The assessment of challenges and risks associated with practising green transformation of the construction industry in Rajasthan, India.

Master Thesis

International Master of Science in Construction and Real Estate Management

Joint Study Programme of Metropolia UAS and HTW Berlin

From

Kuldeep Anand

S0576647

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1st Supervisor: Sunil Suwal

2nd Supervisor: Prof. Dr. Dieter Bunte

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Conceptual Formulation
Master Thesis for Mr Kuldeep Anand
Student number S0576647

Topic: The assessment of challenges and risks associated with practising green transformation of the construction industry in Rajasthan, India.

Background

The motivation towards writing this master thesis is eight years of professional experience that brought the fortune to associate with some multifarious projects in Infrastructure, Industrial, Commercial, Residential and Integrated Township. Learning various conventional aspects of the project execution and supervision, various challenges and shortcomings faced by the construction professionals and the industry were witnessed. Some examples are higher waste generation and lower efficiency, failure of some infrastructure projects in terms of planning, execution and feasibility, decrease in building occupancy and performance, poor construction practices and ignorance of environmental factors which further causes a potential threat to the environment and economy. These issues are commonly shared by several nations. Therefore, there is a strong need for a holistic and workable approach to promote the green transformation of the construction industry to drive towards a better planet for generations. Several initiatives and developments are being done on a global scale to promote green construction practices but still, the transformation of the global economy into a sustainable green economy is a theoretical concept.

Germany has been the first nation, which has demonstrated to the world that the green transformation of economies is no longer a theoretical concept. Several nations have put the green economy to the test but Germany is the nation, which could venture down this path with great commitment and earned universal recognition (Buehler et al., 2016). The World spectates the transformation of the German economy, where the adoption of energy concept document by the federal government in 2010, energy tax reforms, renewal of infrastructure and replacement of out-dated industrial facilities renewable-energy promotions, green infrastructure development and sustainable transportation systems provided some valuable insights and new trends that could change the world. (Notaras, 2010).

Rajasthan is a state of India, which is in known for its Vernacular architecture reflects the environmental realities. Traditional architecture is the outcome of centuries of optimization in climate consideration, natural resources, material use and building science (Saini et al., 2017). In the present scenario the state and the Indian government have made some policies and strategies to practice sustainability in the construction industry while on the ground level; these are proving to be just official formalities and marketing gimmicks. Significant work is required to be done in this segment. With this academic assignment, the focus will be on assessing the present policies and challenges associated with them. Various policy documents, development reports, journals followed by some market researches will be studied. German green transformation model will serve as a

principal guideline for this study in addition to this, the study of vernacular architecture will help to get an insight of climatic and technological limitations of the past simultaneously opening the doors for possibilities of revival of traditional practices (Saini et al., 2017). This thesis while providing a assessment of the present scenario of green and sustainable construction practices and will aim to come up with the development of a framework capable of facilitation handling risks and challenges, further leading the evolution of industry towards smart, optimized, innovative and sustainable constructions practices in Rajasthan. Moreover, this thesis will be an effort towards venturing down the path of the green transformation of economies.

Research Objectives

The research objectives of this study are:

1. To assess the policies and initiatives adopted by the government towards sustainable construction practices.
2. To analyse the construction market of Rajasthan for materials, technology, workforce and awareness.
3. To evaluate how Rajasthan could get benefit from the German model of green transformation.
4. To develop a proposal for a framework with possibilities of addressing the challenges and risks associated with practising green transformation of the construction industry in Rajasthan.

Research questions

The research questions, which are proposed to be answered with this study, are:

1. What aspects of vernacular architecture and indigenous designs are helpful to develop the climatic and technological approaches needed for Rajasthan to control the microclimate around the buildings while enhancing the utilization of regional methods and materials?

2. How Rajasthan as a state could take advantages by adoption and customization of national green building policy, Energy Conservation Building Code by the Bureau of Energy Efficiency and various rating systems to make green buildings, affordable green homes and sustainably built communities a foundational part?

3. What factors of German Model of green transformation and energy concept document can help Rajasthan in developing a thoughtful strategy to increase natural resource efficiencies, decrease carbon emissions and to create opportunities for market transformation?

4. How a meaningful regulatory framework can be developed which could efficiently implement, assess and control the developed policies at the state level ensuring the feasible environment for industry professionals to practice green construction?

5. How adoption of Building Information Modelling could help Rajasthan to shape its future with green building infrastructure achieving economic development and sustainability goals?

6. What initiatives could play a crucial role in creating opportunities for market to transform, make greens building affordable and encourage people in making smart investments in green building technologies to ensure greater participation?

Methodology

The proposed methodology for this study consists following inclusions:

1. Conduct a review of the pieces of literature, policy documents, development reports, journals and by-laws of Rajasthan.
2. Research on German model of green transformation and other successful models in sustainable construction practices.
3. Collect information on working of government departments and their mutual coordination.
4. Conduct market research to explore the present condition and possibilities for green building materials, technology and skilled workforce.
5. Conduct questionnaire survey to provide an assessment of awareness & resources among the people and professionals, operation and maintenance of certified green building projects and possibilities of building information modelling in Rajasthan. This collection of data will further help in formulating the framework proposal.

Resources

- Literature & academic research papers
- Policy documents
- Interviews, surveys, case studies
- Right to information Law
- Data and information collection
- Market Research
- Internet

Signature of the First Supervisor

Signature of the Second Supervisor

Sunil Suwal
sunil.suwal@metropolia.fi

Abstract

Increased resource depletion and growing greenhouse gas emissions are to blame for the majority of present environmental damage. There has been an increase in average temperature and a drop in air quality as a result of this degradation. As a construction company moves through its lifespan, it consumes a tremendous number of natural resources. Construction is heavily reliant on the availability of basic materials. People all across the world are responding to this by creating environmentally friendly technology. India has a long-term vision for a green economy. As part of this study, we analyze how India's historical perspectives and vernacular architectural traditions link to present environmental efforts. The report's literature review highlights India's green transformation's five pillars and four facilitators. Rajasthan, India's biggest state, is well-represented in the study, as is the state's contribution to the overall objective of greening economy of the country. Following the research, a case study of Germany's greening efforts was carried out as a follow-up step. Analysis of possibilities and challenges in five key categories: social, technical, economic, environmental, and political, is provided by the STEEP analysis framework. To summarize a company's strengths, weaknesses, opportunities and threats, a SWOT analysis is utilized. Conducting extra study on a case set in a comparable context is important in order to make recommendations more relevant. Research on Germany's model for green transformation is conducted to identify strengths and possibilities, as well as risks, that may be used to improve the advice given in a particular context. This research examines how to use strengths and opportunities while overcoming defects and threats to make recommendations more specific, meaningful, and context-relevant. In order to arrive at some conclusions, we combined the information from the two investigations, the case study and the literature review. There are recommendations for the government, investors, businesses, and citizens of Rajasthan at the end of the study.

Keywords: Green transformation, Green economy, Green finances, Green Building Technology, Sustainable construction, STEEP analysis, SWOT analysis, Environmental degradation, Energy crisis, GHG emissions, Climate change, Energy efficiency code, Energy concept, Carbon footprint.

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List of Abbreviations

BIP	Bureau of Investment Promotion
CAGR	Compound annual growth rate
C&D	Construction and demolition
COP26	26th Conference of Parties
CO2	Carbon dioxide
CSR	Corporate social responsibility
EU	European Union
ECBC	Energy Conservation Building Code
FAR	Floor area ratio
GBC	Green Building Council
GDP	Gross domestic production
GHG	Green house gasses
GHS	Group housing scheme
Gt	Giga tonnes
GSDP	Gross state product
HFT	Heavy Freight Truck
ICE	Internal combustion engines
IPA	Individual parcel assessments
IPCC	Intergovernmental Panel on Climate Change
LCV	Light Commercial Vehicle
LEED	Leadership in energy and environmental design
INDCs	Intended nationally determined contributions
ISO	International Organization for Standardization
JNNSM	Jawaharlal Nehru National Solar Mission
MFT	Medium Freight Truck

MSME	Medium-sized enterprises
MNRE	Ministry of New and Renewable Energy
NDC	Nationally Determined Contributions
NBC	National Building Code
PAT	Perform, Achieve, and Trade scheme
POS	Point of Sale
PWD	Public Works Department
RE	Renewable energy
RIPS	Rajasthan Investment Promotion Scheme
SDGs	Sustainable Development Goals
STEEP	Social Technical Economic Environment Political
SWCS	Single-window clearance system
SWOT	Strengths Weakness Opportunities Threats
SC	Supreme court
UDH	urban development and housing
UNEP	United Nations Environment program
WECD	World Commission on Environment and Development

1. Introduction

1.1. Background

Over the course of the last several decades, rapid economic expansion, coupled with rapid population increase and urbanization, has led to the rapid depletion of natural resources. This trend has been exacerbated by climate change. A large amount of environmental deterioration has occurred as a direct consequence of the heightened rate of resource depletion and the increase in emissions of greenhouse gases. This deterioration has led to climate change, an increase in the average temperature, and a decline in the quality of the air we breathe.

The construction industry is one of the most significant consumers of natural resources such as water, electricity, and several other raw materials. During the course of its life cycle, the industry goes through three distinct stages: building, maintenance, and de-construction. Each of these stages results in the production of a significant amount of waste and pollution. In addition to other raw resources, it is estimated that this industry uses up around 25 percent of the available water and between 35 and 40 percent of the available energy. In addition to this, it is responsible for the production of 40 percent of the world's garbage and 35 percent of the greenhouse emissions. The numerous difficulties and shortfalls that the construction industry and its experts are currently contending has served as the inspiration for the production of this master's thesis.

In light of the rapid acceleration of environmental deterioration, it is urgent that steps be taken to ensure the most efficient utilizations of natural resources, the lowest possible generation of trash, and the lowest possible level of pollution. The use of environmentally friendly construction principles is one way to mitigate the effects of these issues while also inspiring current and future generations to create a more sustainable natural environment.

Several other countries all around the world struggle with the same problems. As a result, there is a pressing requirement for an approach that is both comprehensive and feasible to encourage the green transformation of the construction sector in order to push towards a better world for generations to come. However, the transformation of the global economy into a sustainable green economy is still a concept that exists only

in the realm of theory, despite the fact that there are several projects and advancements being done on a worldwide scale to promote green building techniques.

Germany is the first country in the world to show that the green transformation of economies is no longer only a theoretical idea. This demonstration took place in Germany. Several countries have put the concept of a green economy to the test, but Germany is the only one that has been able to pursue this course of action with the kind of dedication that has garnered it worldwide acclaim (Buehler et al., 2016). Renewable energy promotions, green infrastructure development, and sustainable transportation systems have provided some valuable insights and new trends that could change the world. These reforms, along with the adoption of an energy concept document by the federal government in 2010, energy tax reforms, renewal of infrastructure and replacement of out-of-date industrial facilities have attracted the attention of the rest of the world. The world is watching the transformation of the German economy. (Notaras, 2010).

The state of Rajasthan in India is well-known for the vernacular architecture that it possesses, which reflects the natural conditions of the region. The optimization of climate, natural resources, material utilization, and construction science that went into the creation of traditional architecture took hundreds of years and many centuries (Saini et al., 2017). At the moment, both the state and the federal government of India have formulated a number of guidelines and plans in order to promote environmentally responsible practices in the building sector. Nevertheless, in order to realize the vision of India's green economy, these initiatives will need to be bolstered and improved. There is a significant possibility that the state will become a leader in the Green Transformation Movement for other states in India, and this potential is enormous. This section has a substantial amount of unfinished business to attend to. The evaluation of existing policies and the difficulties that come along with them is the primary emphasis of this academic project. The sources that were used to compile this study include a variety of governmental papers, development reports, journals, and some previous market research. In addition to this study, the German green transformation model is serving as a primary guiding principle for this investigation. In addition, research into vernacular architecture is carried out in order to get an understanding of the climatic and technical constraints that existed in the past, so opening the door to the prospect of the resuscitation of traditional techniques (Saini et al., 2017). This thesis, in addition

to providing an analysis of the current situation of green and sustainable construction practices on the national and state level, seeks to develop a framework and recommendations that are capable of facilitating the handling of risks and challenges, thereby further leading the evolution of industry toward smart, optimized, innovative, and sustainable constructions practices in the state of Rajasthan. In addition to that, this thesis is an attempt to start down the road toward the green transformation of economies.

1.2. Problem Statement

Construction is a major user of water, power, and other natural resources. The industry has three stages: construction, maintenance, and deconstruction. In view of the growing acceleration of environmental deterioration, it's vital to ensure optimal use of natural resources, low waste production, and low pollution. Green construction practices are needed to be developed and implemented to mitigate the risks towards environment and inspire current and future generations to develop a more sustainable natural environment to lead a healthy life and planet.

1.3. Scope of research

The scope of this study is to carry out a comprehensive analysis of the construction industry in Rajasthan to access the present scenario and further possibilities for the expansion of green construction technologies and sustainable practices in the state. the state of Rajasthan's published works of literature, policy papers, development reports, journals, and bylaws. The study focuses on the research of the market to investigate the current state of affairs and the opportunities for environmentally friendly building materials, technology, and skilled labour. Further, gather information on the operation of government agencies and their collaboration with one another and Conducting research on the German model of green transformation model and its various policies which can help Rajasthan to follow the path of becoming a green economy.

1.4. Research Objectives

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1.5. Research Questions

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1.6. Limitations

The limitations of this study include the following points:

1. India is a huge and diversified and so is the Rajasthan it is difficult to study, collect and compile the data form various policy documents, regions and departments.

2. Availability of the data and resources on Rajasthan level as there are limited no of researches and studies available. The government websites are not updated with the recent data.

3. Language barrier was one of the limitations for studying the German model of transformation. Most of the researches and information are in German language.

4. The study is limited to the theoretical approach, field data collection, personal interviews and surveys not conducted therefore non-inclusion's of the practical approach is a limitation

2. Green Transformation: the concept

In recent years, there have been a number of challenges in the world, namely the climate, energy, resources and economic crises. The green economy as concept has emerged as a response to these concerns with an ethical approach that provides vision for growth while protecting the planet's natural resources and environment. It is important to note that making the switch to an eco-friendly economy means moving away from the structure that has permitted and even caused similar crises in the past by developing and implementing the appropriate solutions, methodologies and reformations required to attain a sustainable future for the generations. (Environment, 2017). Green transformation is a novel strategy for assisting economies in becoming green, low-carbon, and resilient. The transition toward carbon-neutral societies and economy and prioritizing the green building practices are illustration of a metamorphosis.

