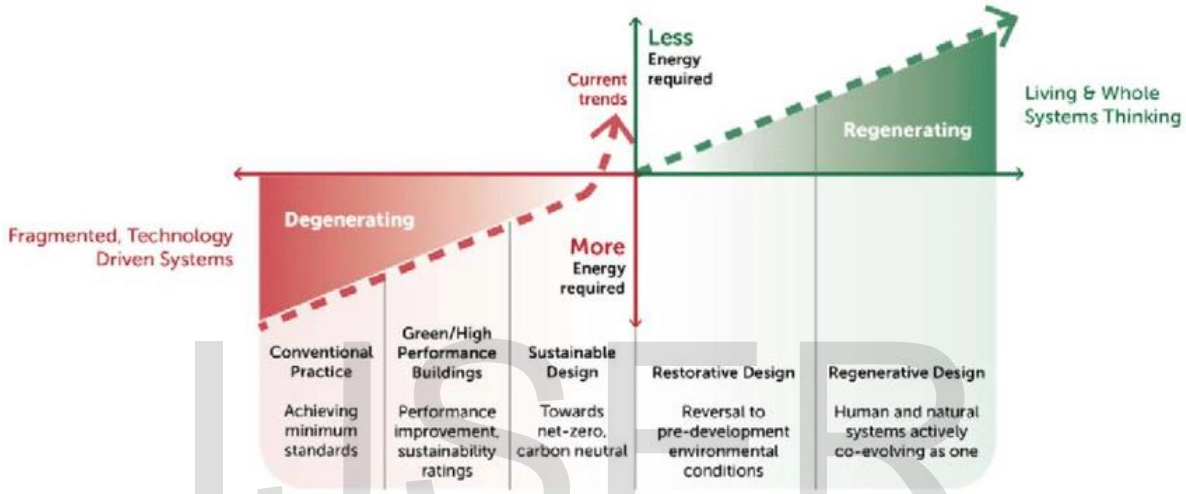



Figure 3 – sustainability approaches

Source: Range of sustainability approaches (Developed from Bill Reed, 2007

Regenerative Architecture Checklist Factors

This study focuses on the relevant literature related to sustainability and regeneration: LEEDS and Living Building Challenges, in order to formulate the most effective parameters of regenerated architecture. The most effective parameters are contained in the theoretical model. Within the framework, each parameter is assigned a set of relevant values that serve as a model for determining whether the building type is reproducible. The following sections describe the most important parameters of the playback structure.

I. Energy Generation
II. Water purification
III. Material effectiveness

I. Energy Generation

The impact of integrated building design on energy consumption and the environment is significant. This section examines this scope and emphasises important factors that differentiate between net-zero energy and net-positive

energy, which is considered regenerative and is relevant to the current study. The following are the relevant definitions.

I.I Near-zero-energy structures

A near-zero-energy building produces energy that is close to (but not equal to) its consumption over the course of a year. In theory, buildings can be designed to be net-zero energy, but in practise, they may not achieve net-zero energy status in operations every year. Factors that shift building energy from net-zero to near-zero include unusual weather that necessitates additional heating and cooling energy consumption, as well as lower-than-average solar and wind energy, which can transform net-zero energy–operating buildings into near-net-zero-energy buildings. (Pless and Torcellini, 2010)

Table 10

Material effectiveness

| S.NO. | FACTORS | | PPOSSIBLE VALUES |
|---|---|---|---|
| 1. | Energy Generation | | Non-renewable-energy building |
| | | | Near-zero-energy building |
| | | | Near-positive-energy building |
| | | | Net-zero-energy building |
| | | | Net-positive-energy building |
| 2. | Water purification | | Non-reusable water purification |
| | | | Partial water purification |
| | | | Neutral water purification |
| | | | Near-positive water purification |
| | | | Positive water purification |
| 3. | Material effectiveness | Thermal properties | Material U-values higher than 0.13 W/m2K<br>Material U-values between 0.1 and 0.13 W/m2K<br>3 W/m2K M |
| | | Local material source | Project material selection does not apply place-based Less than 10% sourced from 800 km |
| | | Waste management | Open-loop waste managing<br>Closed loop with zero waste management<br>Closed loop with net-positive waste management |

Source: Towards regenerative architecture Material effectiveness

I.II Net-zero-energy building

The concept of a net-zero-energy building is based on producing as much energy as the building consumes in a year. Net-zero-energy buildings are those that can meet their energy needs with low-cost, locally available, nonpolluting, and renewable sources. (Cole and Fedoruk, 2015).

I.III Net-positive-energy building

A net-zero energy building generates more energy than it consumes. Simply put, a net positive energy building is one that produces more energy than it consumes and exports the excess to other buildings or systems. (Cole and Fedoruk, 2015).

II Water Purification

Water purification is an important category that contributes to the transition of traditional and degenerative buildings to sustainable and regenerative buildings. Increasing water system efficiency or creating closed loop (net-zero) water systems is dependent on the existing water system design and apparatus for existing buildings.

III Material Effectiveness

Many strategies have been proposed to improve the construction industry's cost effectiveness. Regenerative architecture, on the other hand, intends to use non-toxic, ecologically regenerative, and socially equitable materials (International Living Future Institute, 2014). Some factors influence material effectiveness, which are discussed in greater detail below.

III.I Local material source

According to LEED and Living Building standards for regenerative buildings, locally available materials must be used in regenerative projects that contribute to broadening the regional economy in sustainable practises, products, and services.

III.II Recycling and reducing building materials can have environmental, economic, and performance benefits by reducing or eliminating waste generated from all three phases of the building material life cycle—construction, operation, and building demolition (Chileshe et al., 2012).

III.III Materials that are non-toxic Buildings consume a lot of resources, which is why material choices like biodegradable, recycled, and sustainable materials make a big difference. Material selection is critical because it has the potential to transform a building from sustainable to regenerative. Green material construction can be used to create a sustainable building. Similarly, using regenerative materials in construction results in a regenerative structure.

2.4.4.2 DISCUSSION AND CONCLUSION

The idea of replay architecture extends beyond "not so bad" or "net zero." In architecture, design approaches sustainability and strives to be "net positive." The goal is to regenerate the system with the full effect that allows for human co-evolution. An environment created by nature. Energy production, water purification, material destruction, responsible locations, and the quality of the

indoor climate are the most influential factors in assessing building regeneration. As a result, determine the playback architecture and design with these elements in mind. In other words, if all of the above elements are included in the design, the building can be imagined. You can also use these five factors to create a checklist to determine whether the building is renewable.

2.4.5.1 INTRODUCTION

Table 11

| HOW METHODS IN REGENERATIVE ARCHITECTURE BENEFIT ENVIRONMENT IN COMPOSITE CLIMATE | |
|---|---|
| Introduction | Regenerative Design adapts to, harmonises with and enhances microclimates in a harmonious relation to larger climatic , through designs that are a part of nature, rather than apart from nature. |
| Methods | To study Substantially people need to design with climate, design with nature and design with people in mind. |
| Body | It remains a reference nowadays that climate change is an emergency. It includes principles from ecology, biology, engineering, climatology. |
| Discussion & conclusion | This would mean at the same time restoring or creating ecosystem services, thus adding to the overall resilience of the built environment, creating favourable climatic conditions for people to spend more time in public spaces. |
| Reference list | https://issuu.com/kadk/docs/regenerative_design_in_digital_practice_lowres/1 |

Regenerative Design adapts to, harmonises with and enhances microclimates in a harmonious relation to larger climatic flows through designs that are a part of nature, rather than apart from nature. The balance of energy generation and use is positive

Because the climate, ecosystems, and human life have a synergistic relationship, strategies to address the causes and impacts of climate change may be found in managing local microclimates as a way to reduce and produce energy, eliminate and absorb emissions, combat biodiversity loss, and promote people's lives in outdoor spaces. This would imply restoring or creating ecosystem services at the same time, thereby increasing the overall resilience of the built environment and creating favourable climatic conditions for people to spend more time in public spaces. Substantially, people must design with the climate, the environment, and the people in mind.
Climate change is causing more building emissions, which in turn contribute to even more climate change, in a negative but unstoppable cycle. Buildings currently account for 60% of total global greenhouse gas emissions, and climate change is causing this percentage to rise alarmingly. Climate change, as well as the effects of Urban Heat Island, are thermally stressing the building stock, resulting in an increase in energy consumption used to cool internal spaces. For example, in the mid-latitudes, energy demand for heating has decreased by 25% while cooling demand has increased by 15%. It is well understood that design decisions, such as the shape and materials of buildings and open spaces, alter local thermodynamic phenomena, which in turn influence outdoor thermal comfort.

Industry, the construction supply chain, and those responsible for the provision, management, and maintenance of the world's built environment will be the

primary beneficiaries of resilient materials. Working with resilient materials throughout the supply chain and participating in complementary initiatives will result in the development of a suite of real-life regenerative architecture.

New technologies make it possible to revise traditional construction materials and techniques for reviving renewable and regenerative building materials like straw, clay, and wood-based solutions EcoCocon is a regenerative example of a prefabricated wall panel made of locally sourced straw insulation, FSC-certified wood-stud structure, and wood fiberboard exterior cladding. The interior panel surface is now ready for clay plastering. The product has been certified by the Passive House Institute in Germany and the Cradle-to-Cradle Product Innovation Institute, indicating that it is suitable for highly energy-efficient construction and is recyclable. Because it is made up of 98 percent renewable materials, what cannot be recycled can be composted at the end of the building's life.