There is not one precise definition for green transformation of the economy; however, the term itself emphasizes the economic aspects of sustainability and also, in terms of the recent UNEP report on the Green Economy, which emphasizes the crucial point that economic development and environmental integrity can be complementary strategies. In addition, the term itself emphasizes the economic aspects of sustainability. (Environment, 2017)

In terms of the recent UNEP report on the Green Economy, which emphasizes the point that economic development and environmental integrity can be complementary. The most important aspect of becoming green is that active development plans need to be put into place in order to drive the shift towards new dynamic environmentally friendly activities. One way to look at this approach is as an active kind of industrial and technological policy. In the latter scenario, however, it is essential to underline that the phenomenon in question encompasses not just manufacturing or industry but also the whole spectrum of economic activities that encourage robust reactions from the private sector. (Environment, 2017)

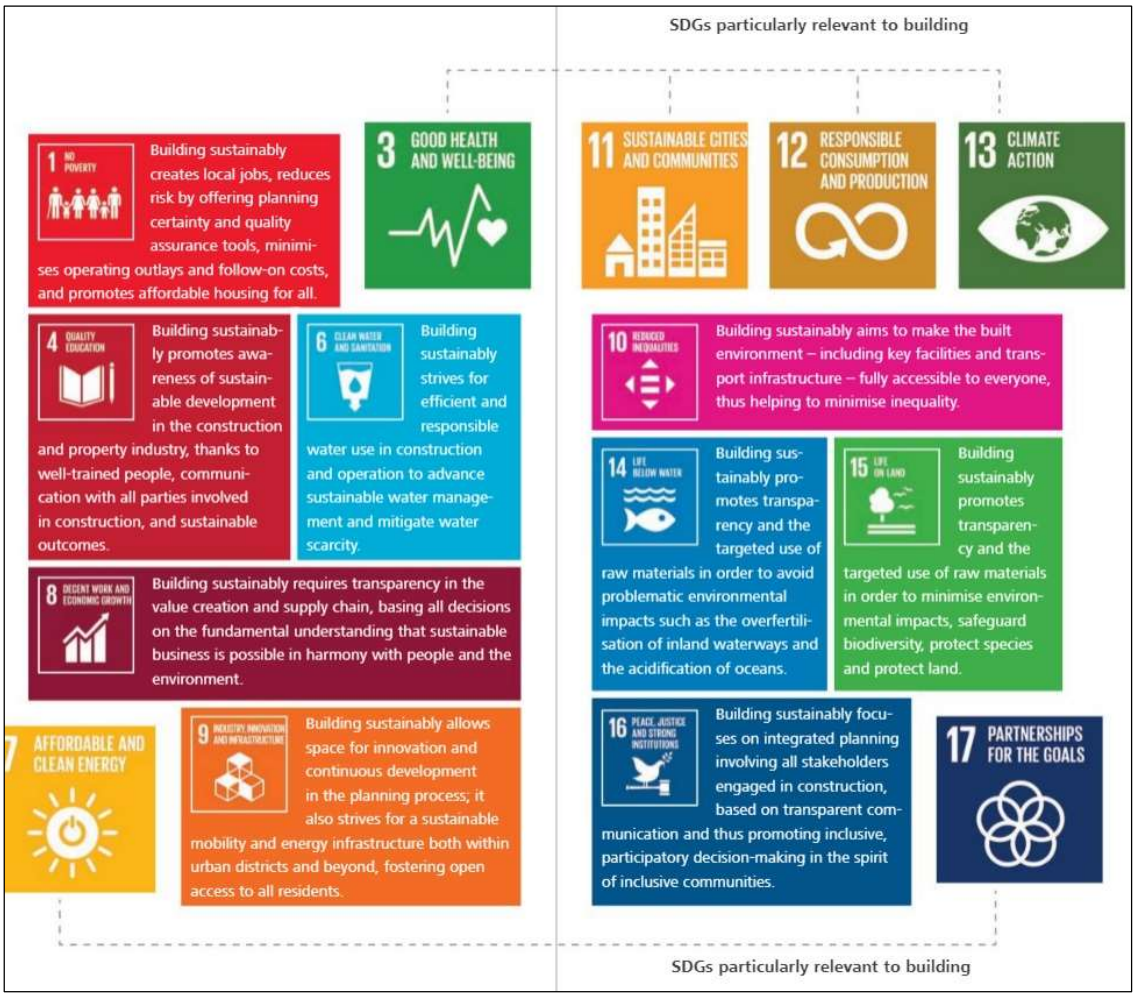

Figure 1: Sustainable development goals and relevancy with construction (Source: DGNB, 2020)

The global challenges like climate change can only be averted if the global economy and behaviours are reformed. The 2030 Agenda for Sustainable Development (Figure1) and the Paris Climate Agreement both have aims that align with one another. As a result, many nations face significant challenges and need a wide range of answers. In order to combine the Sustainable Development Goals (SDGs) and Nationally Determined Contributions (NDCs) in a beneficial manner, an inclusive and sustainable economic model with tangible measures is needed here. While the UN Environment Program (UNEP) first proposed the idea in 2008, it has been actively promoted by the UN alliance Partnership for Action on Green Economy (PAGE) since 2013. As a consequence of the COVID-19 epidemic, the need for a green recovery is high on the world agenda. (giz, 2020)

Sustainable Development Agenda 2030 This resolution marked the first time all 193 UN Member States endorsed a sustainable development action plan. In the preamble, the nations outlined five critical actions Sustainable development addresses today's demands without sacrificing tomorrows. The 17 SDGs and 169 sub-goals (targets) take ecological, economic, and social considerations into account. All governments, stakeholders, communities, enterprises, and organisations were asked to execute this strategy. The SDGs were supposed to make sustainable development more tangible, making it simpler to plan and monitor. First time, anyone worldwide may utilise the same 17 themes as references. They'd speak the same language, so everyone could utilise the SDGs in their own speech and raise awareness of global challenges. Figure 1 shows the SDGs that are related to the buildings and construction industry. (DGNB, 2020)

We inhabit buildings. We work and live there. A building's quality and characteristics affect our health. Buildings interact with their surroundings. Just looking at building facts shows that Transforming our World demands immediate action. Buildings need land and natural resources. Even making construction materials may require non-renewable energy and water, resulting in damaging emissions. Ethical, social, and environmental norms aren't typical. Existing buildings have high energy use and CO2 emissions. Too frequently, structures are demolished, leaving underutilised man-made resources. Greenhouse emissions, raw material shortages, air pollution, soil acidification, and illness are all well-known problems. We're all impacted, but those with minimal tools to defend themselves are severely hurt. Sustainable thinking presents an alternative. We can build our constructed environments so we're comfortable and so they don't hurt others or the environment. We must be honest with ourselves, evaluate the realities, and have the confidence and desire to overhaul the construction business and make sustainability the new normal. (DGNB, 2020)

3. Green India: Vision

India's urbanization and economic development have accelerated at a fast pace. The proportion of floor area of buildings and the amount of energy they use are anticipated to keep rising until at least 2030.The Paris Climate Agreement, signed in December 2015, committed all countries to keeping global warming to 1.5 degrees Celsius by the year 2050. Indian greenhouse gas emissions are 2.46 billion metric tons of carbon, or 6.8% of total world emissions, according to a new report by the Research Institute for Humanity and Nature. International attention has been focused on India's plans to accelerate the country's low carbon development activities and investments over the next 10 years in order to promote a green transition. (www.ETEnergyworld.com, 2021)

At their remote Quad conference, Australia, India, Japan, and the United States agreed to extend global climate action by concentrating on mitigation, adaptation, resilience, technology, capacity-building, and climate financing. The leaders emphasized that the green agenda will be a priority policy. India made great strides toward climate justice in October 2015 when it published its intended nationally determined contributions (INDCs). Reduce GDP emissions by 33 to 35 percent from 2005 levels, expand installed capacity of electric power from non-fossil fuel resources by around 40 percent, and increase forest and tree cover by 2.5 to 3 billion tonnes of CO2 equivalent by 2030 are the goals. The prime minister at the Climate Action Summit in 2019 expanded the initial commitment of 175 GW of renewable energy capacity by 2022 to 450 GW by 2030 in a presentation on renewable energy. (Verghese, 2021)

3.1. Historical perspective

The notion of environmentally friendly buildings is not quite as novel as we now believe it to be. In the beginning of the evolution of housing, people sought refuge from the harsh effects of natural forces such as the sun, rain, and wind by taking refuge in natural features and resources such as trees and caves. Vedic philosophy created various strategies to optimize the utilization of Panch Mahabhuta, also known as the five fundamental elements of nature, such as Jal (water), Agni (fire), Prithvi (earth), and Vayu (wind) and Avkash (ether). These methods were developed on the basis of such

complicated experiences (space). The ancient builders made an effort to create harmony among these five aspects throughout the building design and construction processes. Their goal was to get the most possible benefit from these factors while minimizing any potential drawbacks. They referred to this field of study as Vastushastra. (Saini et al., 2017)

The fundamental idea behind Vastushastra is to get the most possible benefit from nature while minimizing any negative impact on the natural world. It was done so that light and cross ventilation could be provided to rooms that were next to one another by leaving open areas in the centre of a structure. In order to make it easier for the sun's rays to clean the water and the rooms, the water storage and prayer rooms were arranged such that the northeast faced the sun. Heavy materials were used in the construction of the house's south-western section so that it would be resistant to both strong winds and intense rainfall. The kitchen is situated in the south-east corner of the home because this area of the house is subjected to a lower intensity of solar radiation than the rest of the house. As a result, the kitchen does not experience an increase in its average temperature. This is the type of knowledge that was common throughout that historical period. (Saini et al., 2017))

To put it another way, these were the regulations that had to be followed throughout the design and construction of any structure. Our ancestors who built this place had the sincere wish that these guidelines would be strictly adhered to. Because of this, in order to ensure that these rules are followed more effectively, they combined it with fear psychology. They correlated each building rule with a different part of a person's life and stipulated that failure to conform to these norms would result in a decline in health, wealth, or even reputation as a consequence of the displeasure of the nature gods. This was done on purpose to induce terror so that correct construction regulations would be adhered to. It was a remarkable approach to carry out and ensure compliance with the law in the absence of any enforcement or supervising body. (Saini et al., 2017)

3.2. Vernacular architecture: An Inspiration for Modern Green Energy-Efficient Buildings

The architectural and cultural legacy of India is well-known across the world. Understanding the ancient design principle may significantly increase thermal performance and indoor air quality while also saving energy. Monuments built in India's Mughal style are well-known across the globe. Gardens and other outside features were standard features of Indian palaces and monuments. Physical and aesthetic comfort are enhanced by the presence of trees and other greenery surrounding a structure. Passive approaches are used in monumental structures to ensure occupants' comfort in a variety of climates.

As a result of Jali's aesthetic feature, the Taj Mahal and Agra Fort are both more comfortable and ventilated. Step wells were dug to enhance the microclimate of the region and meet the water scarcity, as shown by research conducted in the ancient city of Jaipur. Havelis, traditional Indian residences built to withstand arid conditions, often included courtyards as an integral part of their architectural design. It served as a passive cooling component for the provision of fresh air on a regular basis. An examination of historic buildings, which may serve as a model for more energy-efficient contemporary construction, illuminates old passive approaches for increasing thermal comfort and ventilation. (Saini et al., 2017)

The natural world is reflected in Indian vernacular architecture. Heritage buildings are defined by their architectural merits. Beautiful structures were erected by the Hindus and the Mughals. Climate, material utilization, and building methods have been refined throughout time in traditional architecture. The microclimate of a location and the degree of comfort in a building are both improved by the inclusion of landscaping features such as water bodies and trees in massive structures like temples.

Technology improvement and the growth of urban centres have had a significant impact on energy use in buildings. The country's economic growth depends heavily on the availability of energy. Building and maintaining a comfortable interior temperature with contemporary technology and materials requires a large amount of our national energy. It is critical, in light of today's energy crisis, to revisit the historical roots of architecture and technology in order to restore the level of comfort inside the structure.

Climate-sensitive design is a need of the modern day. Today, most building constructions are built to isolate people from the outside world and need large amounts of energy in order to maintain a comfortable internal atmosphere. Heating and cooling energy usage may be decreased by 50-80% if buildings are planned and constructed with the local microclimate, terrain, and other exterior elements in mind. Climate considerations are being overlooked in the construction of modern structures. Understanding the climatic or technical limits of the past may be gained by studying vernacular architecture. Indigenous architecture has traditionally placed a high value on managing the surrounding environment. The palaces were not the only ones affected by this; the small houses were also an integrated part of this. (Saini et al., 2017)

In the present time the architectural interventions, building materials, and design processes must be carefully examined to reduce energy use, ecological damage, and cost to attain comfort with less traditional energy. Architects and designers do this via solar passive design, renewable energy systems, and natural building materials. Existing structures may be upgraded with energy-efficient and eco-friendly technology to reduce energy usage during design.

Since the CII-Godrej Green Building Council (GBC) began working toward the goal of obtaining the famous LEED certification for their centre in Hyderabad six years ago, the Green Building movement has seen a huge uptick in momentum. The players in the construction sector have become more environmentally conscious as a result of the Platinum Rating awarded to the Green Business Centre building. In today's world, a growing number of businesses and government agencies are giving serious thought to the concept of green buildings. Green buildings are well positioned to achieve astronomical heights, having started off with a modest starting of 20,000 square feet of green footprint in the nation in the year 2003 and predicted to reach a startling 10 million square feet. In the present day, numerous projects such as residential complexes, exhibition centres, hospitals, educational institutions, laboratories, information technology parks, airports, government buildings, and corporate offices are being developed in the country with the implementation of green building technologies.

3.3. Indian economy and green transformation

During the last three decades, the Indian economy has seen a dramatic transformation as a result of the forces of liberalisation and globalisation. The leadership has accelerated these trends by enacting a series of far-reaching reforms, which have led to the establishment of macroeconomic stability, a solid safety net for everybody, and high growth. (Sinha, 2020)

In contrast to Western countries, India's shift to a greener economy does not require paying individuals working in industries that need to be decarbonized while simultaneously upgrading other, more lucrative industries. Also, unlike certain countries in East Asia with upper-middle incomes, India is not currently sufficiently industrialised that the natural transition from manufacturing to services would be enough to lower the carbon intensity of its production. (Sharma, 2022)

India is on the verge of two major changes. It has never been tried before by a country to simultaneously attain higher competitive strength and protracted sustainability. With countries shifting from traditional agriculture to resource-intensive, urban industry, the farm-to-factory development model has been the typical paradigm for economic growth. India needs a new paradigm of growth, one that shifts the country's workforce away from agriculture and toward resource-efficient, global leaders. In addition, these businesses must use the most cutting-edge green technology and business strategies. As a result, India's growth strategy will have to move the country's economy from "the farm to the green frontier”. (Sinha, 2020)

3.3.1. India's Role in the Global Climate Change Crisis

When it comes to the issue of climate change, India is in a category all to itself. It is simultaneously the country with the most citizens at risk from the dangers posed by a changing global climate, the country that will need to make the most significant changes to its agenda if the world is to keep warming to less than two degrees Celsius, and the member of the G-20 that has made the most progress toward meeting its sustainability objectives. (Sharma, 2022)

When it comes to climate change, India's decisions will have a significant impact on the rest of the globe. Indian emissions per capita are among the lowest in the world. However, it will have a far higher impact on future emissions than China since its population is expected to continue to rise and eventually overtake China's in 2025. Between 2013 and 2040, some GDP (Gross domestic production) predictions see the nation growing at a pace substantially above the global average, at approximately 6.5% per year. If this growth is driven by an expanded industrial base and stronger consumer demand, energy consumption and emissions may see a significant rise. (World Economic Forum, 2021)

The Paris Agreement, which was signed in December 2015, made it obligatory for every nation on earth to reduce the average temperature of the planet to 1.5 degrees Celsius by the year 2050. According to research that was published not too long ago by the Research Institute for Humanity and Nature, India is the third-largest emitter of greenhouse gases and is responsible for 2.46 billion metric tonnes of carbon, which is equivalent to 6.8% of the total world emissions. It is of interest to people all over the world to follow India's progress as it works toward its goal of achieving a green transition by intensifying its urgent decarbonization activities and investments within the next 10 years. (Verghese, 2021)

Therefore, India's leadership on the issue of climate change is not just a question of the government honouring its commitments; rather, it is a symbol of the country accepting its place as a responsible global citizen. However, the reality is that India has to ramp up its efforts to reduce carbon emissions while also bearing the massive costs of adaptation. All of this must be done while simultaneously delivering a thorough economic transition that satisfies the hopes and dreams of its youthful people. (Sharma, 2022)

When it comes to the climate catastrophe, India's pledge to reach "Net Zero" emissions by the year 2070 is the equivalent of not just talking the talk but also running the talk. The Indian government said during the 26th Conference of Parties (CoP26) that in order to accomplish this goal, they would use a five-pronged approach that they have dubbed the Panchamrita. These five points of Panchmitra are as follows:

- By the year 2030, India's ability to generate electricity from sources other than fossil fuels will reach 500 gigawatts (GW).

- By the year 2030, India's energy needs will be satisfied by renewable sources for fifty% of the time.
- Starting today and continuing until 2030, India will bring the overall amount of predicted carbon emissions down by one billion tonnes.
- By the year 2030, India will have cut the amount of carbon dioxide emissions produced by its economy by less than 45%.
- Therefore, the objective of Net Zero will be accomplished in India by the year 2070. (Narain, 2021)

The decision to invest in a greener economic growth trajectory will carry with it certain rewards, and it is a sensible political option to make. A more buoyant atmosphere for private investment that may capitalise on this opportunity would make it much simpler to recover from the epidemic and provide for people's livelihoods. This would be an enormous help in both of these endeavours. A commitment to the clean energy transition would encourage investors to perceive a progressive policy environment, which would assist lower investors' perceptions of risk while also unlocking more interest. The revitalization of India's economic narrative might be facilitated by the transformation of some high-emission industries in conjunction with cross-cutting reforms. These changes would act as facilitators for wider and more inclusive growth. Investing in India has the potential to become associated with the urgently required measures to mitigate the effects of global warming. (Narain, 2021)

Moreover, India's unique green economic trajectory will rely on how well these four aspects of commitment, co-benefits, cost, and capital can be incorporated to embrace the sustainable management of other sectors, from transportation, housing, manufacturing to agriculture. It is envisioned that the transition to a greener economy would not act as a drag on national economy, but rather serve as the driving force behind a transformation of the economy that will result in higher levels of both growth and inclusiveness. (Sharma, 2022)

3.3.2. The Current Carbon Footprint of India

Indian greenhouse gas emissions are third in the world after the United States and China. Today, more than 96% of India's greenhouse gas emissions are caused by contributions from five different industries: power, agriculture, industry, transportation,

and infrastructure. For India's transition to net zero, an ambitious effort spanning many decades would be required to overhaul each of these industries. (Narain, 2021)

There are many admirable aspects of India's climate change goals and the wealthy world must now prove that they are serious about reducing emissions. To put it another way, India hasn't been a major contributor to greenhouse gas emissions during the last 150 years, contributing only 4% of the world total from 1870 to 2019. Despite its reputation as the world's third-worst polluter in 2019, China's emissions of 2.88 gigatonnes (Gt) of CO2 in 2018 pale in comparison to those of the world's worst polluter, the United States, which emitted 10.6 Gt. In addition, India has a pressing need to expand the economy and provide enough energy for the country's many millions of residents. (Narain, 2021)

India's use of energy on a per-person basis is now lower than that of the majority of countries, its consumption of resources such as iron is still comparatively low, and its industrial sector is still considered to be relatively under-developed. India, in contrast to wealthy countries with well-established greenhouse gas (GHG) infrastructure, does not yet have a significant portion of its GHG inventory in place. (www.ETEnergyworld.com, 2021). Because of this, India did not need to accept these worldwide objectives to cut our carbon emissions. Even while India has its own unique challenges, the rest of the globe has its own unique challenges as well. However, As India develops, its carbon emissions may also expand, which is something that neither India nor the rest of the world can afford. (Narain, 2021)

Country/region	Unit	2015	2016	2017	2018	2019
China	$MtCO_2e$	11108.86	11151.31	11385.48	11821.66	12055.41
United States	$MtCO_2e$	5665.20	5743.85	5689.61	5892.37	5771.00
India	$MtCO_2e$	3003.07	3076.48	3215.07	3360.56	3363.59
European Union (27)	$MtCO_2e$	3019.49	3364.77	3379.38	3295.53	3149.57
Indonesia	$MtCO_2e$	2067.75	1434.45	1447.22	1692.36	1959.71
Russia	$MtCO_2e$	1602.81	1733.91	1769.68	1868.15	1924.82
Brazil	$MtCO_2e$	1366.89	1455.86	1475.82	1434.51	1451.63

Figure 2: Global CO2 emissions (Source: CAIT, 2019)

Emissions of greenhouse gases (GHG) created by humans are the primary driver of climate change. Only ten countries are responsible for around sixty percent of all greenhouse gas emissions, whereas the one hundred nations with the lowest emissions each contributed less than three percent (Figure 2).

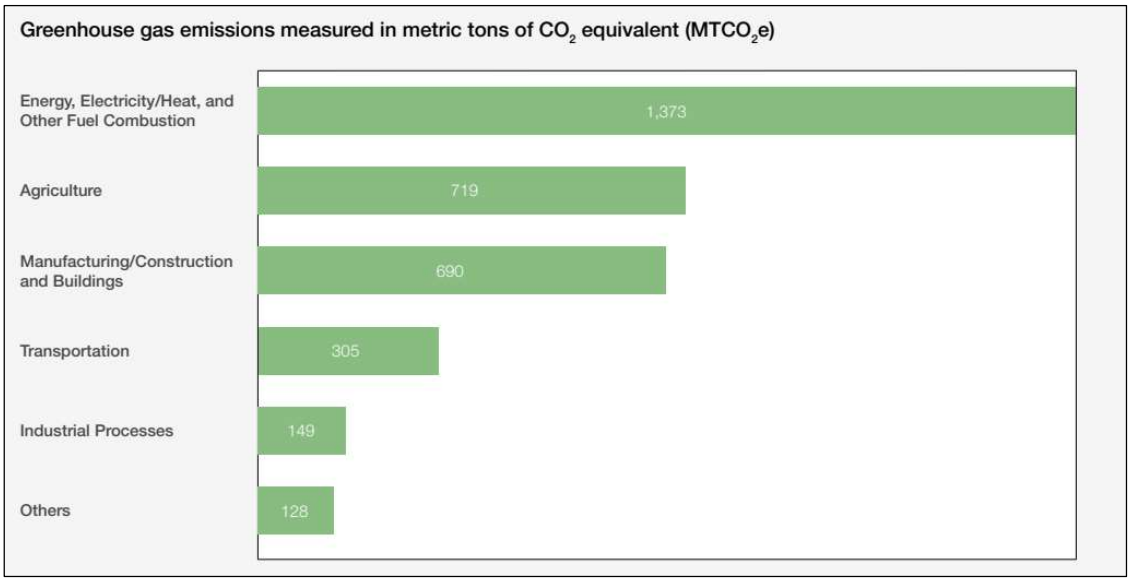

Figure 3 India's greenhouse gas emissions by sector (Source: Narain, 2021)

Figure 3 illustrates the emissions of greenhouse gases by industry. Emissions from energy and agriculture account for more than two-thirds of global greenhouse gas (GHG) emissions. There are three major emitters in the energy sector: transportation, manufacturing, and electricity and heat generation. According to the Intergovernmental Panel on Climate Change (IPCC), a goal of worldwide net zero emissions by the year 2050 is the least necessary to reduce the temperature rise to 1.5 degrees Celsius. To put it another way, a country should not be contributing to the overall amount of greenhouse gases in the air. As of 2030, India aims to reduce its economy's emissions intensity by 45 percent (including CO2 as well as other greenhouse gases). In comparison to the country's prior aim, which was to reduce emissions intensity by 33-35 percent from 2005 levels by the same year, this is a more aggressive plan. (Menon, 2021)

3.3.3. The Blueprint for India's Transition to a Green Economy

In this section, a lay out of a potential sectoral roadmap for India's transition to a net zero economy by the year 2070 is discussed, which simultaneously addresses some of the most vital aspects. The framework consists of five sectoral pillars and four horizontal enablers, all of which are essential to the successful realisation of the vision of a green economy. (Narain, 2021)

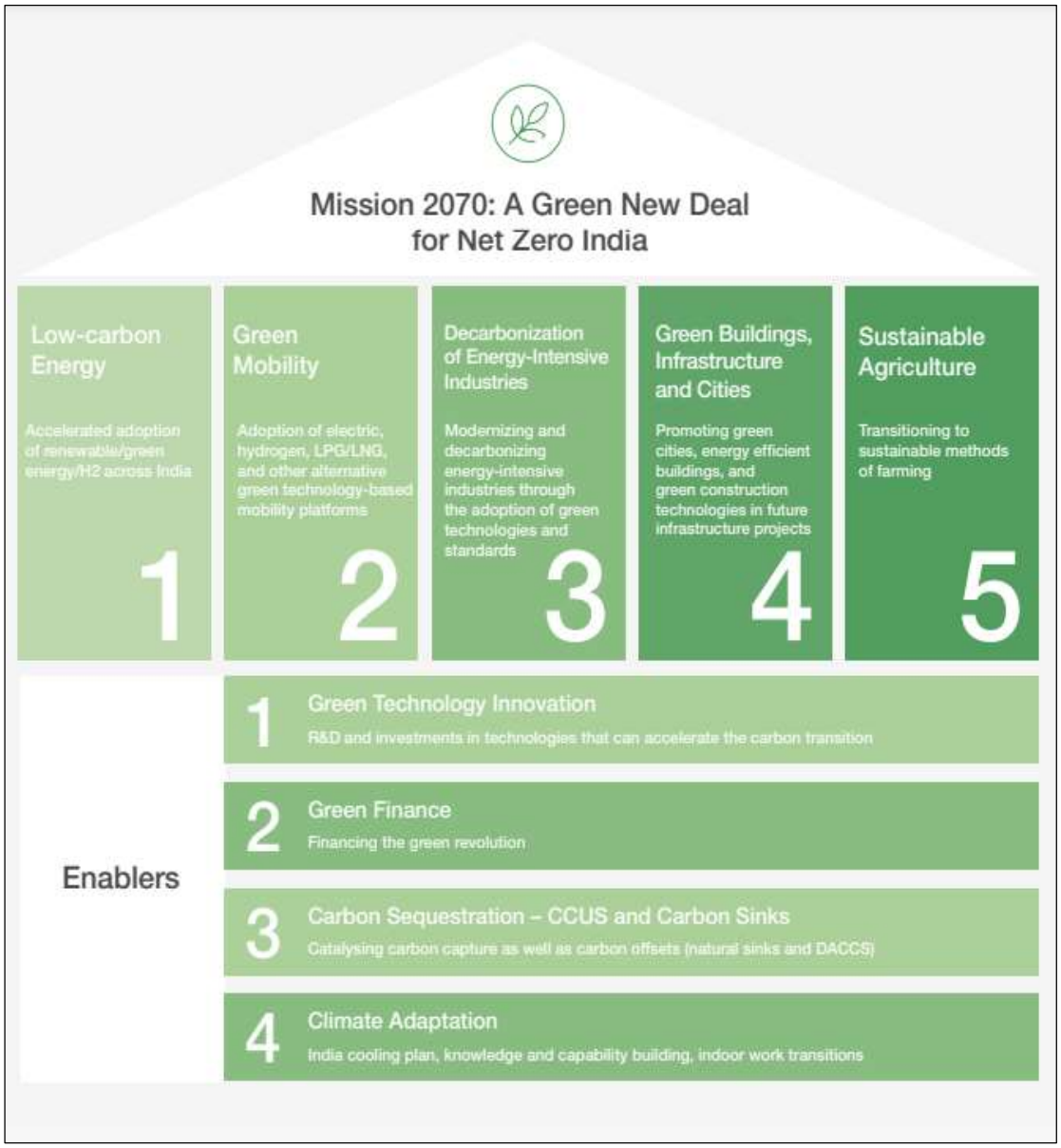

Figure 4: Sectoral Pillars and Cross-Sector Enablers of a Green New Deal for a Net Zero India (Source: Narain, 2021)

The Figure 4 demonstrates that in order to spearheading towards green transformation there are five sectoral pillars and four enablers that cut across sectors needed to be addressed efficiently.

3.4. Five Pillars of green transformation

Over ninety percent of India's greenhouse gas emissions are produced by the country's five primary economic pillars: energy, transportation, industry, infrastructure and cities, and agriculture. As part of its move toward a more environmentally friendly economy, the research indicates that India will have to address these following five pillars.

3.4.1. Low-Carbon Energy- First pillar

India is the third biggest country in terms of the amount of power that it consumes. Approximately forty percent of India's emissions come from the energy sector, which includes the generation of electricity, heat, and the burning of other fuels. Of the country's total fossil CO2 emissions, 65% are caused by the combustion of coal. Oil and natural gas have both been gradually increasing their proportions of India's overall energy supply in recent years. It is anticipated that India's overall economic development and growing per capita income levels would push the country's energy consumption to increase at a compound annual growth rate (CAGR) of between 4% and 5% over the next decade. (Narain, 2021)

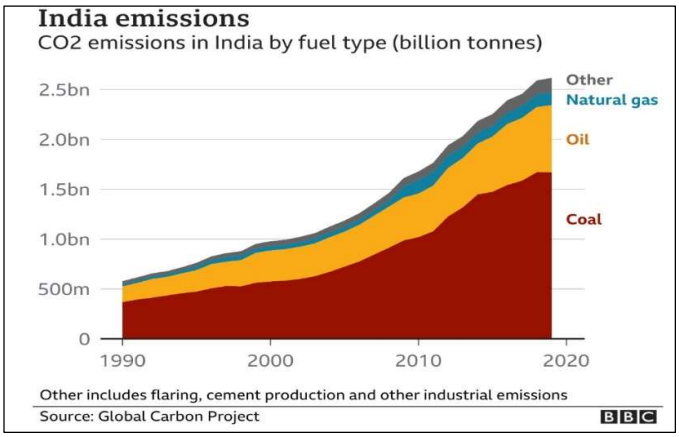

Figure 5: Emissions of carbon dioxide from fossil fuels in India (Source: Menon, 2021)

The government of India has committed to increasing the country's ability to generate electricity from sources other than fossil fuels to 500 gigawatts (GW) by the year 2030. It is now capable of producing around 157GW. In the past, India has set for itself the goal of attaining 175GW by the following year. This objective did not include substantial hydroelectric and nuclear capacity, and it seems as though it will fall short of this target given that it is now barely over 100GW.In order to decarbonize India's energy sector, comprehensive interventions are required across all of the country's fossil-fuel sources (coal, gas, oil). In addition, novel approaches for cutting emissions throughout the process of transferring energy from generators to consumers via transmission and distribution networks need to be developed. (Menon, 2021)

The following strategies must be implemented in order to reduce emissions:

I. Upgrade fossil-fuel infrastructure with renewables

Even if renewable energy sources are now more cost-effective in India than the construction of new coal-fired power plants, the country may yet need the construction of new coal plants in order to satisfy its expanding energy demands. In this context, the shift to green energy in India may be sped up by implementing more advanced renewable solutions (hybrid+ thermal, storage, and packaged solutions). According to current projections, in order for India to reach its goal of reaching net zero by the year 2070, it would need to completely phase out its use of coal power

by the year 2060 and see its capacity for solar and wind power increase from 100 GW today to more than 7,400 GW by the year 2070. This rapid road toward greener alternatives will need significant investment in new energy infrastructure in the coming decades. This is because the electrical grid and fuel supply chains will need to be reconfigured to accommodate new energy flows. (Narain, 2021)

II. Optimize fossil fuel infrastructure performance to lower emissions

The coal-fired power stations and oil refineries of India are the primary contributors to the country's emissions. It is essential to lessen their carbon footprint in order to meet the challenge of maintaining some of this legacy infrastructure for the decades to come. The use of technology will be the most important additional fuel efficiency lever for large-scale fossil fuel facilities that must continue operating until their end of life. Running assets at best-in-class heat rates and yields by means of reliability-centred maintenance and operating parameter optimization, driven by artificial intelligence and machine learning, may have a major influence on decreasing emissions and boosting productivity. In addition, cutting down on energy waste in the distribution network by using digital methods to cut down on aggregate technical and commercial loss, as well as adopting smart grids to anticipate power flows and allow two-way communication with consumers, may contribute to a decrease in emissions. The operation of gas plants may be made possible and carbon emissions from coal can be reduced if peaking reserves are increased throughout the grid. (Narain, 2021)

III. Eliminate inevitable carbon emissions

India's energy sector will continue to produce significant GHG emissions notwithstanding the "optimize and upgrade" measures outlined above. As a result, eliminating all sources of unavoidable emissions is essential. Setting up carbon pricing requirements for corporations and encouraging the use of green hydrogen at commercial sizes will speed up the process. As India proceeds its journey, the support of government policy will be essential for the purposes of redirecting existing investments, raising additional financing, reforming power distribution companies, driving wider electricity market

reforms, coordinating efforts across various regions, states, and municipalities (i.e., the Green Energy Corridor programme). (Narain, 2021)

3.4.2. Green Transport- Second pillar

The transport industry in India is responsible for around 10% of the country's total GHG emissions. 60% of India's ultimate transportation energy usage is expected to come from passenger transport, while 40 % comes from freight transport.

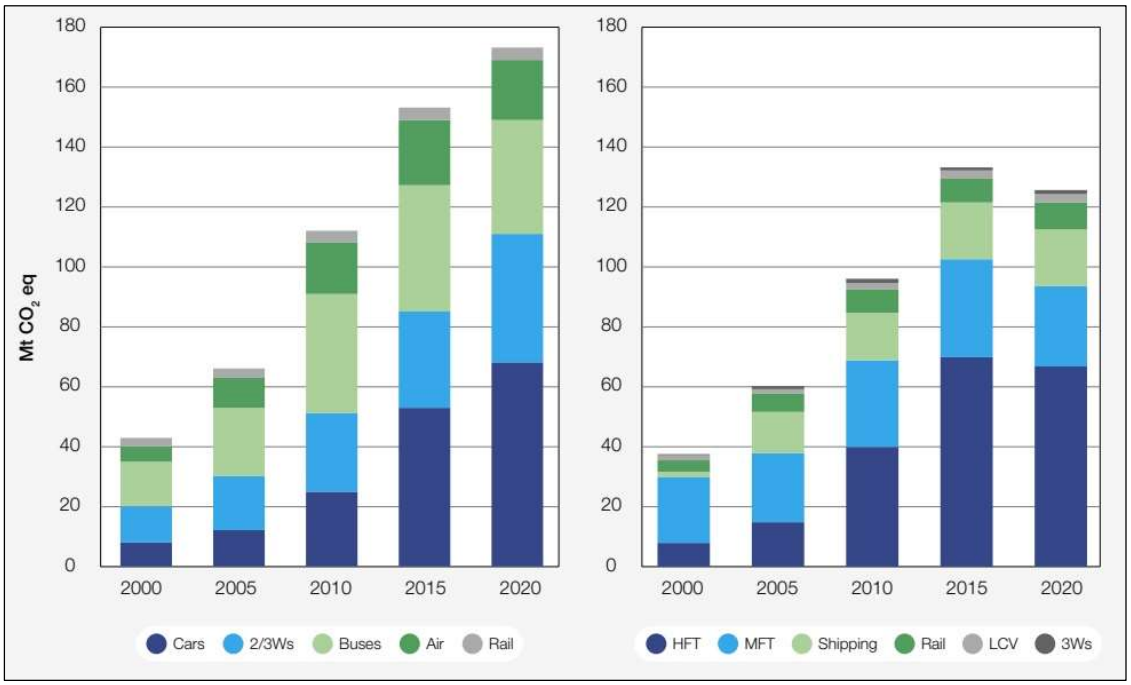

Figure 6: Tank-to-wheel CO2 emissions for passenger and freight transport in India, 2000-2020 (Source: Menon, 2021)

The above figure shows LCV stands for Light Commercial Vehicle; MFT stands for Medium Freight Truck; and HFT is for Heavy Freight Truck. An analysis that was done by the ITF with the assistance of the IEA Mobility Model. Data on energy use served as the basis for these results. The data for the year 2020 are based on estimations, which carry with them a greater degree of uncertainty than estimates used for preceding years. IPCC's 2019 report provides the CO2 intensities for fossil fuels, whereas IEA's report provides the carbon intensities for electricity production. (Menon, 2021)

The transition to more environmentally friendly modes of transportation in India will be driven by two key aspects:

I. Modal shift in transportation (from Road to Rail)

Only 3% of passenger transport energy is used for a quarter of passenger transport activity, making rail the most energy-efficient method of passenger transportation. As a land-based form of transportation, rail is the most environmentally friendly. But in 2020 it will only account for 9% of freight transport energy consumption. Inland freight rail transportation activity was close to 30%. Rail relies heavily on power, which may be generated using renewable resources to reduce or eliminate greenhouse gas emissions. Investments in rail are more environmentally friendly than those made in roads because of their lower emissions per dollar invested. When it comes to passenger transportation, cars rank towards the bottom when it comes to energy efficiency. For every rupee invested on infrastructure, road operations emit anywhere from three to 14 times as much CO2 as rail activities9 on an annual basis. Rail and other energy-efficient modes of transportation may minimise GHG emissions as India grows. (www.ETEnergyworld.com, 2021)

II. Green Fuel and Green Vehicles

Indian transportation accounts for over half of the country's total oil consumption. Because of increased car ownership and road transportation utilisation, oil consumption has more than quadrupled in the previous two decades. India's dependence on oil imports is expected to climb to 75% in 201910 due to the country's lack of indigenous reserves. Following four-pronged strategy is supporting India to meet its transport greenhouse gas emission reduction targets in this state. (World Economic Forum, 2021)

i. Fuel efficiency

Beyond the present BS-VI rules for automobiles, as well as the TREM and CEV regulations for tractors and construction equipment, respectively, India will need to continue

developing its fuel economy standards in order to bring them into alignment with global standards. (World Economic Forum, 2021)

ii. Green fuels

There are a number of alternative fuels that are both environmentally friendly and financially feasible, including biofuels like ethanol and methanol, and gas-based fuels like CNG and LNG. The carbon footprint of sustainable aviation fuel derived from waste and agricultural by-products or power-to-liquid based on hydrogen technology may be 100% less than regular jet fuel during its life cycle. Cleaner short-term options are available for India's transformation with the help of these fuels. (World Economic Forum, 2021)

iii. Electric vehicles

In comparison to internal combustion engines (ICEs) and other carbon-neutral choices (such as synthetic fuels), electric cars are now the technology with the highest efficiency. According to the most current projections, the proportion of battery-powered automobiles and commercial vehicles on the road would need to reach 84 and 79% respectively by the year 207012. In order to successfully electrify India's transportation system over the next few decades, original equipment manufacturers (OEMs), suppliers of charging infrastructure, and government policymakers will need to work together. The widespread adoption of electric vehicles will need a variety of incentives, including financial, behavioural, and those connected to infrastructure. (World Economic Forum, 2021)

iv. Hydrogen fuel transportation

Hydrogen has the potential to become a competitive alternative fuel for large mobility modes that are difficult to mitigate, such as trucks. Even though technologies for hydrogen mobility are still in the process of developing, India may be able to convert its light-duty vehicles (LCVs), trucks, and buses from using fossil fuels to hydrogen within the next several decades. (World Economic Forum, 2021)

3.4.3. Decarbonization of Energy-Intensive Industries - Third pillar

The iron and steel, cement, and chemicals and fertiliser industries of India are the most significant emitters of CO2 in the country's economy. The demand from these industries is likely to expand as a result of the projected economic expansion and urbanisation. GHG emissions will rise as a result of this expansion in the business-as-usual model. As India's manufacturing sector continues to expand rapidly, it is imperative that a carbon-neutral, industrial development model be developed. (World Economic Forum, 2021)

These industries' final product costs are heavily influenced by energy and feedstock, making investments in GHG reduction technology impractical since consumers are unwilling or unable to pay a premium for green goods. The adoption of specific quick-win measures where GHG reduction is also EBITDA positive has been helped driven by regulations such as the Perform, Achieve, and Trade (PAT) scheme. These measures include improved energy and thermal efficiency, waste heat recovery systems, and partial substitution of high GHG feedstock (such as clinker reduction in cement).

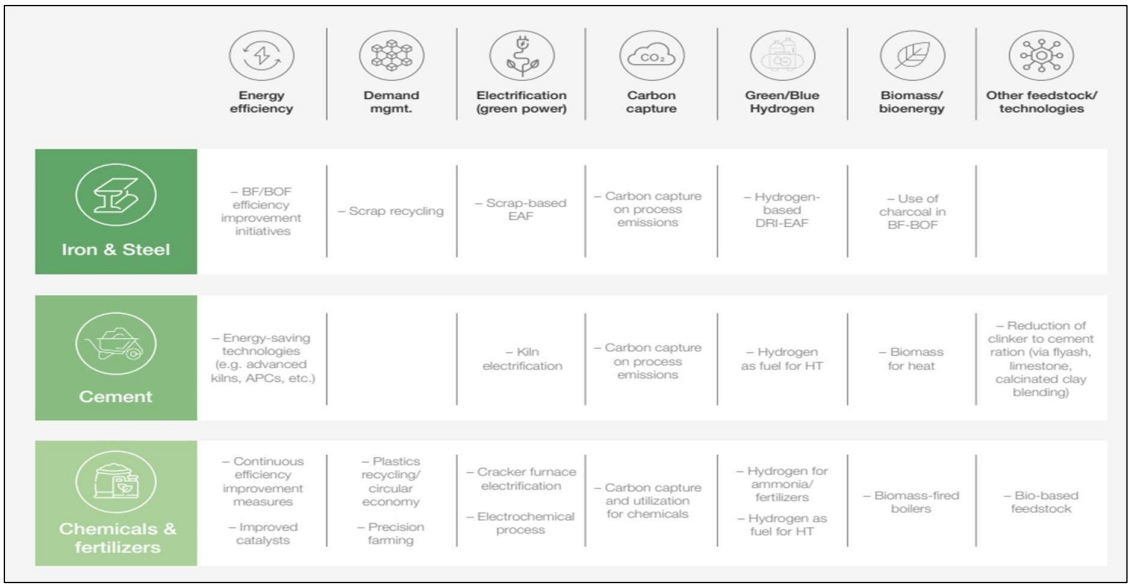

Figure 7: Measures to address industrial sector carbon dioxide emissions (Source: Narain, 2021)

India's industrial decarbonization strategy is off to a solid start thanks to the voluntary participation of more than 60 significant Indian enterprises and numerous multinationals operating in India in the SBTi (Science Based Targets initiative)-based emission reduction targets16. But there's still a lot of work to be done. Currently available commercially viable technology can only reduce GHG emissions by a fifth to a quarter of what is required to meet the 1.5C goal. (Narain, 2021)

In order for India to succeed, the cost of decarbonized goods will continue to fall, as well as the availability of resources (such as biomass or geological storage capacity for absorbed CO2) and the ability to adapt both existing and new facilities. In order to make this shift possible, we'll need government support and incentives, as well as R&D investment to make new technologies like hydrogen affordable, as well as enhanced global cooperation and policy support. (World Economic Forum, 2021)

3.4.4. Green Infrastructure - Fourth pillar

To achieve the 1.5°Climate objectives, all CO2 emissions from the built environment will need to be eliminated by the year 2040. Figure 8 shows that built environment is responsible for about half of the total yearly CO2 emissions around the globe. The buildings and construction industry are responsible for 36% of final energy usage and 39% of energy and process-related carbon dioxide (CO2) emissions. 11% of these emissions occurred from the manufacture of building materials and products such as steel, cement, and glass. (International Energy Agency, 2019)

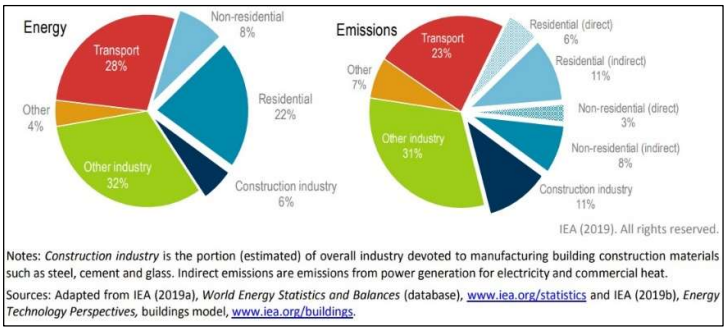

Figure 8: Final energy consumption and emissions from buildings and construction across the world. (Source: International Energy Agency, 2019)

The three principal construction materials concrete, steel, and aluminium are responsible for 23% emissions produced around the globe (most of this used in the built environment). Therefore, because of its significant contribution to overall greenhouse gas emissions, the building and construction industry should be a central concern of efforts to reduce those emissions. (International Energy Agency, 2019)

In India there are 1.3 billion people living, while the urban areas are home to 31% of the country's population. The use of energy in business settings has increased by 700% over the past four decades, and this trend is expected to continue. By the year 2030, India's annual energy consumption is expected to reach 4 trillion units. More than 15% of country’s GHG emissions are attributed to the top 25 cities. In addition, these cities are predicted to emit an average of 2.6 tonnes of CO2 equivalent per capita, which is 40% more than India's per capita emission of 1.8 tonnes of CO2 equivalent. India's urban population is expected to expand from 480 million now to 814 million by the year 2050, making it the most populous country in the world. (Narain, 2021)

As cities develop and change, there is an increasing need in India for improved urban planning and the construction of low-carbon infrastructure. Green construction and infrastructure present one big solution to this unsustainable growth. These are means of making the surrounding environment better. It is beneficial to people, communities, and the environment as a means of lowering the use of resources while simultaneously improving quality of life. This, in the end, leads to a reduction in greenhouse gases, which helps to contribute to a reduction in the greenhouse effect. The implementation of cutting-edge green infrastructure construction technology has a significant impact on the preservation and appropriate utilisation of resources such as land, water, energy, air, and material, which in turn results in a reduction in both the overall cost of construction and the negative effects of climate change. (Narain, 2021)