Figure 4 - EcoCocon wall panel, an example of a regenerative building product
Source: https://link.springer.com/chapter/10.1007/978-3-030-71819-0_14

As a result, it is critical to anticipate these changes and incorporate strategies that allow the building to adapt to a variety of uses over time. Today, vast

quantities of construction materials end up in landfills or incinerators long before they have lost any quality or utility.
Flexible construction systems can facilitate structure dismantling and, as a result, the recovery, upgrading, modification, or transformation of building materials. The use of a flexible construction system allows future users to dismantle or disassemble a building in its elements and components, increasing the building's resilience in terms of multi-functionality and flexibility of spatiality and use interpretation.

The goal of the regenerative design framework is to address building products, optimise the material selection process, and integrate certified products into buildings to increase their value. Each brick, board, piece of wood, or piece of glass in a building has a monetary value. Buildings, rather than becoming waste, must function as banks of valuable materials, slowing resource consumption to a rate that meets the planet's capacity.

C2C-certified products or similar eco-labels generate less waste and waste because they come from biosphere or technosphere beneficiaries. Choosing regenerative building products ensures that building components are healthy, safe, and beneficial to humans as well as the environment. These components or products are designed in such a way that their ingredients can be safely reintroduced into natural or industrial cycles, and they are assembled or manufactured using 100% renewable and non-polluting energy. Regenerative building materials and products are intended to safeguard and expand clean water resources (as a basis for social and environmental justice). The use of such products also results in chain partnerships with the goal of validating each intermediary in a manufacturing process. Mechanisms for material recovery and reuse, but also, waste or process synergy emerges between the actors in these chains.

The use of regenerative materials, whether biological or technological, must be accomplished without sacrificing quality. Materials with EPD, C2C certified materials, or any other eco-certified products should be used in accordance with the regenerative design principles mentioned previously. Particular consideration must be given to fire safety, embodied energy and carbon content, as well as the structural, mechanical, hydrothermal, and acoustic performance of the materials used. To the greatest extent possible, biosphere materials such as clay, wood, straw, bamboo, or hemp should be preferred.

### 2.4.5.2 DISCUSSION AND CONCLUSION

Regenerative Design adapts to, harmonises with, and improves microclimates in a harmonious relationship to larger climatic flows through designs that are a part of nature rather than separate from nature. The energy generation and use balance is positive. Because the climate, ecosystems, and human life have a synergistic relationship, strategies to address the causes and impacts of climate

change may be found in managing local microclimates as a way to reduce and produce energy, eliminate and absorb emissions, combat biodiversity loss, and promote people's lives in outdoor spaces..

Substantially, people must design with the climate, the environment, and the people in mind. Climate change is causing more building emissions, which in turn contribute to even more climate change, in a negative but unstoppable cycle. Outdoor thermal comfort, as opposed to indoor thermal comfort, is constantly changing, with wide spatial and temporal variability due to weather changes. Industry, the construction supply chain, and those responsible for the provision, management, and maintenance of the world's built environment will be the primary beneficiaries of resilient materials. New technologies enable the revision of traditional construction materials and techniques in order to breathe new life into renewable and regenerative building materials such as straw, clay, and wood-based solutions.

The product has been certified by the Passive House Institute in Germany and the Cradle-to-Cradle Product Innovation Institute, indicating that it is suitable for highly energy-efficient construction and is recyclable. Flexible construction systems can facilitate structure dismantling and, as a result, the recovery, upgrading, modification, or transformation of building materials. The goal of the regenerative design framework is to address building products, optimise the material selection process, and integrate certified products into buildings to increase their value. Regenerative building materials and products are intended to safeguard and expand clean water resources (as a basis for social and environmental justice). The use of such products also results in chain partnerships with the goal of validating each intermediary in a manufacturing process. The use of such products also results in chain partnerships with the goal of validating each intermediary in a manufacturing process. The use of regenerative materials, whether biological or technological, must be accomplished without sacrificing quality. Particular consideration must be given to fire safety, embodied energy and carbon content, as well as the structural, mechanical, hydrothermal, and acoustic performance of the materials used.



2.4.6.1 INTRODUCTION

Table 12

| APPLICATIONS ON BUILDINGS AND THEIR EMPIRICAL OUTCOMES TOWARDS ENVIRONMENT | |
|---|---|
| Introduction | Performance evaluation has generally been approached through the constructing enterprise in phrases of the dreams of minimizing the poor environmental influences of the buildings |
| Methods | How evaluation has generally been approached through the constructing enterprise in phrases |
| Body | The human performance side **isn't** emphasized in these materials, **and also the** expressed goal is to avoid negative environmental impacts |
| Discussion & conclusion | The human performance side **isn't** emphasized in these materials, **and also the** expressed goal is to avoid negative environmental impacts |
| Reference list | https://www.iea.org/reports/tracking-buildings-2021<br>https://issuu.com/kadk/docs/regenerative_design_in_digital_practice_lowres/1 |

Performance assessments are generally from construction companies in the form of dreams of minimizing the negative impact of the building's environment (such as reducing energy consumption and emissions) and significantly improving the comfort and well-being of the building's occupants. It has been approached. Qualitative subsequent occupancy evaluation of the building user's view. Both civilian identity and high-performance building marketing focus on environmental measures (such as "green buildings") and mitigate their impact (such as “net zero energy” and “near zero emissions” buildings have been emphasized. These materials do not emphasize aspects of human performance, and the stated purpose is also to avoid adverse environmental impacts. To date, this approach has not been very successful. Despite the growing numbers, green buildings remain a small part of recent buildings and refurbishments, both in the residential and commercial sectors.

Despite growing awareness of climate change, the concentration of carbon dioxide in the world's atmosphere has steadily increased since the publication of the Brundland Report in 1987 (Fig. 5). At the same time, the latest IPCC report estimates that today's human activity has raised global warming by about 1.0 ° C above pre-industrial levels, impacting global warming on land and marine ecosystems. It shows that it has already been observed.



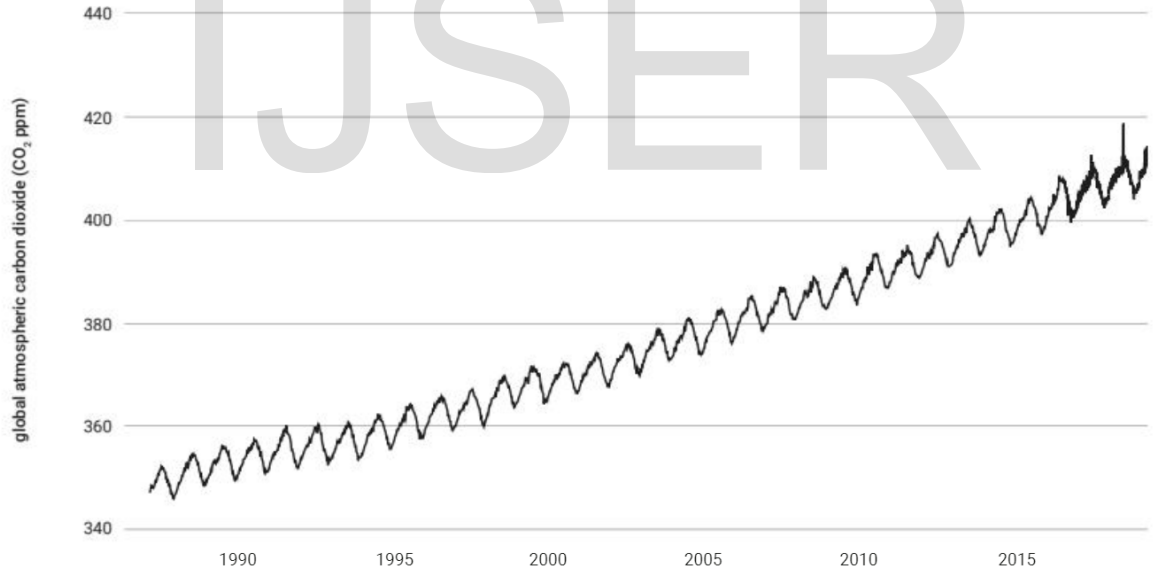



Figure5 - Brundland Report in 1987
Source: https://issuu.com/kadk/docs/regenerative_design_in_digital_practice_lowres/1

Direct and indirect emissions from building operations increased by an average of 1% annually since 2010 and then declined to about 9 Gt in 2020. Although minimum performance standards are becoming stricter, the use of heat pumps and renewable energy equipment is accelerating and the energy sector continues to be decarbonized. The decline in carbon emissions in the building sector in 2020 is primarily due to lower activity in the services sector. Despite the

expected recovery in emissions in 2021, the energy sector has been mitigated by continued decarbonisation, but the building is on track to reach carbon neutrality by 2050. To reach this goal, 20% of all new construction and building stock must be carbon-free by 2030.