3.4.4.1. Developments towards green construction and infrastructure in India

International Finance Corporation (IFC) says 70% of India's necessary buildings by 2030 have not been built. If India adopted green buildings to satisfy this need, the

environment and economy would benefit. In India, barely 5% of buildings are green. This may seem like a challenge, yet it opens up many potentials for green building. (IGBC, 2019)

The CII-Sohrabji Godrej Green Business Centre project in Hyderabad was given the first and most prestigious Platinum certified green building rating in India, which served as the impetus for the beginning of the Green Building movement in India. The Green built-up area in the country had a humble beginning of 20,000 square feet in the year 2003, but as of April 2022, more than 7,558 green building projects coming up with a footprint of over 8 billion square feet are registered with the Indian Green Building Council (IGBC). Of these, 2,581 green building projects are certified and fully functional in India. This growth is the result of the cumulative initiatives of public and private stakeholders taken to facilitate the green building movement. (IGBC, 2019)

3.4.4.2. Green building rating systems in India

The Green Building Code in India is an amalgamation of many different codes and standards that can be found in the by-laws of the National Building Code, the Energy Conservation Building Code (ECBC), and in the norms set by the ratings systems. Though the National Building Code (NBC) includes basic and broad rules for the effective use of energy, but these guidelines are not sufficient to support the vision of green infrastructure. There are various rating systems available in India with their own methodologies, specifications and certifications. These certification systems cover almost entire range of construction industry from methodology, manpower, technology, materials, design and planning. This paper will focus on the prominent rating systems in practice. (Green tree global, 2020)

3.4.4.3. LEED/ IGBC (Indian Green Building Council)

In the year 2001, the Confederation of Indian Industry (CII) initiated the formation of the Indian Green Building Council (IGBC), which is now in existence. "To enable a

sustainable built environment for everybody and support India's rise to become one of the world leaders in the sustainable built environment by 2025," this is the goal that guides the work of the council. (Green tree global, 2020)

The CII Green Business Centre was established in 2001, and the IGBC is a component of that organisation. IGBC is also a founder member of World Green Building Council, which is the nodal institution of nation councils from all over the world. WGBC has acknowledged and praised IGBC's accomplishments in a variety of different venues due to IGBC's leadership in the green building industry. The council provides a broad variety of services, some of which include the development of new green building rating programmes, green building certification services, and green building training programmes. Green Building Congress, the organization's annual flagship event focused on green buildings, is also organised by the council. (IGBC, 2019)

IGBC has introduced 26 comprehensive ratings that cater to the design, construction, and operation of almost all different types of project typologies, including Green Homes, Green New Buildings, Green Healthcare Facilities, Green Schools, Green Factory Buildings, Green Campuses, Green Townships, Green Cities, and so on. The International Green Building Council (IGBC) has structured all of its grading systems to address national objectives and to make it easier to accomplish a number of the Sustainable Development Goals set by the United Nations. The Certified, Silver, Gold, or Platinum level can be achieved by a project throughout the certification process. (Green tree global, 2020)

3.4.4.4. GRIHA (Green Rating for Integrated Habitat Assessment)

The Green Rating for Integrated Habitat Assessment was initially conceived of by TERI (The Energy and Resources Institute), and it was developed jointly with the Ministry of New and Renewable Energy, Government of India. In 2007, the Government of India adopted the Green Rating for Integrated Habitat Assessment as the national rating system for green buildings. The Green Rating for Integrated Habitat Assessment provides the fundamental prerequisites for green buildings in terms of predefined parameters. The Green Rating for Existing Buildings in America (GRIHA) is a rating instrument that enables individuals evaluate the performance of their building in comparison

to specific nationally approved criteria. As a result of doing an all-encompassing analysis of a building's environmental performance over its entire lifespan, it establishes an unmistakable benchmark for what it means to speak of a structure as a "green building." The rating system, which will be based on generally acknowledged energy and environmental principles, will attempt to find a middle ground between the well-established techniques and the developing ideas, both on a national and an international scale. (GRIHA Council, 2021)

The performance of the building is rated on a scale of five levels (1 star to 5 stars). GRIHA is available in seven different configurations to accommodate any kind of structure. The GRIHA version 2015 has been subjected to a comprehensive upgrade in order to take into consideration the constant improvements that have been made in the extremely dynamic construction industry. Concepts such as life cycle cost analysis, life cycle analysis, and the water performance index are among those that have been incorporated into this version (i.e., GRIHA v2019). This version has incorporated user experience, listened to comments from the market, and made it easier to implement and accept. These are all things that have been taken into consideration. Under GRIHA v.2019, certification can be awarded to any new construction projects that have a built-up area that is greater than 2500 m2 (this does not include parking, basement space, or typical structures). (GRIHA Council, 2021)

3.4.4.5. BEE Star Rating

BEE (Bureau of Energy Efficiency) developed a voluntary Star Rating Development plan for commercial buildings, which was launched by the Ministry of Power in 2009. This system is based on the actual performance of a building, measured in terms of the amount of energy used in the building divided by its total area and expressed as kWh/sq. The focus of this program has been to create a market pull for energy efficient buildings. Buildings in India that have been awarded the Energy Star rating have considerable benefits in comparison to non-green structures. These benefits include a 40% increase in energy efficiency in comparison to ordinary buildings and a significant reduction in the expenses of operations. According to data from the relevant industry, approximately 85% of buildings that have been given the Energy Star rating make use

of a system that contains energy management controls, and approximately 50% make use of lighting system motion sensors in order to qualify for the Energy Star certification. (Bureau of Energy Efficiency, 2009)

This system will give office buildings a rating on a range from one to five stars, with five stars being awarded to the most energy-efficient structures. This initiative will target five different types of buildings around the country: office buildings, hotels, hospitals, retail malls, and IT Parks. These buildings will be located in each of the country's five temperature zones. (Bureau of Energy Efficiency, 2009)

3.4.4.6. GEM (Green & Eco-friendly Movement)

The Associated Chambers of Commerce and Industry of India (ASSOCHAM) initiated the "GEM Sustainability (Green) Certification Program" in 2017 with the intention of fostering environmentally responsible green building design and construction practises. The GEM Sustainability Certification Rating Program uses BEE ECBC 2017 and NBC 2016 as its primary sources of data. Its goal is to address the issue of sustainability throughout a specific development's lifespan, beginning with the design phase and continuing through construction and operation. (Green tree global, 2020)

3.4.4.7. Comparative analysis of rating systems

All of the grading systems have rooted their attention on the social, environmental, and economic objectives of buildings, and they assign points to each technique based on how well it accomplishes those objectives, as outlined in the following Figure 9.

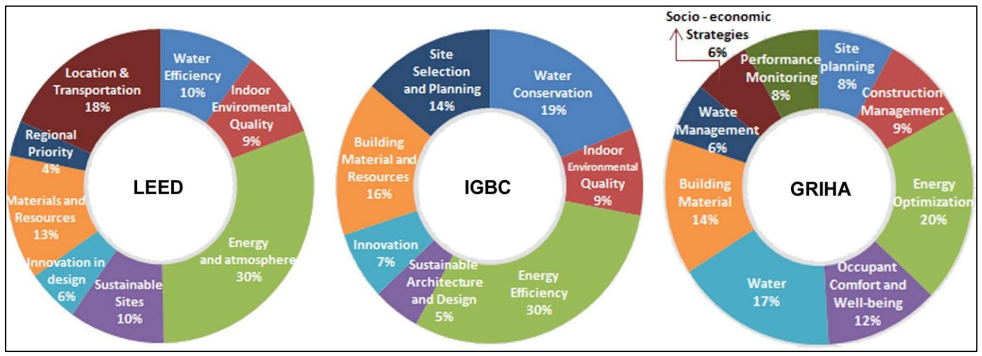

Figure 9: Inclusion of various Parameters in different rating systems. (Source: Green tree global, 2020)

The figure depicts the weightage of distinct parameters associated with the most popular rating systems in India. This also shows the development of new IGBC model after the inclusion of LEED model. GRIHA has one additional parameter then IGBC.

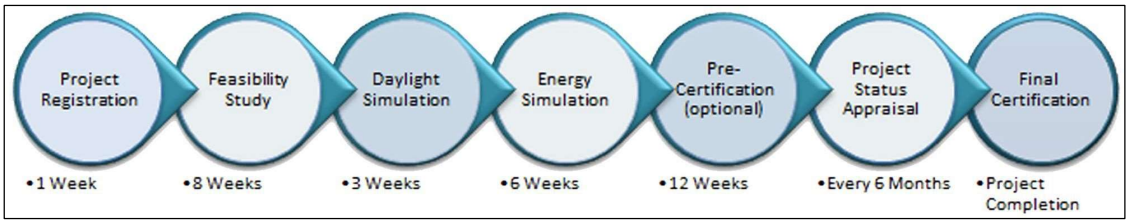

Figure 10: Typical certification and average timeline for the certification process. (Source: Green tree global, 2020)

The Figure 10 shows the typical procedure and average timeline for the green building certification process in India. This timeline may vary depending on the project and the rating system opted.

Figure 11: Different Green building certificates and their respective performance levels. (Source: Green tree global, 2020)

For integrative analysis, the levels in several grading systems are integrated into a single performance level, namely Outstanding, Excellent, Marked, and Competent Performance, based on IGBC, GBCI, (Figure 11). Maximum-rated buildings are assumed to have achieved excellent performance; this indicates that they either aimed for exceptional performance but settled for a lesser level, or that they met a minimum threshold to attain excellent performance that is related to ULB incentives. (Green tree global, 2020)

In 2008, the IGBC released the pilot edition of the Green Homes (IGBC GH) programme. Near the same time, many ULBs, such as the Noida Development Authority and the Pimpri-Chinchwad Municipal Corporation, initiated incentive programmes for new developments that adhered to IGBC, GRIHA, and LEED that provided a property tax refund and discounts on FAR. IGBC was able to get the early mover advantage since LEED and GRIHA were unable to meet the requirements of the residential sector for an extended period of time. (Green tree global, 2020)

3.4.4.8. Policies and initiatives towards green infrastructure

India's national and state governments offer diversified incentives to encourage green construction. The Government of India (GOI) subsidises 30% of the installation cost of rooftop solar panels in most states. Beneficiaries might also earn INR 2 per unit of generation if they produce more than 1100-1500 kWh per year. The Ministry of Environment, Forests, and Climate Change (MoEFCC) offers fast-track environmental

approval for IGBC-certified projects. This provides the developer advantages over red-tape, enabling him to deliver the property on schedule. (Bhosale, 2022)

The Tamil Nadu Industries Department, Government (TN Industrial Policy 2021) provides a 25% subsidy on the cost of setting up environmental protection infrastructure (up to Rs 1 crore) for industrial projects that get IGBC green certification. The incentive is for industrial units, industrial parks, R&D initiatives, warehousing, and logistics parks. (Bhosale, 2022)

The Energy Conservation Building Code (ECBC) establishes minimum energy requirements for non-residential buildings that have a connected load of at least 100 kW or a contract demand of at least 120 KVA. The EC Act 2001 gives the state governments the authority to make modifications to the code in order to make it more appropriate for local circumstances. ECBC was initially introduced by BEE in 2007 and received an upgrade in 2017. At the moment, 22 states have finished implementing the amendment, 15 states have sent out notices, and 11 states have brought their building bylaws on the state level up to date. Eco Niwas Samhita, a standard for residential structures, was introduced by BEE in 2018; it is applicable to all residential constructions with a plot area of less than 500 square metres. (Green tree global, 2020)

Several states have enhanced the floor-to-area ratio (FAR) for GRIHA developments, encouraging developers to construct green. Andhra Pradesh gives a 25% incentive on green projects with an Indian Green Building Council green grade (IGBC). Tamil Nadu and Maharashtra have built the greenest buildings in the nation due to these incentives, according to USGBC research. This pioneer state governments' success has spurred other governments to embrace green building. Karnataka has suggested reducing property tax and stamp duty for green construction projects, following Andhra Pradesh, Haryana, Punjab, West Bengal, and Sikkim. (Utsav Soi, 2020)

3.4.4.9. Market Trends

India is spearheading towards green future. This can be attributed to the significant push toward green buildings that has taken place over the course of the last decade. By the year 2015 Green buildings were responsible for approximately 5% of the total construction market. India had 450 million square feet of green homes, with 1.2 billion

square feet of green buildings ready or pre-certified. The most recent five have seen a 37% increase in the supply of green certified buildings, with an additional 78 million square feet of certified stock. The market of green buildings in India is expanding rapidly and is expected to reach around 93 million square metres by the end of 2022. (Green tree global, 2020)

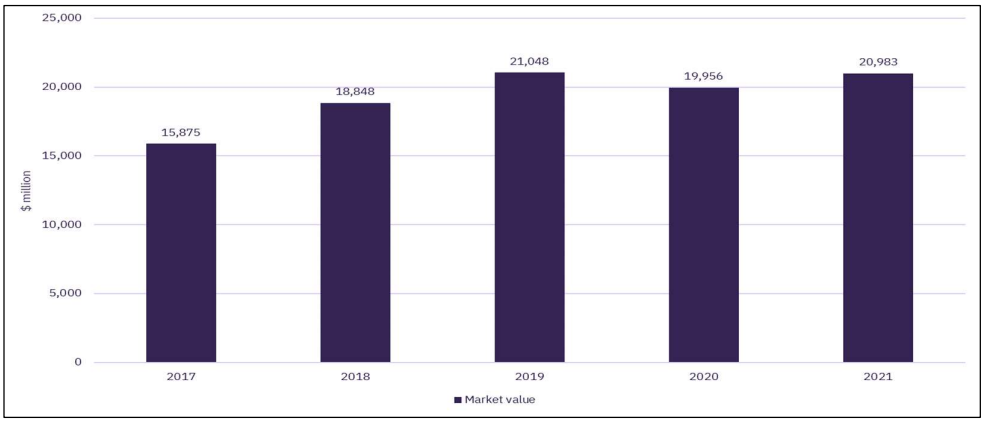

Figure 12: Market value trends of Green Buildings in India. (Source: GlobalData, 2022)

The Figure 12 shows the value of green buildings in India during past five years. This market for green buildings in India has shown a significant growth rate of 5.1% between 2020 and 2021, reaching a value of $21.0 billion in 2021. Throughout its entire existence, the market experienced a compound annual growth rate of 7.2% between the years 2017 and 2021 (GlobalData, 2022).

"The green building market is anticipated to be among the fastest growing industries worldwide. India has been driving the green building movement in a significant way since 2001. And 2007 was a turning point, with demand for green buildings escalating. Besides, with 75% of the buildings that will be required by India in 2030 yet to be built, this sector has immense potential in India," On the margins of the conference, United Technologies Corporation's chief sustainability officer, John Mandyck, made this statement. (Oct 6, 2017 and Ist, 2017)

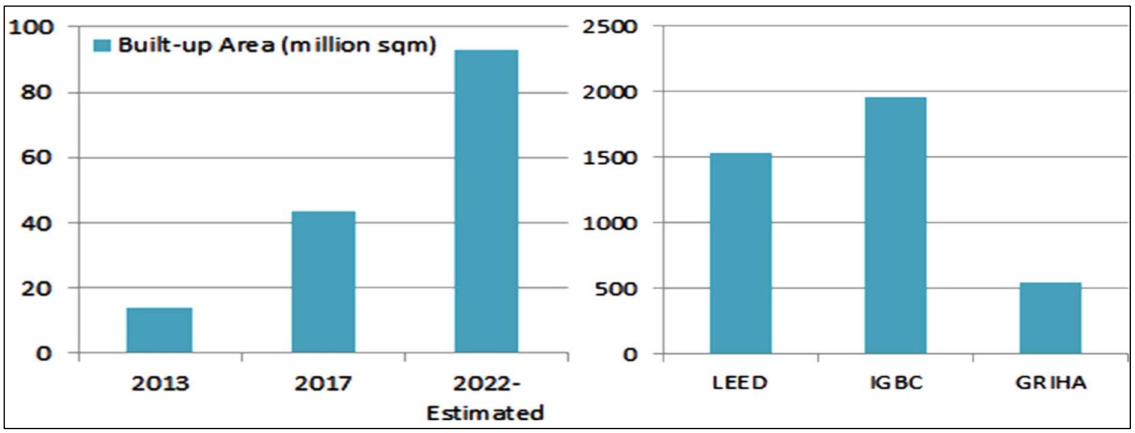

Figure 13: Historical trends of listed and certified Green Buildings in India. (Source: Green tree global, 2020)

The GBCI took over management of the LEED projects that had been handled previously by IGBC on the Indian subcontinent. Therefore, the data in the Figure 13 for certified green buildings is a combine representation of the projects by both IGBC and LEED. The classic controlling command-and-control system, which is implemented by municipal bye-laws, NBC, ECBC, and fiscal/FAR incentives; the latter is linked with green certification, which has helped the market move towards being more environmentally friendly. (Green tree global, 2020)

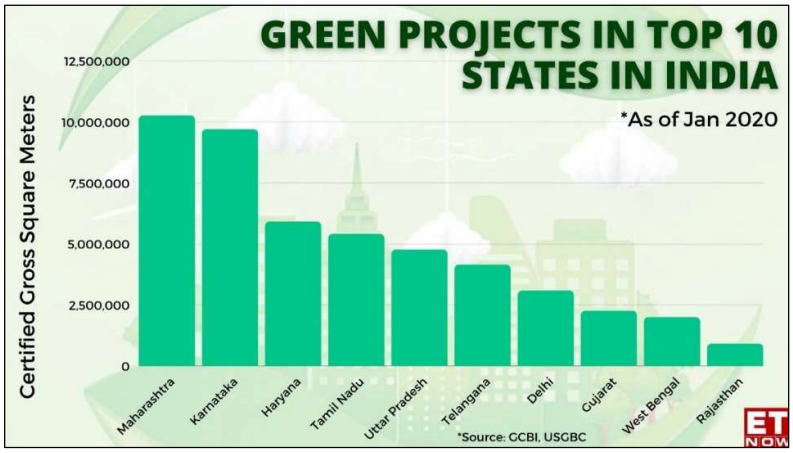

Figure 14: Top 10 States in Green Buildings registrations and the types of registered projects. (Source: Green tree global, 2020)

On the list of states that are leaders in environmentally friendly construction, Maharashtra comes in first, followed by Karnataka, Haryana, Tamil Nadu, and Uttar Pradesh (Figure 12). According to the findings of the research, the residential sector is expected to have growth of roughly close to 10% between the years 2010 and 2020. According to the United States Green Building Council, India is now ranked third in the world in terms of the number of sustainable buildings, behind only Mainland China and Canada, and this figure is expected to continue rising in the near future. According to the Leadership in Energy and Environmental Design (LEED) report conducted by the Green Construction Council of India (GCB-India). (Green tree global, 2020)

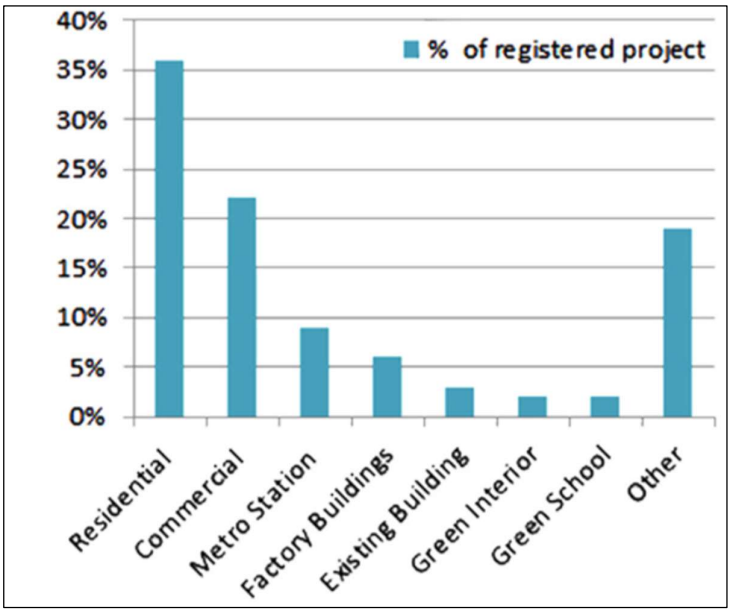

Figure 15: Types and percentage of total registered projects. (Source: Green tree global, 2020)

According to the Indian Green Building Council, India has successfully accomplished 7.17 billion square feet of 'Green Building Footprint' (IGBC). There are approximately 6,000 green projects and over 5.77 lakh acres of significant development projects in the country as of this date, both of which have contributed to the nation's achievement of the 75% green building footprint objective two years sooner than the actual aim was to be achieved. The projects fall under residential development forms the majority of in terms of percentage of total registered projects, which is further followed by

commercial developments (Figure 14). India has shown concrete evidence of its dedication to the adoption of environmentally friendly, sustainable, and green construction practises progressing towards its present target of 10 billion square feet by the year 2022. (Green tree global, 2020)

3.4.5. Sustainable Agriculture - Fifth pillar

Agriculture and domesticated animals contribute 18 % of the country's total greenhouse gas emissions. At about 80% of all nitrous oxide emissions are attributed to agriculture, predominantly due to the application of inorganic fertilizers topsoil and grasslands. It also accounts for an estimated 45 % of all methane emissions. Nearly 80% of all agronomic methane emissions come from animals, mostly from manure management and enteric fermentation. For agricultural methane emissions, rice production is the second most significant producer, followed by savanna burnt and crop wastes used in agriculture, respectively. Over a period of 20 years, nitrous oxide and methane are much more potent greenhouse gas drivers than carbon dioxide, making the need for more sustainable agriculture an urgent need. (World Economic Forum, 2021)

While agriculture's GHG emissions contribute to climate change, the repercussions of a changing climate have a significant influence on the industry as a whole. With more frequent and intense dry spells, heat waves, and unpredictable rainfall, climate change threatens India's agricultural prosperity. In light of a rapidly expanding population and the need to increase food production, it will be difficult to establish a balance between boosting food production and lowering GHG emissions from agriculture. (World Economic Forum, 2021)

The National Mission for Sustainable Agriculture (NMSA) has been in place in India since 2014-15 to promote sustainable agriculture. For example, there are sections on water and soil health and implications of climate change as well as adaptation strategies for agroforestry as well as rain-fed places. In addition to NMSA, the Pradhan Mantri Krishi Sinchai Yojana and the Integrated Watershed Management Program encourage rainwater gathering and micro-irrigation. According to government figures, NMSA

receives only 0.8% of the Ministry of Agriculture and Farmers Welfare's (MoAFW) budget. In addition to the MoAFW's budget of INR 142,000 crore (USD 20 billion), the Central government spends roughly INR 71,309 crore (USD 10 billion) yearly on fertilizer subsidies. (Gupta et al., 2021)

One of the most difficult changes that India will face in the next decades will be making the switch to sustainable agriculture. More than one 1 billion farmers will have to be empowered, acquainted, and given the opportunity to embrace precision farming (particularly in terms of reshaping rice production, lowering nitrogen/urea consumption, and resizing low- and no-tillage methods), sustainable animal husbandry (a set of steps to ameliorate methane emissions from cattle), and clean technology (changing diesel pumps to renewable energy and adopting electric farm equipment). This initiative will require a grassroots movement. (World Economic Forum, 2021)

3.5. Four enablers of green transformation

In addition to the above discussed five pillars there are four enablers that cut across sectors. These enablers include a plan for climate adaptation, an accelerated approach to innovation in green technology, an overarching framework to catalyse green finance, an integrated approach to carbon capture, utilisation, and storage; and an accelerated approach to carbon capture, utilisation, and storage. The continuance of India's economic growth, which is being driven by technical advancement, financial innovation, and strong political leadership, is necessary for the implementation of the five pillars and four enablers. (May, 2021)

3.5.1. Green Innovation: First enabler

Without extensive technological research and development as well as the introduction of innovative models in every sector of the economy, the voyages toward green economy on both a global and an Indian scale are unattainable. Technology development for lower-cost renewables, large scale battery management system, novel energy

technologies (e.g., nuclear fusion), distributed generation, and transmission optimization will all be part of this. In the realm of transportation, the technologies for renewable fuels and electric transit are required to be continuously advancing to attain the point of commercial maturity in the not-too-distant future. In a similar vein, technological innovation will also serve as an essential cornerstone for the business sector, agricultural industries, and the construction sector. In addition to technological advancements, a significant amount of corporate entrepreneurship model will be required to facilitate the ecosystem. This involves the creation of new business models for EV-charging, business strategy for distributed power, and finance mechanisms for the global green transition. (May, 2021)

India has a once-in-a-generation potential to evolve as a worldwide powerhouse for green innovation; this opportunity arises as a result of the fact that the globe is still in the formative stages of the green industrial revolution. Incentives and research and development (R&D) subsidies for the private sector would be key facilitators in the process of reaching this goal, which will assist position India as a worldwide innovation and entrepreneurial hotspot. Support for the development of a marketplace for low-carbon, high-value added products and services will be crucial, as will the development of business start-ups and research and development centres in green technology that will work in tandem with universities; luring inventive international businesses to establish or expand their presence in India and create jobs in high-growth sectors; and attracting innovative foreign businesses to determine or broaden their pan - India presence. All of these will be crucial attributes. (May, 2021)

3.5.2. Green Finance – Second enabler

Expanding India's new green infrastructure, green technologies, and encourage people to adopt to sustainable and green consumer preferences will require a exponential rise in governments and private capital flows in order to facilitate India's transition to a greener economy. The problem with financing India's transition to a greener economy has been the limited availability of grant. The shift to net zero in India will require a tillering financing sector as a prerequisite. (World Economic Forum, 2021)

Green financing refers to financial provisions for ecologically sound or climate-change-aware undertakings. Environmentally sustainable initiatives include renewable energy generation (solar energy, wind energy, biofuels, etc.), clean transportation (reduced greenhouse gas emissions), energy-efficient projects (green building), and trash management (recycling, efficacious treatment of waste, energy conversion, etc.). Climate change adaptation, sustainable waste and water management, sustainable land use (including forestry and agriculture), and biodiversity protection are also considered sustainable projects for Green Debt Securities (SEBI 2017).

The Reserve Bank educates the public, investors, and banks on green finance through reports and other communications. In its Annual Report (2015-16), the Reserve Bank cited the G20 Green Finance Study Group's (GFSG14) conclusions on the need to establish local green bond markets, facilitate cross-border investments in green bonds, share knowledge on environmental hazards, and improve overall green finance operations. The yearly report also covers wider green financial challenges. These include green activities, intellectual property rights in development and technology transfer from developed nations, and bank environmental risk assessment. (RBI, 2021)

Bank Credit Outstanding to the Non-conventional Energy as on March, 2020

	Public Sector Banks	Private Sector Banks	Foreign Banks	All Banks
Amount outstanding (₹ Cr.)	21,655	12,302	2,586	36,543
As per cent of power sector credit	6.2	11.9	27.1	7.9
As per cent of total bank credit (excluding personal loans)	0.5	0.5	0.7	0.5

Note: Excludes Regional Rural Banks and Small Finance Banks.
Source: BSR, RBI, Authors' calculations.

Figure 16: Nonconventional Energy Bank Credit Outstanding of India. (Source: RBI, 2021)

The Priority Industry Lending (PSL) scheme of the Reserve Bank was expanded in 2015 to cover the small renewable energy sector as part of an attempt to promote

sustainable green funding. As of the end of March 2020, the total outstanding bank credit to the non-conventional energy sector was nearly INR 36,543 crore. This represented 7.9 % outstanding bank credit to the power generation sector (Table 2), which is an increase from the 5.4 % that was represented in March 2015. The degree of exposure of India's commercial banks to the non-conventional energy industry differed significantly among bank groups (Table 2) and across the country's most populous states (Figure 16). (RBI, 2021)

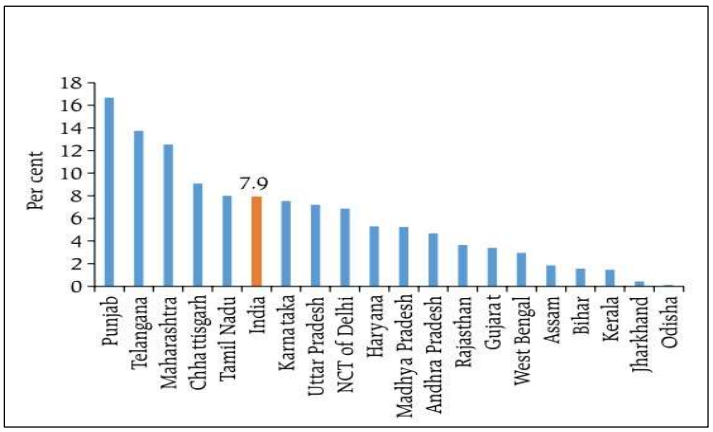

Figure 17: Non-conventional energy finance share: March 2020. Source: Reserve Bank of India, 2021)

The percentage of non-conventional energy in the outstanding bank credit for electricity generation is shown in this chart (percentage). Regional Rural Banks and Small Finance Banks are not included in this category. The data used here comes from the Reserve Bank of India's Basic Statistical Returns. (RBI, 2021)

Green Bonds

Green bonds are a type of bond that can be issued by any sovereign authority, as well as intergovernmental groupings or alliances, and corporations, with the intention that the revenues from the bonds would be used for ecologically beneficial initiatives. Since 2015, India has been issuing environmentally responsible bonds. As of the 12th of February in the year 2020, the total amount of outstanding green bonds in India was $16.3 billion USD. Since the beginning of 2018, India has issued green bonds totalling

around US$8 billion. This amount represents approximately 0.7% of the total bonds that have been issued in the Indian financial market. (RBI, 2021)

The majority of environmentally friendly bonds that were issued after 2015 had maturities of five years or more, but were still under ten years. Approximately 76% of all green bonds that have been issued in India since 2015 have been denominated in US dollars. Green bonds have been issued towards a variety of projects in India from time to time by the World Bank in addition to business entities and the Indian government (Appendix Table 1). According to the Green Bond Impact report (2019) published by the World Bank, the outstanding amount of Green Bond proceeds allocated to assist the financing of such projects in India is anticipated to be $640 million U.S. dollars as of the 30th day of June in 2019. (RBI, 2021)