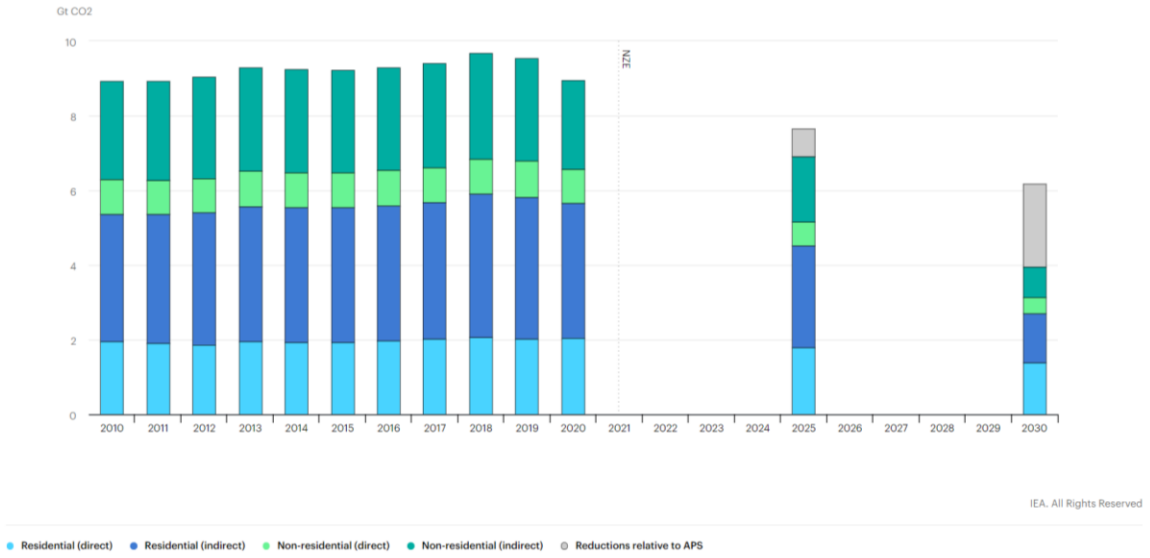



Figure 6: Direct and indirect emissions from building operations
Source: https://www.iea.org/reports/tracking-buildings-2021



The decline in CO2 emissions in 2020 was primarily due to the Covid 19 pandemic and decarbonisation of electricity generation. Decreased activity in the tertiary industry (results of telework, closed schools, empty hotels and restaurants) was the main reason why the tertiary industry saw the largest decline in energy demand. In parallel, electricity in 2020 will be carbon deficient compared to 2019 due to increased renewable energy production and lower overall electricity demand. If activity resumes and electricity demand recovers again, consumption and emissions may increase again in 2021.

Visible advances in energy efficiency over the past year have spurred advances in separating energy use from the growth of area in the building sector. The final energy consumption of the building increased at an average annual rate of 1% from 118EJ in 2010 to nearly 130EJ in 2019, lagging behind the average annual increase of 2% over the same period.

The fastest growing energy end applications in buildings (cooling, appliances, and electrical sockets) are driving electricity demand in the building sector. Electricity accounted for one-third of the building's energy consumption in 2020, but fossil fuel consumption has also increased at a CAGR of only 0.7% since 2010. The decline in building energy intensity (energy consumption per square meter) was caused by the development of building energy codes in 80 countries. Additional more stringent minimum energy performance standards (MEPS) for

devices. By switching to more efficient heating technologies such as heat pumps, total inventories increased from 100 million units in 2010 to 180 million units in 2020.

Still, the energy intensity of the building sector needs to decline almost five times faster in the next decade than in the last five to meet the net zero emission scenario by 2050. This means that energy consumption per square meter should be 45% lower in 2030 than in 2020.

The total final energy consumption in the world is the building sector remained at the same level in 2019 compared to the previous year building operations have raised to the highest level still about 10 GtCO2, or 28% of global CO2 emissions Energy-related CO2 emissions. Including emissions from the construction industry, this will increase to 38% of the world's total energy-related CO2 emissions. The slightly lower share of building emissions compared to 39% in 2018 was due to higher transportation and other industrial emissions compared to buildings.

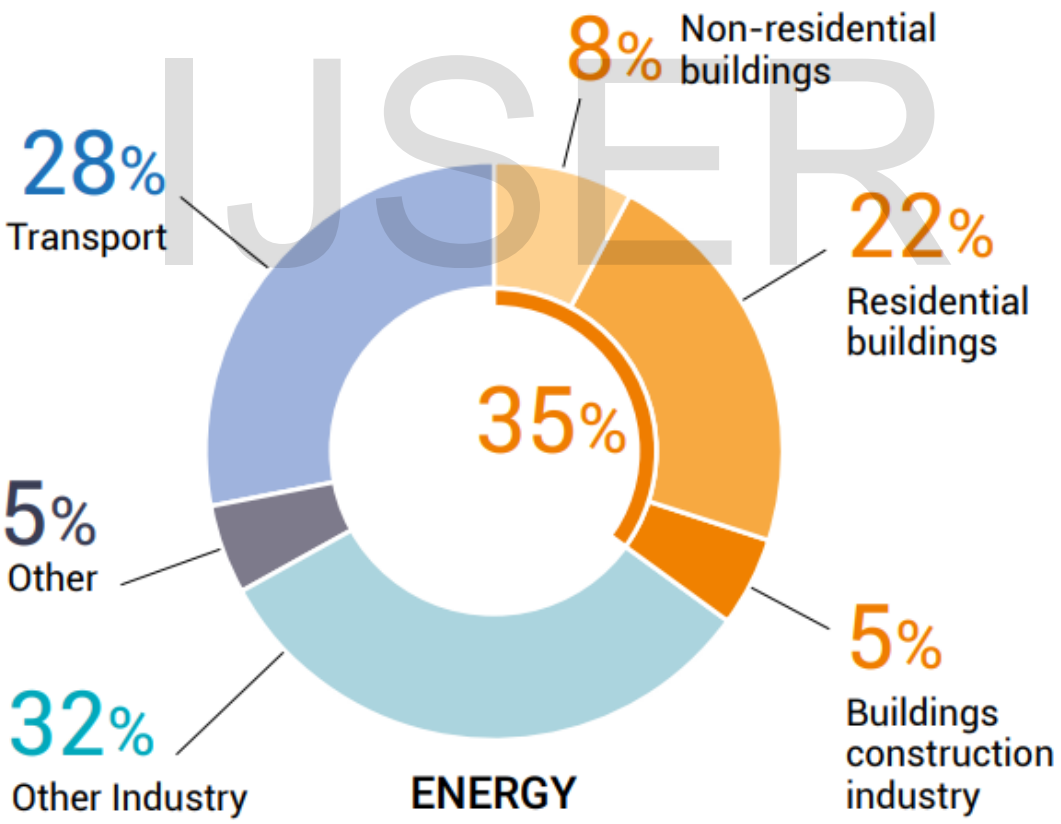



Figure 7 - Global share of buildings and construction final energy and emissions, 2019
Source: https://wedocs.unep.org/bitstream/handle/20.500.11822/34572/GSR_ES.pdf

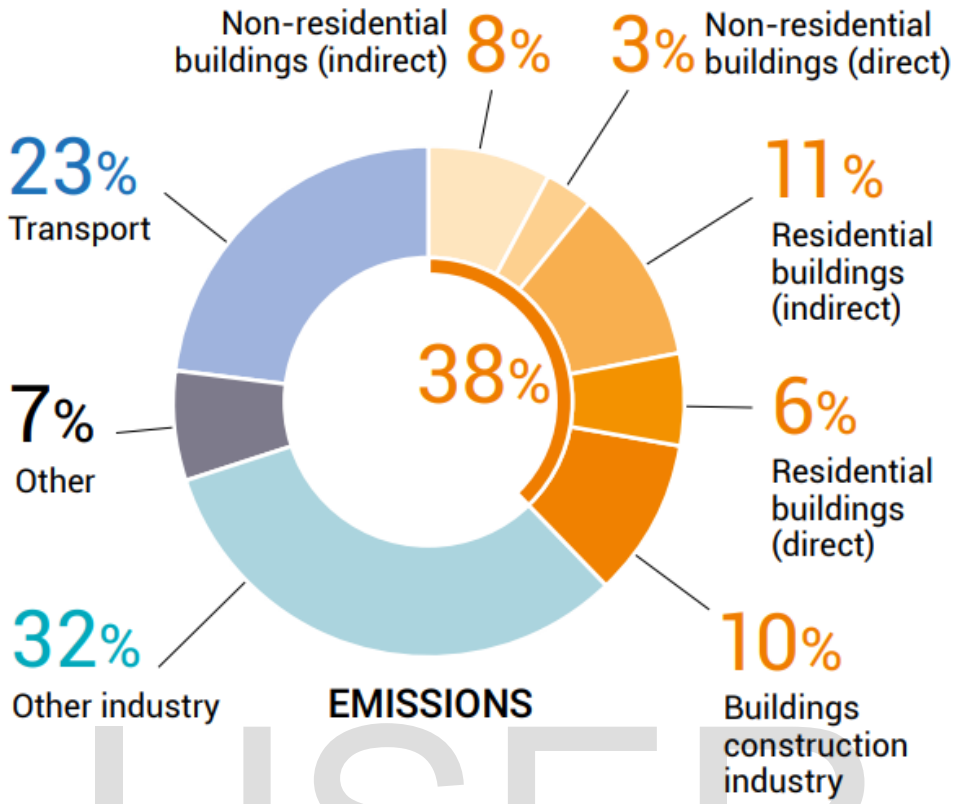



Figure 8 - Global share of buildings and construction final energy and emissions, 2019
Source: https://wedocs.unep.org/bitstream/handle/20.500.11822/34572/GSR_ES.pdf

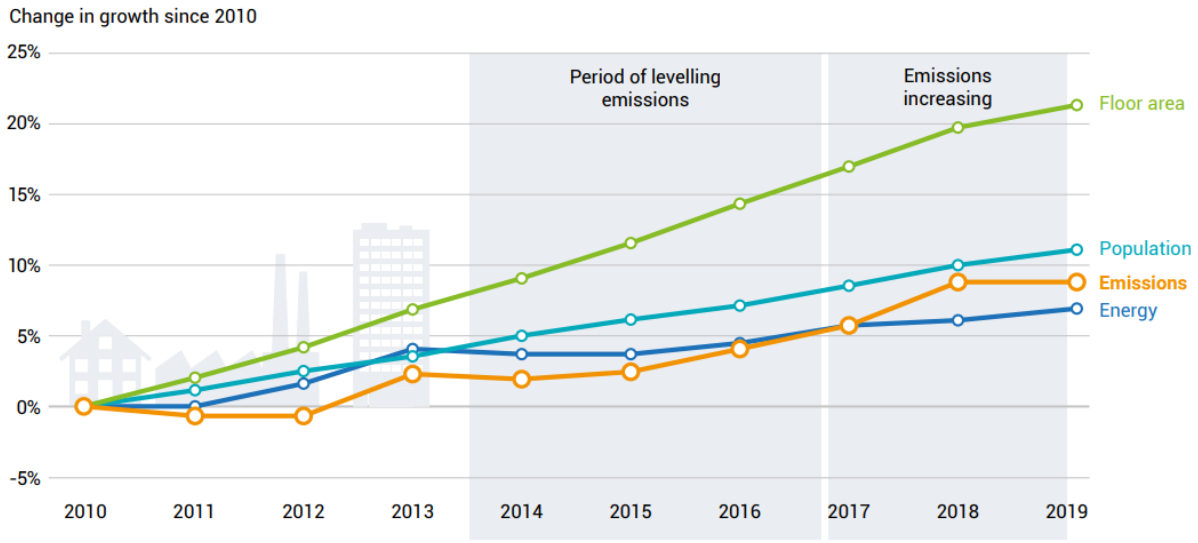



Figure 9 - Change in global drivers of trends in buildings energy and emissions 2010-2019
Source: https://wedocs.unep.org/bitstream/handle/20.500.11822/34572/GSR_ES.pdf

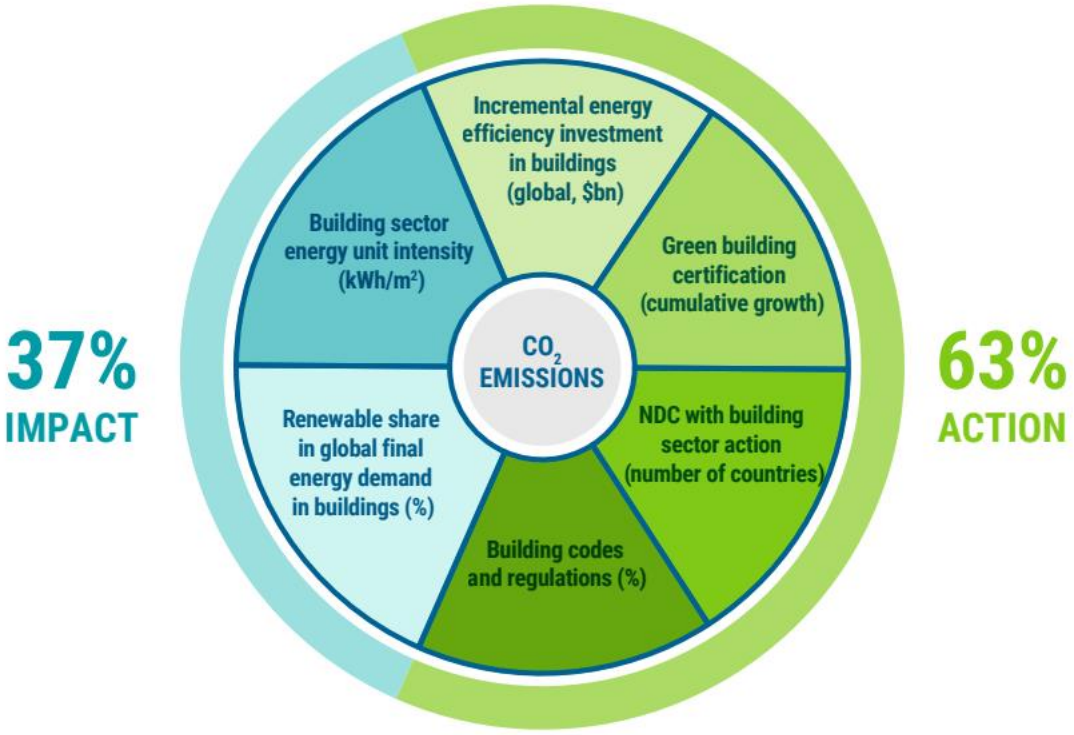



Figure 10 - The weighting of individual indicators in the decarbonisation index, and their data sources, are as follows: energy intensity 19% (IEA 2021a); renewable share 19% (IEA 2021a); building regulations 18% (author analysis; World Bank, 2019); energy efficiency investments 19% (IEA 2021a); green building certifications 15% (author analysis); building measures in NDCs 11% (author analysis). Instead of a weighted share, CO2 emissions are used as a factor because they are the main measure for decarbonisation.
Source: https://globalabc.org/sites/default/files/2021-10/GABC_Buildings-GSR-2021_BOOK.pdf

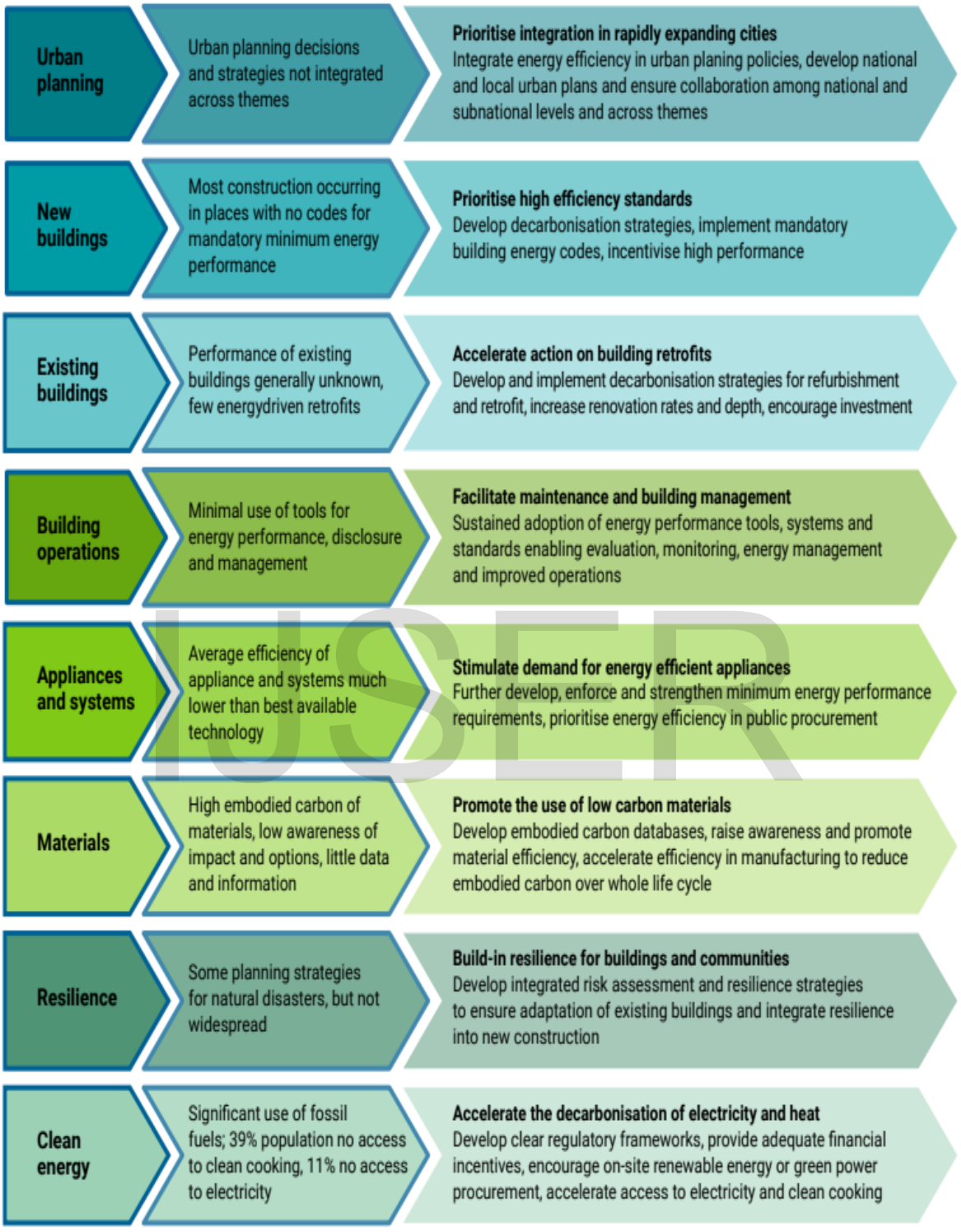



Figure 11 - Decarbonisation roadmaps: Eight key categories
Source:https://globalabc.org/sites/default/files/2021-10/GABC_Buildings-GSR-2021_BOOK.pdf

### 2.4.6.2 DISCUSSION AND CONCLUSION

Qualitative subsequent occupancy evaluation of the building user's view. These materials do not emphasize aspects of human performance, and the stated purpose is also to avoid adverse environmental impacts. Despite growing awareness of climate change, the concentration of carbon dioxide in the world's atmosphere has steadily increased since the publication of the Brundland Report in 1987. Although minimum performance standards are becoming stricter, the use of heat pumps and renewable energy equipment is accelerating and the energy sector continues to be decarbonized.