To summarise, the practise of greener finance in India is still in its infant stages. Green bonds only made up 0.7% of all bonds issued in India since 2018, while bank financing to non-conventional energy made up roughly 7.9% of outstanding bank credit to the power industry as of March 2020. The Reserve Bank of India underlined the danger of climate change on financial assets and the need to expedite green finance for sustainable development. It recognises "greenwashing" or misleading claims of environmental compliance, many definitions, and maturity mismatches between long-term green investment and short-term investor objectives. It also stresses the need for legislative action to strengthen India's green finance ecosystem through concerted initiatives. (RBI, 2021)

3.5.3. Carbon Sequestration – Third enabler

There are bounds to the emissions that can be cut given India's aggressive plan for economic expansion. India will require a similarly ambitious sequestration agenda in order to make the transition to a net zero economy, which is being led by the most ambitious global initiative named Mission Innovation (MI) carbon capture innovation challenge. The goal and scope of the Mission Innovation carbon capture innovation challenge is to enable power plants and other businesses that are heavily dependent on carbon to emit almost zero amounts of carbon dioxide. Both power stations (fed by coal, natural gas, and biomass), as well as industrial applications, have the potential

to achieve considerable reductions in CO2 emissions with the use of Carbon Capture, Utilization, and Storage programme (CCUS). (Department of Science and Technology, 2021)

India is working with 24 nations and the EU on eight innovative problems as part of Mission Innovation (MI). Carbon capture—Enable near-zero CO2 emissions from power plants and carbon-intensive sectors. Since India lacks expertise with large-scale CCUS implementation, the innovation strategy relies on peer learning across MI nations (DBT and DST 2018). The dynamism of wealthy nations' climate change commitments would affect India's outlook and decision making. Escalating global goals may put diplomatic pressure on India to reach net-zero or enhance its emission reduction commitments. India is commended for its climate change efforts. India is the only G20 country on pace to limit warming to 2°C. India is a worldwide climate change leader. As more G20 nations5 set carbon neutrality objectives, India's failure to do so might cost it its dominance in international climate change politics. (Malyan and Chaturvedi, 2021)

Region	Initiative	Budget	Scope
UK	CCS Infrastructure Fund	USD 1.37 billion	The fund aims to develop four carbon capture and storage hubs and cluster projects across UK by end of decade with vision to reach net-zero by 2050. Additional USD 0.2 Billion has been announced for CCUS under UK 10-point plan.
Norway	CCS Infrastructure and Support Fund [Longship CCS project]	USD 1.83 billion	The fund aims to support CCS infrastructure and create a whole new value chain that is needed to deliver on the Paris Agreement.
European Commission	ETS Innovation Fund	Total fund: USD 11.9 billion (part of which will be allocated to CCUS)	The fund aims to support low-carbon technologies including CCUS, renewables, and energy storage to achieve carbon neutrality in Europe.
United States	Federal funding to support the development and advancement of carbon capture technologies	USD 72 million	The support aims to support research and development of coal and natural gas power plants' projects and remove CO_2 from the atmosphere. Out of the total federal funds pledged, USD 51 million has been awarded to nine projects in power plants and rest is for 'direct air capture'.
	Section 45Q Tax credit	---	Section 45Q tax credit is one of the most aggressive CCS-specific incentives providing break-even cost estimate ranges from 5 USD/t-CO_2 to 60 USD/t-CO_2
India	DBT-DST-ACT support for R&D in CCS	USD 1.19 million (INR 8 crore)	DST participated in multilateral ACT (Accelerating CCS Technologies) programme that is focused on accelerating CCUS technologies. Current plan is to support four projects, with each receiving around USD 0.3 million (~INR 2 crores).
Australia	Support fund for CCUS [part of larger new energy technology package (USD 1.5 billion)]	USD 39 million	The fund will provide targeted support to a wide array of carbon capture, use and storage opportunities, including carbon recycling, etc.
Canada	Tax incentives for CCUS adoption	---	As a part of green programs in the budget, 50 per cent reduction in income tax rates is announced for businesses that manufacture zero-emission technologies as well as tax incentives to adopt carbon capture, utilisation and storage (CCUS).

Figure 18: Major economies' CCS funding and investment initiatives. (Source: Malyan and Chaturvedi, 2021)

The Figure 18 provides a description of the most significant CCS facility-related announcements on financial assistance and investment efforts made by the governments of major economies. To prevent "carbon leakage," the EU is among the first to adopt the Carbon Border Adjustment Mechanism (CBAM). The CBAM might cause a shock in global commerce and alter the parameters of national competitive advantages. On the one hand, India is inching closer to a free trade agreement with the European Union, which would facilitate European companies' entry into the Indian market. On the other hand, the EU plans to charge imports from high-emitting markets with a carbon tax. The cohabitation of these agreements is expected to damage the global and

domestic competitiveness of Indian industry. These concerns have prompted the private sector in India to begin pilot projects for CCS/CCUS facilities in industrial settings. (Malyan and Chaturvedi, 2021)

In terms of both GHG emissions and energy consumption, India's industrial sector will remain critical. By 2050, the industry is predicted to account for 58% of all final energy consumption in the United States. While by mid-century, its contribution of the whole economy's emissions will be roughly 31%. The industrial sector is also predicted to remain heavily reliant on fossil fuels, which accounted for 66% of total industrial energy consumption in 2017 and are only expected to decrease by 2% to 64% by 2050. In deep decarbonization scenarios, CCUS technologies are a need due to India's predicted long-term reliance on fossil fuels in its industrial sector. Although CCUS technologies are critical to the Indian economy, there is little government funding for the promotion of these mitigating solutions. (Malyan and Chaturvedi, 2021)

In July of 2018, Department of Science and Technology (DST) and Department of Biotechnology (DBT) had jointly launched a Call on IC3 on CCUS in order to conduct joint research and development with member countries of the MI in order to identify and prioritise ground-breaking technologies in the field of CO2 capture, separation, storage, and CO2 value addition. This was done in order to improve the efficiency of these processes. There are a total of 20 proposals that have been proposed for financial assistance, 17 of which come from DST and 3 from DBT. Entities like as Dalmia Cement, one of the country's biggest cement producers, are investigating the use of CCS technology. For India's industrial sector, the active engagement of the private sector in the direction of extensive emission reduction of industry might be a game-changer. (Department of Science and Technology, 2021)

3.5.4. Climate Adaptation – Fourth enabler

Carbon emissions reduction and carbon sequestration are no longer adequate to completely reverse climate change's negative effects. Most of the globe, particularly India, must begin preparing for a changing climate. One of the first areas to see heatwaves that exceed a healthy person's ability to survive in the shade is predicted to be India. Many Indians might be subjected to a deadly heatwave by 203026 if climate change is not properly addressed. (May, 2021)

It is vital that people adapt, but it will be difficult since heat exposure is ubiquitous and requires large-scale adjustments in how millions of Indians live and work (e.g., changes in shift hours, government sponsored shelters for the homeless, etc.). The urban poor will face special difficulties in adapting and may require governmental assistance, such as temporary shelters. Adaptation to climate change will need the cooperation of both public and private sector partners. (May, 2021)

Accelerated adoption of cooling plans

The India Cooling Action Plan, which was announced by the Ministry of Environment, Forests, and Climate Change in March 2019, is a pioneering initiative in the context of the global climate change conversation. Other chosen states and cities have also produced their own heat action plans, but given the severity of the climate danger, practically the whole country of India will require a heat-action plan, with local governments making cooling a priority in their strategies. (May, 2021)

Indoors work transition

The employees in India's agriculture industry, construction industry, mining industry, and other outdoor occupations are the ones most at danger from the immediate effects of climate change. At the same time as India is dramatically stepping up its infrastructure and development efforts, the country will have to move quickly to make the challenging shift from outside to indoor work (by further strengthening its services and manufacturing industries indoors). (May, 2021)

Air conditioning and other cooling measures

Given the here and now effects of climate risk, India will need to speed the development and deployment of low-carbon, cost-effective cooling systems, including air conditioning and other cooling methods. In addition to the prospective construction of air-conditioned emergency shelters all throughout the country, this will involve the incorporation of air-conditioning technology into any and all housing developments, even those aimed at providing cheap housing options. (May, 2021)

4. Rajasthan: A flag bearer of green transformation

Rajasthan the largest state of India is in western part of country, an arid/semi-arid area with significant water shortages and inadequate rainfall. The state is water-poor. Rajasthan has 10.4% of the country's land but just 1% of its water resources. The state has 33 districts, 39753 villages, 249 Panchayat Samities, and 9168 Gram Panchayats. Deserts cover most of the state's landmass. 4.19 % of national forest cover is from the state. Rajasthan covers 10.4% of India's total area. 76% of the state's population is rural. Rajasthan produces 5.49% of the nation's food grains and 21.31% of its oil seeds. The state's 49 million cows, buffaloes, and goats make up 10.13% of the nation's livestock. (Government of Rajasthan, 2022)

Demographics include Population: 56.5 million. Population density ranges from 13 per sq. km. in Jaisalmer to 471 per sq. km. in Jaipur. The decade-long growth rate of 28.41% is greater than the national average of 21.5%. 76% of the population lives rurally. In 2001, Rajasthan's sex ratio was 921, up from 910 in 1991. Future demographic predictions show a 100% rise in Rajasthan's population, indicating greater population pressure. State life expectancy is 62.0. (Government of Rajasthan, 2022)

Rajasthan's economy is largely agricultural and rural, with swings in NSDP (Net State Domestic Product) growth rate due to agriculture's reliance on rainfall. The GSDP grew 6.5% and 6.1% in the decades ending 1991 and 2001, respectively. Despite a little fall to 5.1% between 2000-06, Rajasthan's growth is still greater than the all-India average, making it one of the three top performing states. Each capita GSDP growth has been low while the state's population has grown by 2.5% per year, the most among major Indian states. The lowest per capita incomes are in Dungarpur, Barmer, and Dholpur. Gross/Net State Domestic Product (GSDP/NSDP) and Per Capita Income (PCI) year-wise estimates in the 1970s to 15.4 percent in 1999-2000. Table 3.3 shows a growing trend in urban poverty levels at constant costs. (Government of Rajasthan, 2022)

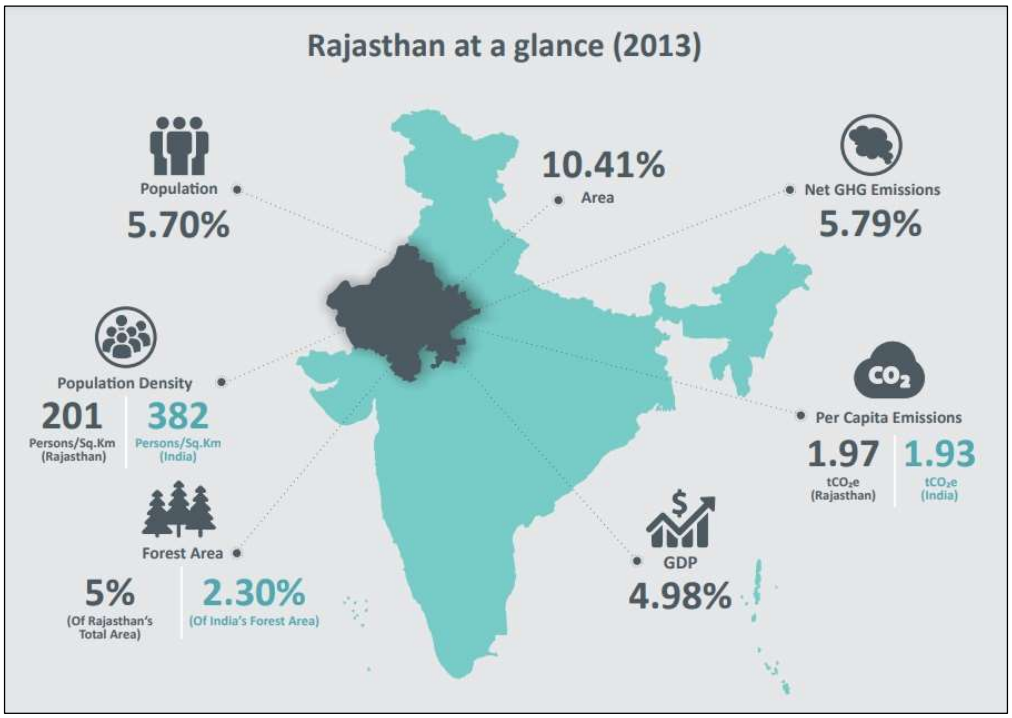

Figure 19: Rajasthan at a glance. (Source: GHG Platform India, 2016)

A state's population needs education, health, nutrition, family welfare, sanitation, water supply, and roadways. Despite improvement in every facet of social development, Rajasthan trails in several metrics. Ganganagar (0.656), Hanumangarh (0.644), Kota (0.613), and Jaipur (0.607) have high HDI ratings. Dungarpur (0.456), Barmer (0.461), Banswara (0.472), and Jalore have HDIs below 0.5. (0.500). In the 11th five-year plan for the state, the greatest budget allocations are for Power, Social & Community Services, and Irrigation. Most of the population lives in rural regions and depends on agriculture and livestock for their living, with more than 50% of the population being cultivators. The state government is promoting and facilitating industrial development. (Government of Rajasthan, 2022)

State officials prioritise energy. December 2009 installed capacity was 7716 MW. Rajasthan has 5,585km of National Highways, 11,758km of State Highways, and 7,673km of significant district highways. The state's road density rose from 54.6 km per 100 sq. km in 2008-09 to 54.9 in 2009-2010. Under the Missing Link initiative and the Central Road Fund, new roads are connecting all state communities. (Government of Rajasthan, 2022)

4.1. State of Rajasthan and the Sustainable Development Goals

India has made tremendous progress towards achieving SDGs by setting up institutional architecture and entrusting numerous organizations/ministries to execute Agenda 2030. Rajasthan's government has taken similar steps toward SDG implementation and accomplishment. Niti Aayog's SDG India Index shows Rajasthan's SDG development is sporadic. (INDIA EDUCATION DIARY BUREAU ADMIN, 2021)

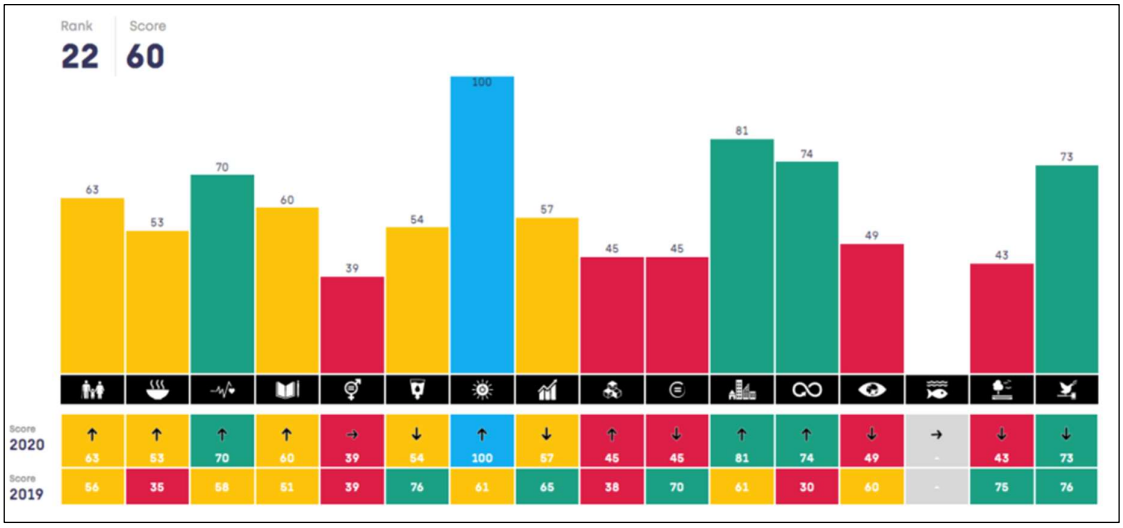

Figure 20: Rajasthan's SDG Index Position in India. (Source: Directorate of Economics & Statistics, Rajasthan, Jaipur, 2021)