The decline in carbon emissions in the building sector in 2020 is primarily due to lower activity in the services sector. The decline in CO2 emissions in 2020 was primarily due to the Covid 19 pandemic and decarbonisation of electricity generation. Decreased activity in the tertiary industry (results of telework, closed schools, empty hotels and restaurants) was the main reason why the tertiary industry saw the largest decline in energy demand. Visible advances in energy efficiency over the past year have spurred advances in separating energy use from the growth of area in the building sector.

The final energy consumption of the building increased at an average annual rate of 1% from 118EJ in 2010 to nearly 130EJ in 2019, lagging behind the average annual increase of 2% over the same period. The fastest growing energy end applications in buildings (cooling, appliances, and electrical sockets) are driving electricity demand in the building sector. Still, the energy intensity of the building sector needs to decline almost five times faster in the next decade than in the last five to meet the net zero emission scenario by 2050. The total final energy consumption in the world is the building sector remained at the same level in 2019 compared to the previous year building operations have raised to the highest level still about 10 GtCO2, or 28% of global CO2 emissions Energy-related CO2 emissions. Including emissions from the construction industry, this will increase to 38% of the world's total energy-related CO2 emissions.

2.4.7.1 INTRODUCTION

Table 13

| IMPLEMENTAIONS OF REGENERATIVE ARCHITECTURE ON RESIDENTIAL BUILDINGS | |
|---|---|
| Introduction | Performance evaluation has generally been approached through the constructing enterprise in phrases of the dreams of minimizing the poor environmental influences of the buildings |
| Methods | How evaluation has generally been approached through the constructing enterprise in phrases |
| Body | Regeneration design creates new supply chain opportunities and increases the availability of resources for future projects of all kinds |
| Discussion & conclusion | Regenerative design is the responsibility and action taken to mitigate the negative effects of carbon emissions caused by the buildings we design. It's about design lenses that are more holistic, data-driven, and evolving towards an innovation-centric approach |
| Reference list | https://www.researchgate.net/publication/352002188_Assessment_of_regenerative_design_practices_for_residential_housing_a_case_study_in_Awka<br>https://www.hdrinc.com/insights/6-things-know-about-regenerative-design |

Traditional building design and construction has a negative impact on the environment. At the current pace of social development today, these issues cannot be fully addressed by the concept of sustainable design and construction, which is based on low environmental impact. Therefore, the concept of regeneration is becoming more relevant as it aims to transform the construction paradigm towards a human-centered environment and enable the development of the natural environment in combination with the circular economy. In order to deliver regenerative buildings more frequently, we need to expand our knowledge of regenerative design.

The built environment plays an important role in climate change, from how to build a project to how to use and dismantle the project at the end of its life cycle. For decades, the design and construction industry has implemented increasingly rigorous "high performance" design techniques to minimize these impacts.

But as climate change approaches a turning point with irreversible consequences, high-performance behavior still has a negative net impact and should only be seen as a first step towards something bigger. We don't have to think about our development in the context of less harm, but we're actually doing well. In other words, our projects need to actively regenerate or have a positive impact on the people who use them and the ecosystems of the surrounding areas. The term "regenerate" refers to the process of imitating nature itself by restoring or renewing its own energy sources and substances.

1. Regeneration design realizes net ecological, health and social impact.

Regeneration projects create performance metrics in these three areas to repair damage caused by years of traditional development. Regeneration designs that mimic natural ecosystems incorporate cutting-edge designs for wellness and are actively participating in unique site-based social justice solutions.

2. Regeneration design integrates and builds an existing paradigm.
Everything we do as a company and as an industry is based on a true level of performance in remanufacturing design. The following paradigms are included in the Replay Design Framework.

I. Triple NetZero (energy, water, waste)
II. Carbon balancing (embodied operational carbon)
III. Health and wellness design
IV. Material transparency
V. Resiliency
VI. Social equity

3. Regeneration design is continually involved and involved in the community.

The project needs to maintain and inspire continued stakeholder involvement in order to align community values with the project's goals and plan future co-evolution of the socio-ecological system.
This new design approach changes the basic idea of long-term construction work and its impact on communities and ecology.

This changes the approach to how the entire project life cycle (cradle-to-cradle) is performed. Regeneration design creates new supply chain opportunities and increases the availability of resources for future projects of all kinds, both in vertical buildings such as roads, bridges and water systems and in horizontal infrastructure. It also addresses community development issues as it needs to help vulnerable and deprived people, promote affordable housing, and plan in ways to put social justice issues at the forefront of design. Change our approach.

Ultimately, rehabilitation design is the responsibility and action taken to mitigate the negative effects of carbon emissions caused by the buildings we design. It's about design lenses that are more holistic, data-driven, and evolving towards an innovation-centric approach.

Table 14
Implementation framework of regenerative design

| Environment | Cultural | Social | Experiential | Educational | Economic |
|---|---|---|---|---|---|
| Attention to the uniqueness and sense of a place | Human and ecological co-evolution | Stakeholders and community participation and collaboration | Create systems of long-time value | Dissemination of information and Feedback | Eliminate waste |
| Optimise and enhance natural environment | Integrate/ maintain cultural identity and image of a place | Integrate and utilize the natural systems and landscape | Landscape and community connectivity | Encourage awareness and education of developers and users | Integrated and Intelligent design & construction |
| Design with nature | | | | | Promotion of diversity/ Flexibility<br>Redundancy and resilience |

Source:https://www.researchgate.net/publication/352002188_Assessment_of_regenerative_design_practices_for_residential_housing_a_case_study_in_Awka



## 2.4.7.2 DISCUSSION AND CONCLUSION

Traditional building design and construction has a negative impact on the environment. In order to deliver regenerative buildings more frequently, we need to expand our knowledge of regenerative design. The built environment plays an important role in climate change, from how to build a project to how to use and dismantle the project at the end of its life cycle.

For decades, the design and construction industry has implemented increasingly rigorous "high performance" design techniques to minimize these impacts. But as climate change approaches a turning point with irreversible consequences, high-performance behaviour still has a negative net impact and should only be seen as a first step towards something bigger. We don't have to think about our development in the context of less harm, but we're actually doing well.

1. Regeneration design realizes net ecological, health and social impact. Regeneration projects create performance metrics in these three areas to repair damage caused by years of traditional development.
2. Regeneration design integrates and builds an existing paradigm. Everything we do as a company and as an industry is based on a true level of performance in remanufacturing design.
3. Regeneration design is continually involved and involved in the community.

The project needs to maintain and inspire continued stakeholder involvement in order to align community values with the project's goals and plan future co-evolution of the socio-ecological system. This new design approach changes the basic idea of long-term construction work and its impact on communities and ecology.

This changes the approach to how the entire project life cycle (cradle-to-cradle) is performed. Ultimately, rehabilitation design is the responsibility and action taken to mitigate the negative effects of carbon emissions caused by the buildings we design. It's about design lenses that are more holistic, data-driven, and evolving towards an innovation-centric approach.

2.4.8.1 INTRODUCTION

Table 15

| BENIFITS OF REGENERATIVE ARCHITECTURE ON RESIDENTIAL BUILDINGS | |
|---|---|
| Introduction | Buildings for regeneration and restoration are living buildings by enhancing the environment |
| Methods | A regenerative building and the regenerative design process not only restores but also improves the surrounding natural environment by enhancing the quality of life for biotic (living) and abiotic (chemical) components of the environment |
| Body | All of these design processes require a different way of engaging the design team than simply recommending green technologies. |
| Discussion & conclusion | The result is a building that not only meets all the needs of the field, but also contributes to the health of the surrounding environment, enhances biodiversity and maintains a vibrant relationship with the surrounding environment. |
| Reference list | https://www.designingbuildings.co.uk/wiki/Regenerative_design |



Buildings for regeneration and restoration are living buildings by enhancing the environment, for example by restoring the site's natural hydrology or creating lost habitats for wildlife and plants. Beyond the level these buildings are integrated into the natural environment and are designed to improve the degraded environment.

Regeneration and restoration buildings are designed and operated to generate all energy, capture and treat all water, as well as have a net positive impact on the environment, including the restoration of surrounding ecosystems. It has been. It produces more energy and shares surplus than it consumes so that other buildings can meet their energy needs. Create opportunities for urban agriculture. Grow food on the rooftop.

Replenishing groundwater systems and creating ecosystems for local species whose niches have been lost, damaged or destroyed are examples of how buildings can help restore the environment. In order to share the surplus energy generated by private power generation with the surrounding buildings, it is necessary to connect the buildings to the power grid. The subtle difference is that restoration design reverses the damage caused to a particular location by

either nature or humans, while regeneration design provides better conditions to support the properties that improve the life of the ecosystem.

A regenerative building and the regenerative design process not only restores but also improves the surrounding natural environment by enhancing the quality of life for biotic (living) and abiotic (chemical) components of the environment. The regenerative design process promotes the pattern of relationships between the physical, built, and natural environment. The laws of heat transfer, thermodynamics, and material performance in a harsher climate determine overall system design and equipment selection versus a milder climate. In the regenerative design process, the same principles are followed as for living and restorative buildings, but include all aspects of systems thinking from site, water, materials, and energy to plants, microbes, human social systems, and culture.

All of these design processes require a different way of engaging the design team than simply recommending green technologies. The result is a building that not only meets all the needs of the field, but also contributes to the health of the surrounding environment, enhances biodiversity and maintains a vibrant relationship with the surrounding environment.
Regenerative design aims not only to mitigate the damage of new developments, but also to use design and construction as an active force to repair natural and human systems.




Figure 12 - Path from sustainability to regenerative design.
Source:https://sustainablebrands.com/read/product-service-design-innovation/the-shift-from-sustainable-to-regenerative-design

### 2.4.8.2 DISCUSSION AND CONCLUSION

Buildings for regeneration and restoration are living buildings by enhancing the environment, for example by restoring the site's natural hydrology or creating lost habitats for wildlife and plants. Regeneration and restoration buildings are designed and operated to generate all energy, capture and treat all water, as well as have a net positive impact on the environment, including the restoration of surrounding ecosystems.

Replenishing groundwater systems and creating ecosystems for local species whose niches have been lost, damaged or destroyed are examples of how buildings can help restore the environment. A regenerative building and the regenerative design process not only restores but also improves the surrounding natural environment by enhancing the quality of life for biotic (living) and abiotic (chemical) components of the environment. The laws of heat transfer, thermodynamics, and material performance in a harsher climate determine overall system design and equipment selection versus a milder climate. All of these design processes require a different way of engaging the design team than simply recommending green technologies.

# CHAPTER 3
# CASE STUDY
## Delhi

Delhi is a city and the national capital territory of India, located in north-central India. The city of Delhi is actually divided into two parts: Old Delhi, the historic city in the north, and New Delhi, the capital of India since 1947, built in the first half of the twentieth century as the capital of British India. Delhi, one of the country's largest urban agglomerations, is located astride (but primarily on the west bank of) the Yamuna River, a tributary of the Ganges (Ganga) River, approximately 100 miles (160 km) south of the Himalayas. The national capital territory includes Old and New Delhi, as well as the surrounding metropolitan region and rural areas. The territory is bounded to the east by the state of Uttar Pradesh, and to the north by the state of Punjab..

Delhi is historically significant as an important commercial, transportation, and cultural hub, as well as India's political center. The implementation (albeit partial) of the Delhi Development Authority's 20-year (1962–81) master plan had a significant impact on the pattern of land use in Delhi. In general, public and semipublic land use was concentrated in New Delhi's Central Secretariat area and the Old Secretariat area in the Civil Lines, with subsidiary centers developing in the Indraprastha Estate (an office complex) to the east and Ramakrishnapuram (an office-cum-residence complex) to the south. There are numerous small manufacturing establishments in almost every part of Old Delhi, but the main industrial areas have gravitated toward Najafgarh Road in the west and the large planned Okhla Industrial Estate in the south.

Although there are numerous small manufacturing establishments in almost every part of Old Delhi, the main industrial areas have gravitated toward Najafgarh Road in the west and the large planned Okhla Industrial Estate in the south. Commercial land can be found primarily in the areas of Chandni Chowk and Khari Baoli in the north; Sadar Bazar in Old Delhi; the Ajmal Khan Road area of Karol Bagh in western Delhi; around Connaught Place in New Delhi; and Lajpat Nagar and Sarojini Nagar in the south. In other areas, a number of district and local shopping centres have sprouted up.

Figure 13 – aerial view
Source : https://www.rediff.com/

## Dwarka

Dwarka is a residential neighborhood at the western edge of the Indian capital, New Delhi. Framed by the winding Najafgarh drain river to the west, it's home to sacred sites like the red-roofed ISKCON Dwarka Temple and the sprawling Dada Dev Mandir Hindu temple complex. Nearby, the Lodi Era Baoli is a centuries-old monument with steps leading down to an octagonal well.

I. Area: 56.48 km²

II. District: South West Delhi

III. Civic agency: DDA

IV. Vidhan Sabha constituency: Dwarka/Matiyala (Different sectors fall in different constituencies)

The Dwarka sub city is one of the recently developed areas situated in South West Delhi District. It was named after the legendary Dwaraka Kingdom and lie in close proximity to the business hubs of Gurgaon.

Dwarka was recently named as the largest suburb in Asia. A few areas of this sub city fall under the colony of Pappan Kalan which is undergoing development under the 'Urban Expansion Projects' of the Delhi Development Authority. This sub city is also known as the one of the largest residential areas in Asia and has a 'Zero Tolerance' policy towards common misuses of land, encroachments or illegal usage of property which is predominant in most parts of Delhi. It is also referred to as the 'Model Township' owing to its most organized well planned and 'Clean & Green' policies that makes it a preferred residential area of Delhi and nearby townships.

Dwarka sub city is known for its wide and well laid road network that easily connects to other parts of the Capital City. Unlike places like Gurgaon or Noida, Dwarka was mainly developed as a primary residential township; however, it also has its share of commercial complexes that cater to the business needs of people as well as well-structured shopping arcades, Restaurants and eating joints, departmental stores that cater to all the daily needs of the residents.

The Dwarka sub city offers essential facilities and services such as Hospitals, Educational Institutes, Safety and Security. The only hitch is the drinking and potable water which is a concern created by the Delhi Jal Board and DDA who have not been very organised in their distribution of water; however, this region is still better off in terms of water availability compared to the other parts of the NCR towns including Gurgaon and Noida.

The planned structure of Dwarka includes a well-established and self-contained community centre for each of the respective residential sectors that have been

designed to accommodate a population of about 30,000 residents each. Each Sector is bounded on all sides by corridors of roads measuring 45 m and 60 m wide. Each Sector has its own network of cycle tracks and pedestrian pathways that links the housing societies and their facilities within each sector. The Dwarka Forum' is a registered forum that assists in connecting a large number of residents, RWA representatives and CGHS Representatives who play very crucial roles in the administration and upkeep of the Housing Societies. All concerns pertaining to the Societies are discussed and solutions are offered through representation and RTI.Dwarka sub city is located very close to the Indira Gandhi International and Domestic Airports. It borders the National Highway – 8, Najafgarh Road, Pankha Road, Outer Ring Road, and the Rewari Railway link. Places situated close to this sub city include Bijwasan, Delhi cantonment and Janakpuri residential zones, Najafgarh, Palam Vihar, Vasant Kunj, Vasant Vihar, Vikas Puri, Westend and Gurgaon.

Recently a Second Diplomatic enclave has been proposed and accepted to be developed as part of the Dwarka Phase 2 in the near future. This sub city is easily accessible via the Delhi Metro Link which connects 10 major Metro Stations [2 under construction] located in 10 different Sectors to the other parts of the City including Gurgaon and Noida. It also showcases a robust and well connected road network that links a 45 m wide road that connects Pankha Road to Dwarka if entering from the Northern side. This was done by partly covering the Palam drain and constructing a road line over it. If one is entering from the west, a 60 m wide road connects the sub city to Najafgarh Road. If one is entering from the east, a 45 m wide road connects through the Cantonment area with a flyover that runs near Palam. If one is entering from the southeast, a 60 m wide road connects Dwarka from NH-8 through a rail underpass. There is also a special metro line known as the 'Airport Express line' that connects Dwarka to the Indira Gandhi International Airport.

Figure 14 – Dwarka aerial view

Source:https://www.dwarkaapartment.com/blog-post/one-best-sectors-dwarka-live-affordable-price

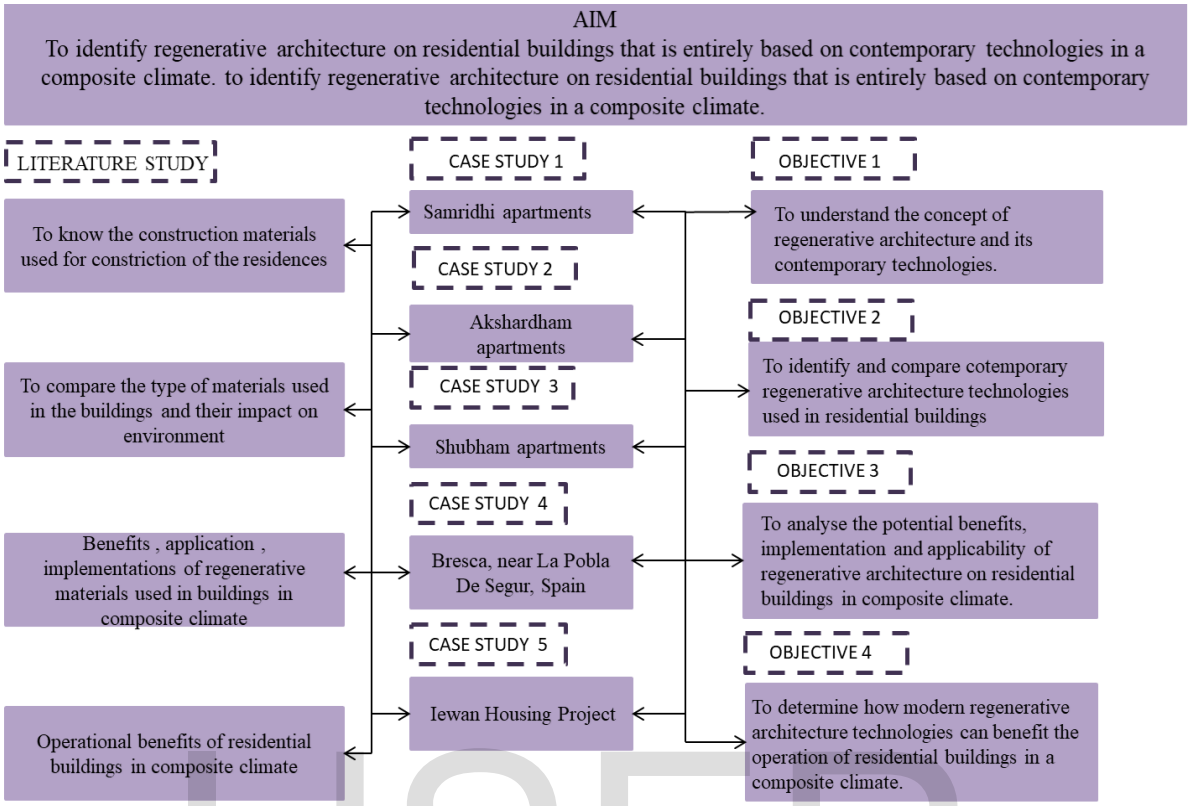



Table 16
Case study parameters

| S. No. | Parameters identified | Case study | Purpose of study | Types of user | Expected Deliverables |
|---|---|---|---|---|---|
| 1 | Construction materials used<br>Impact on surrounding environment<br>Carbon footprint | Akshardham apartments | Materials used<br>Carbon footprint<br>Environmental impact | All age group | Able to understand how materials leave impact on the environment |
| 2 | Construction materials used<br>Impact on surrounding environment<br>Carbon footprint | Samridhi apartments | Materials used<br>Carbon footprint<br>Environmental impact | All age group | Able to understand how materials leave impact on the environment |
| 3 | Construction materials used<br>Impact on surrounding environment<br>Carbon footprint | Shubham apartments | Materials used<br>Carbon footprint<br>Environmental impact | All age group | Able to understand how materials leave impact on the environment |

Table 17
Literature and case study parameters

| | Parameters | Literature study | Case study | | |
|---|---|---|---|---|---|
| | | | Shubham apartments | Akshardham apartments | Samridhi apartments |
| Objectives 1 To understand the concept of regenerative architecture and its contemporary technologies. | Nature of Materials used | The nature of material used in residential buildings | - | - | - |
| | Impact on environment | How do materials react towards environment used in residential buildings | - | - | - |
| | Timeline | The developmental timeline of materials that impact the environment. | - | - | - |
| Objective 2 To identify and compare cotemporary regenerative architecture technologies used in residential buildings. | Comparison in environmental impact of materials | How much do materials react and give back in the environment | - | - | - |
| | How much is the carbon footprint of each of the materials used | What is the carbon footprints of different materials according to the previous studies | - | - | - |
| Objectives 3 To analyse the potential benefits, implementation and applicability of regenerative architecture on residential buildings in composite climate | Benefits of materials towards environment used in residential buildings | How do these materials benefit the environment in terms of lowering their impact on environment. | - | - | - |
| | How is regeneration implemented on environment used in residential building | Regenerative architecture implementation on residential buildings in composite climate | - | - | - |
| | Application of materials in buildings that are used in terms of regenerating buildings. | The developmental timeline of materials that impact the environment. | - | - | - |
| Objective 4 To determine how modern regenerative architecture technologies can benefit the operation of residential buildings in a composite climate. | Operational impact on residential buildings in composite climate | How do residential buildings operate in terms of the materials used that have lower impact on the environment. | - | - | - |

Table 18
Case study chart

| S.NO. | PARAMETERS | SHUBHAM APARTMENTS | AKSHARDHAM APARTMENTS | SAMRIDHI APARTMENTS |
|---|---|---|---|---|
| 1. | Location | Sector 7 extension , Pocket 4 , sector 12 , Dwarka , Delhi , 110078 | Pocket 3 , sector 19 , Dwarka ,110075 | Sector 18 dwarka |
| 2. | Built by | Delhi development authority (DDA) | Delhi development authority (DDA) | Delhi development authority (DDA) |
| 3. | Building height | 12M | 12M | 12M |
| 4. | Housing typology | High income group (HIG) | Medium income group (MIG) | Low income group (LIG) and High income group (HIG) |
| 5 | Year built in | 2004 | 2000 | 2013 |
| 6 | Configuration | 3BHK , 4BHK | 1BHK,3BHK,1BHK VILLA , 3BHK VILLA , PLOTS | 1BHK , 3BHK |

| S.NO. | PARAMETERS | SHUBHAM APARTMENTS | AKSHARDHAM APARTMENTS | SAMRIDHI APARTMENTS |
|---|---|---|---|---|
| 1. | Site area | 7 Acre | 5 Acre | 7 |
| 2. | Area of 1rk | | 485 sq.ft. | - |
| 3. | Area of 1bhk house | - | 500.00 sq.ft | - |
| 4. | Area of 2bhk house | - | 1,100 sq.ft. | - |
| 5. | Area of 3bhk house | 1300 Sq-ft | 1500.00 sq.ft | 1800 sq.ft. |
| 6. | Area of 4bhk house | - | - | - |
| 7. | Total towers | 6 | - | 6 |
| 8. | Total units | 305 | | 220 |

## 3.1Shubham apartments (Case study 1)

Location: Shubham Apartments Pocket 4 Sector 12 Dwarka, Pocket 3, Sector 12 Dwarka, Dwarka, Delhi

Project Introduction: Shubham Apartment is a one-of-a-kind residential property in Dwarka Sector 12, Delhi. The project provides numerous advantages, including a prime location, a comfortable and lavish lifestyle, excellent amenities, a healthy environment, and a high return.

Builder Information: DDA constructed Shubham Apartment. It is a prominent group in the Delhi real estate market. This builder group's team is well-known for its superior work and on-time delivery of high-end Residential Apartments built precisely in accordance with the pre-defined specifications.

Units and interiors: Shubham Apartment has a variety of 2 and 3 bedroom apartments. The size of the area included in this property varies according to the number of bedrooms. Shubham Apartment has four floors and is spread out over a large area. Shubham Apartment's master plan is designed in such a way that these apartments have plenty of space and proper ventilation in every room. The interiors are exquisitely designed, with designer tiled floors, granite counter slabs in the kitchen, modern sanitary fittings in the bathroom, and large windows to allow in natural light.



Comforts and Amenities: Shubham Apartment provides the following amenities: Play Area, Wifi, Gated Community, Maintenance Staff, Pucca Road, and Security. All of these features add up to a plethora of options for unwinding, revitalising, and savouring at home. Aside from that, appropriate security devices are installed to ensure the residents' safety 24 hours a day, seven days a week.

Orientation of the façade:

Balconies are facing towards North – East and South – West direction
Connectivity:

- Only 12 km from IGI Airport
- Nearest railway station is only 5 km away at Palam
  Delhi Cantt Railway Station is 7 km away
- The nearest commercial hub from Dwarka Sector-12 is Cyber City, Gurgaon, located at a distance of 17 km
- Only 5 km from the upcoming Dwarka Expressway


Figure 15 - Site plan of Shubham apartments


Figure 16 – Shubham apartments view

Materials used on external façade:

I. Clay brick wall

Clay Brick is also one of the oldest building materials and has been used in early civilizations. It is very easy to produce, resistant, and durable to all weather conditions. Just like Stone, many structures produced with Clay Brick centuries ago are still standing strong to this day. Its production is very simple; it is simply mixing clay and water. Averaging on 345kg embodied carbon per $m^3$

II. Rcc reinforced structure

Concrete has a low tensile strength, and are usually reinforced by steel bars inside to make is suitable for buildings. Reinforced concrete is the most common material used today for constructing the foundation stages of a building (walls, foundation, columns, etc.) With an average of 635kg embodied carbon per $m^3$

III. Steel railings

It's very flexible in design, affordable, and strong, but the carbon footprint that is produced from the manufacturing process to delivering is immense. With another significant jump from Glass, it carries on average 12090kg of embodied carbon per $m^3$.

IV. Glass

Glass is by far a building material that we see the most today; it exists in pretty much every single building on the planet. There are laws that require structures to have a certain percentage of natural light to enter into it, make Glass a must use material. Unfortunately, Glass on average produces 3600kg embodied carbon per $m^3$

## 3.2 Akshardham Apartments (Case study 2)

DDA Akshardham Apartments is a DDA-completed premium residential property. Strategically located in Sector 19, Delhi. The project boasts superior lifestyle amenities, a convenient location, and a variety of thoughtfully designed 1 BHK, 2 BHK, and 3 BHK units. DDA Akshardham Apartments features cutting-edge Apartments that are sure to provide you with a superior lifestyle..

DDA Akshardham Apartments is located in Dwarka Sector 19, Pocket 3, and Delhi, INDIA. one of the most sought-after addresses in Delhi The area is well connected to hospitals, recreation areas, and shopping malls, among other things. Staying in these Apartments allows residents to maintain a healthy work-life balance.

Comforts and Amenities:
The project consists of a meticulously designed array of Apartments starting at 500 sq.ft. And a maximum area of 1500 square feet. Landscaped Garden, Rain Water Harvesting, Gated Community, Maintenance Staff, 24Hr Backup Electricity, and Security are some of the most notable amenities available as part of this project. DDA Akshardham Apartments is approved by almost all of the city's top banks, making it easy to obtain a housing loan. These houses, which have been approved by the city's development authority, are ideal for people looking for a stress-free lifestyle.


Figure 17 – views of Akshardham apartments

Materials used on external façade:

I. Clay brick wall

Clay Brick is also one of the oldest building materials and has been used in early civilizations. It is very easy to produce, resistant, and durable to all weather conditions. Just like Stone, many structures produced with Clay Brick centuries ago are still standing strong to this day. Its production is very simple; it is simply mixing clay and water. Averaging on 345kg embodied carbon per $m^3$

II. Rcc reinforced structure

Concrete has a low tensile strength, and are usually reinforced by steel bars inside to make is suitable for buildings. Reinforced concrete is the most common material

used today for constructing the foundation stages of a building (walls, foundation, columns, etc.) With an average of 635kg embodied carbon per $m^3$

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## 3.3 Samridhi apartments (Case study 3)

Introduction: Samridhi Apartment is a sprawling luxury enclave of magnificent Apartments in Delhi, elevating the contemporary lifestyle. These Residential Apartments in Delhi offers you the kind of life that rejuvenates you, the one that inspires you to live life to the fullest. Samridhi Apartment in Dwarka Sector 18 is meticulously designed with unbound convenience & the best of amenities and are an effortless blend of modernity and elegance. The builders of Samridhi Apartment understands the aesthetics of a perfectly harmonious space called 'Home', that is why the floor plan of Samridhi Apartment offers unique blend of spacious as well as well-ventilated rooms. Samridhi Apartment offers 3 BHK luxurious Apartments in Delhi. The master plan of Samridhi Apartment comprises of unique design that affirms a world-class lifestyle and a prestigious accommodation in Apartments in Delhi.

Amenities: The amenities in Samridhi Apartment comprise of Car Parking and 24Hr Backup Electricity.

Location Advantage: Location of Samridhi Apartment is a major plus for buyers looking to invest in property in Delhi. It is one of the most prestigious addresses of Delhi with many facilities and utilities nearby Dwarka Sector 18.

Figure 18 – Samridhi apartments

Materials used on external façade:

I. Clay brick wall

Clay Brick is also one of the oldest building materials and has been used in early civilizations. It is very easy to produce, resistant, and durable to all weather conditions. Just like Stone, many structures produced with Clay Brick centuries ago are still standing strong to this day. Its production is very simple; it is simply mixing clay and water. Averaging on 345kg embodied carbon per $m^3$

II. Rcc reinforced structure

Concrete has a low tensile strength, and are usually reinforced by steel bars inside to make is suitable for buildings. Reinforced concrete is the most common material used today for constructing the foundation stages of a building (walls, foundation, columns, etc.) With an average of 635kg embodied carbon per $m^3$

III. Steel railings

It's very flexible in design, affordable, and strong, but the carbon footprint that is produced from the manufacturing process to delivering is immense. With another

significant jump from Glass, it carries on average 12090kg of embodied carbon per $m^3$.

IV. Glass

Glass is by far a building material that we see the most today; it exists in pretty much every single building on the planet. There are laws that require structures to have a certain percentage of natural light to enter into it, make Glass a must use material. Unfortunately, Glass on average produces 3600kg embodied carbon per $m^3$

# CHAPTER 4
# CONCLUSION

Regenerative structure is the practice of engaging the natural international because the medium for, and generator of the structure.
Regenerative structure has focuses; it is a structure that specializes in conservation and overall performance via a targeted reduction at the environmental effects of a constructing.
Regenerative structure is the practice of attractive the natural international because the medium for, and generator of the structure_ It responds to and makes use of the dwelling and natural structures that exist on a website that grow to be the `` constructing blocks '' of the architecture.
It is embodied inside the fabric selection, decreased strength consumption, and clever layout The 2d, extra profound piece of regenerative structure is the treatment of the environment as an same shareholder inside the shape It is a exercising that employs full and complete facts of herbal and living structures in the layout of a structure.
In this dissertation attempt is made to severely overview the modern technology in regenerative structure and applicability of identical in composite weather area. All the issues discussed above can be alleviated by incorporating regenerative architecture in residential buildings as well as it's technologies in composite climate.
The aim of this paper is to identify regenerative architecture on residential buildings that is entirely based on contemporary technologies in a composite climate.
The study is produced from the evaluation of contemporary regenerative architecture technologies in a composite climate particularly for residential buildings. The dissertation discusses approximately numerous contemporary regenerative architecture technologies of residential buildings and their advantages may be highlighted and the way regenerative design strategies are applied to these technologies that increase capability and do much less damage to building.
The literature study states theories and principles of regenerative architecture concept and contemporary technologies that have less damage to environment and increase capability.
As a result, the regenerative concept is gaining traction as it shifts the construction paradigm toward the delivery of a human-centric environment, which, when combined with the circular economy, aims to allow the natural environment to evolve. Bioclimatic Architecture (1906-19), Environmental Architecture (1963-1972), Energy Conscious Architecture (1972-1983), Sustainable Architecture (1980-1993), Green Architecture (1990-2006), Carbon Neutral Architecture (2006-2015), and the last, Regenerative Architecture is a sense of concepts and approaches in connection with the environmentally friendly concept The regenerative approach seeks to improve the living quality and community equity by promoting a healthier and more resilient way of life.

Bioclimatic is a response to environmental and climate problems, whereas Green Building and Sustainable Development are solutions to more complex and integrated technical-environmental issues Gwen the deterioration of environmental conditions as evidenced by an increasing number of disasters, the concept of resilience emerges Natural conditions that are unfavorable are addressed by emphasising the significance of the presence of natural elements.

Regenerative architecture (which extends beyond the scope of sustainable design) is regarded as the highest architectural design concept in terms of positive productivity toward the environment, whereas sustainability aims to be neutral, implying less harm to nature and the environment.

Factors that shift building energy from net-zero to near-zero include unusual weather that necessitates additional heating and cooling energy consumption, as well as lower-than-average solar and wind energy, which can transform net-zero energy - operating buildings into near-net-zero-energy buildings.

The climate, ecosystems, and human life have a synergistic relationship, strategies to address the causes and impacts of climate change may be found in managing local microclimates as a way to reduce and produce energy, eliminate and absorb emissions, combat biodiversity loss, and promote people's lives in outdoor spaces. Climate change, as well as the effects of Urban Heat Island, is thermally stressing the building stock, resulting in an increase in energy consumption used to cool internal spaces.

New technologies make it possible to revise traditional construction materials and techniques for reviving renewable and regenerative building materials like straw; clay, and wood-based solutions EcoCocon is a regenerative example of a prefabricated wall panel made of locally sourced straw insulation, FSC-certified wood-stud structure, and wood fiberboard exterior cladding. The interior panel surface is now ready for clay plastering the product has been certified by the Passive House Institute in Germany and the Cradle-to-Cradle Product Innovation Institute, indicating that it is suitable for highly energy-efficient construction and is recyclable.

Regenerative building materials and products are intended to safeguard and expand clean water resources (as a basis for social and environmental justice). The use of such products also results in chain partnerships with the goal of validating each intermediary in a manufacturing process.

Flexible construction systems can facilitate structure dismantling and; as a result, the recovery, upgrading, modification, or transformation of building materials The goal of the regenerative design framework is to address building products, optimise the material selection process, and integrate certified products into buildings to increase their value. Regenerative building materials and products are intended to safeguard and expand clean water resources (as a basis for social and environmental justice). The use of such products also results in chain partnerships with the goal of validating each intermediary in a manufacturing process. The use of such products also results in chain partnerships with the goal of validating each intermediary in a manufacturing process. The use of regenerative materials, whether biological or technological, must be accomplished without sacrificing quality Particular consideration must be given to

fire safety, embodied energy and carbon content, as well as the structural, mechanical hydrothermal, and acoustic performance of the materials used

A regenerative building and the regenerative design process not only restores but also improves the surrounding natural environment by enhancing the quality of life for biotic (living) and abiotic (chemical) components of the environment The regenerative design process promotes the pattern of relationships between the physical, built, and natural environment The laws of heat transfer, thermodynamics, and material performance in a harsher climate determine overall system design and equipment selection versus a milder climate.

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