Figure 20 shows the state's score climbed 3 points to 60 in 2020, while the national average grew from 60 to 66. The state's growth rate after Bihar, West Bengal, and Assam is 57 in 2019 and 60 by 2020. Unemployment, crime, shortage of clean water, pollution, fewer women in Panchayati Raj Institutions, and fewer bathrooms for females in schools slowed progress toward 100% objective by 2030 (Srikanta Tripathy / TNN /, 2021). While the state has reduced poverty by expanding MNREGA work and improved health and well-being by lowering maternity and under-5 mortality, it has failed to reduce crime and pollution. Murders per 1 lakh people have risen to 2.10 from 1.98, while juvenile crimes have risen. While courts per 1 lakh population stayed at 1.90, PCA and IPC cases per 10 lakh population rose to 5.46 from 5.40 in the prior year. (Directorate of Economics & Statistics, Rajasthan, Jaipur, 2021)

Even though the state has expanded renewable energy and used more LED lights to reduce CO2, it has not been able to manage growing pollution, according to the research. According to 'India: Health of the Nation's States 2017', India's DALY rate owing to air pollution was 3,469. Rajasthan had a DALY rate of 4,528, whereas Nagaland had 1,408. Rajasthan scored 81 on housing, drainage, and door-to-door rubbish collection. The state's severe geography dropped its 'Life on Land' score to 43 out of 100. Rajasthan has one of the lowest tree cover percentages. Even though forest and tree cover increased to 7.23% of the total area, the biggest proportion of degraded land (52.69% of the total land area) lowered the score in the SDG objective. (Srikanta Tripathy / TNN /, 2021)

Category wise classification of Districts

Aspirant (Score is less than 50)	Performer (Score is less than 65 but greater than or equal to 50)	Front Runner (Score is less than 100 but greater than or equal to 65)	Achiever (Score is equal to 100)
Baran, Dungarpur, Dhaulpur Barmer, Jalore, Ptatapgarh Jaisalmer,	Karauli, Kota, Churu, Dausa, Jaipur, S.Madhopur, Jhunjhunu, Bundi, Nagaur, Jhalawar, Hanumangarh, Tonk, Alwar, Udaipur, Chittorgarh, Bhilwara, Jodhpur, Sikar, Bharatpur, Baran, Ajmer, Sirohi, Pali,Dungarpur,Dholpur,Pratapgarh, Rajasmand Banswara , Bikaner, Ganganagar	-	-

Figure 21: Category wise performance classification for SDGs for districts of Rajasthan. Source: Directorate of Economics & Statistics, Rajasthan, Jaipur, 2021)

The lack of knowledge, coordination, and availability of data are important challenges that need to be addressed in order to attain Sustainable Consumption and Production, which is the 12th Sustainable Development Goal. This, together with a lack of finance and a scarcity of technical people, which results in poor monitoring and reporting, seems to be the most major problem facing SDG12 implementation at the state level. Figure 21 shows the category wise distribution of districts of Rajasthan (INDIA EDUCATION DIARY BUREAU ADMIN, 2021)

4.2. Rajasthan's Emissions Profile

The total quantity of greenhouse gas emissions (GHG) that were produced by human activities in Rajasthan in the year 1990 was 18.6 million tonnes of CO2, 827.9 thousand tonnes of CH4, and 6.6 thousand tonnes of N2O. The quantity of CO2 equivalent that is released into the atmosphere is 38 million tonnes. According to estimates that are comparable, the total quantity of greenhouse gas emissions that were produced as a result of human activity in Rajasthan in the year 1995 was 27.0 million tonnes of CO2, 104.4 thousand tonnes of CH4, and 10.5 thousand tonnes of N2O. 52.2 million tonnes of CO2 equivalent were released into the atmosphere in 1995 due to human activities. In 1990, Rajasthan was placed 10th with 3.7% of India's emissions, and by 1995, it had moved up to the 9th position with 4.2% of India's emissions. On a sectoral basis, estimates of emissions were derived from the energy sector, the agricultural sector, industrial operations, waste disposal activities, and the forestry sector, as well as from land use, land use change, and the sector of forestry. Ganganagar, Jaipur, Ajmer, Johhpur, Nagaur, Udaipur, Chittaurgarh, and Kota were some of the key districts that had large emissions in the year 1990. The total emissions in these districts were higher than 1.5 million tonnes of CO2 equivalent. The year 1995 saw the addition of Alwar, Sawai Madhopur, and Bhilwara to this group of states. (Government of Rajasthan, 2022)

The only other estimates or new information on GHG emissions is for the year 2007, and it was included in a paper by INCCA called India's Greenhouse Gas Emissions in 2007. According to these estimates, there was a compound annual growth rate (CAGR) of around 3% between 1997 and 2007. However, because the research does not include state-by-state figures, it is impossible to find comparable numbers for Rajasthan. The following section will discuss some of the more recent developments in activities that are responsible for greenhouse gas emissions. This will be done with the intention of locating opportunities that could enable the state to benefit from already established international mechanisms such as CDM. (Government of Rajasthan, 2022)

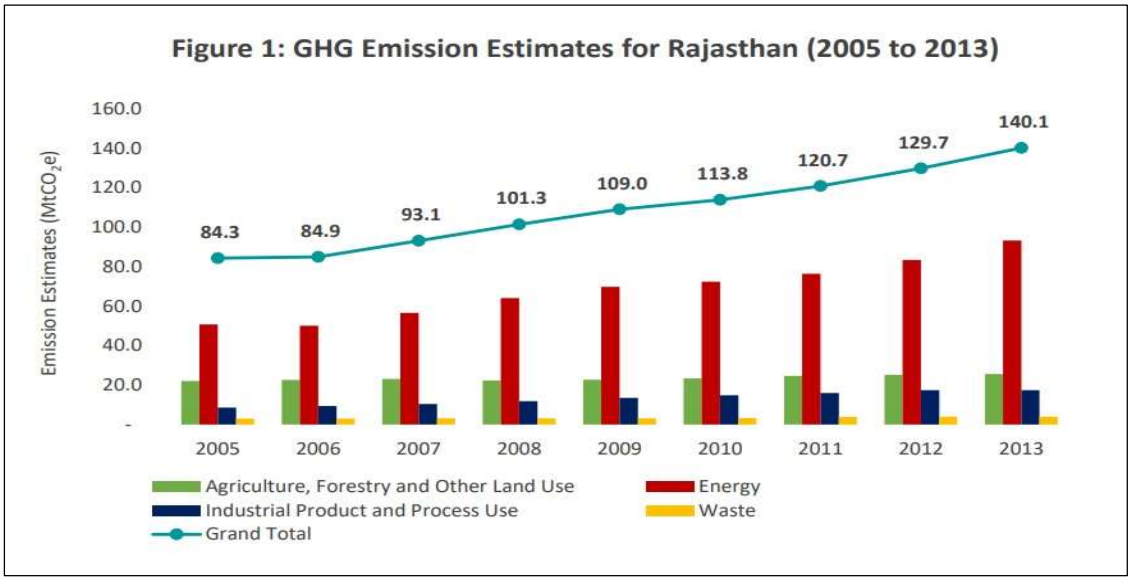

Figure 22: Estimates of GHG Emissions in Rajasthan by 2013 (Source: GHG Platform India, 2016)

As seen in the Figure 21 on the right, Rajasthan's emissions increased at a compound annual growth rate1 of 6.56 %, going from 84.3 MtCO2e in 2005 to 140.1 MtCO2e in 20132. Across all of the reference years, the Energy sector was the primary source of greenhouse gas emissions that contributed to Rajasthan's total emissions. (GHG Platform India, 2016)

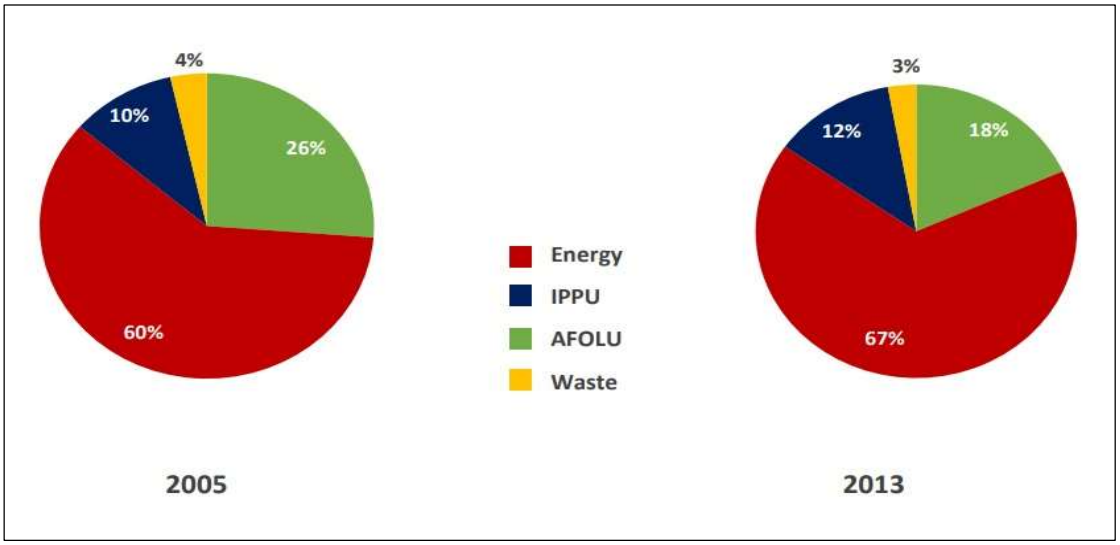

Figure 23: Rajasthan's Sectoral Contribution to the State's Overall GHG Emissions. (Source: GHG Platform India, 2016)

The percentage of emissions that came from the Energy sector increased from sixty % in 2005 to 67% in 2013, as shown in Figure 22 above. On the other hand, the percentage of emissions that came from the AFOLU sector, which is the second biggest emitter of greenhouse gases from Rajasthan, decreased from twenty-six percent in 2005 to 18% in 2013.The per capita emissions for the state of Rajasthan between the years 2005 and 2013 were almost identical to those of India throughout all of the reference years. From 2005 to 2013, the compound annual growth rate (CAGR) of per capita emissions in Rajasthan was 4.58 %, which was somewhat higher than the CAGR for India, which was 4.07% for the same time period. (GHG Platform India, 2016)

4.3. State Urban Policy Scenario

Rajasthan had the country's highest decadal population growth rate, at 28.41% between 1991 and 2001. To a large extent, Rajasthan's rapid population increase is due to an age structure with strong growth potential, according to the state's 11th Five-Year Plan. Of addition, between 1991 and 2001, the urban population in Rajasthan increased by 31% per decade. A large-scale movement of people from rural regions and smaller towns to larger cities and towns was documented in the state's 2001 census. Rapid urbanisation has raised the demand for and placed a huge pressure on urban resources, services, and infrastructure. Migration and other government-led infrastructure development initiatives in Rajasthan are expected to boost the state's urban population to 26.1% by 2020. (Government of Rajasthan, 2022)

In the preceding portion of the thesis, we examined sustainable habitats, water supply, sanitation, solid waste management, transportation, urban planning, and urban governance, all of which fall under the umbrella of sustainable development in India. Even while Rajasthan does not have a dedicated policy aimed at decreasing urban climate change risk or adapting to or mitigating it, other policies exist that have indirect effects, at the very least on reducing the susceptibility of some sectors and populations. (Government of Rajasthan, 2022)

When it comes to urban development, the state has taken on many initiatives, such as the creation of an urban infrastructure development plan; increasing the number of

transportation facilities; enhancing urban transportation with the introduction of BRTs, CNG-powered vehicles, and MRTS; and expanding the state's transportation network. Urban development and governance issues are handled by the Rajasthan state government's Department of Urban Development, Housing, and Local Self-Governance. Some of the most important policies created by this department are reviewed below in order to better understand the current environment in terms of policy making for urban adaptation and mitigation action. (Government of Rajasthan, 2022)

Ongoing Government Programs/ Initiatives	Key Objectives/Goals	Salient components/strategies/activities	Implementing agencies in the State (Nodal and supporting)
Affordable Housing Policy 2009	• To reduce the housing shortage in the State, especially in EWS/LIG categories • To take up large scale construction of Affordable Housing (with focus on EWS/LIG housing) • To bring down the cost of EWS and LIG categories of houses to affordable limits. • To promote investments in housing in Urban Sector on PPP Model. • To involve Private developers in the construction of EWS/LIG categories of houses by offering various attractive incentives. • To create Rental Housing as transit accommodation for migrants to urban areas, and • To check creation of slums	The policy framework and built in incentives are used to motivate agencies and the existing central government policies are dovetailed to achieve efficient utilization. The policy document mandates earmarking of plots/houses for EWS/LIG category in the following models: 1. Mandatory provision (Rajasthan housing board, urban local bodies and developers) 2. Private developers on land owned by them 3. Private developers on acquired land 4. Private developers on Government land (For rental housing or outright sale basis) 5. Slum housing (schemes approved by GoI and 'Mumbai Model' of slum redevelopment)	Nodal Agency- AVAS VIKAS Limited Supporting Agency- • State Government • Rajasthan Housing Board • Urban Local Bodies
Rajasthan Urban Infrastructure Development Project (RUIDP)	• Providing sustainable urban infrastructure and services for economic and tourism growth and better quality of life to the urban population.	The vision to be achieved through policy reforms to strengthen urban management and support for priority investments in urban infrastructure and services required to meet basic human needs, improve quality of life, and simulate sustainable economic development. RUIDP will (i) redress immediate infrastructure and service deficiencies to meet basic service delivery norms, (ii) act as a medium through which policy reforms are effectively executed, and (iii) provide maximum demonstration effect for replication in other cities of the State.	Nodal Agency- Local Self Government Department of Government of Rajasthan
Rajasthan Township Policy (above 10 hectares) and	• The policy promotes planned/integrated development of various towns by providing basic infrastructure facilities and	• Technical and financial parameters Development Control regulations and planning considerations	Nodal Agency- Department of Urban Development & Local Self Government,
Ongoing Government Programs/ Initiatives	**Key Objectives/Goals**	**Salient components/strategies/activities**	**Implementing agencies in the State (Nodal and supporting)**
Policy for Residential, Group Housing and other schemes in the private sector (upto 10 hectares).	safeguards the interest of the public at large by ensuring availability of residential plots/houses at affordable prices.		Govt. of Rajasthan.
Slum Development Policy (Under PPP)	• The policy essentially aims at involving the private sector for redevelopment/improvement of slum areas as an add on to the efforts already underway by the urban local bodies.	• Constitute an Empowered Committee for speedy and transparent approach.	Nodal Agency- Department of Urban Development & Local Self Government, Govt. of Rajasthan.

Figure 24: The Urban Policies of Rajasthan in the Context of the State Action Plan. (Source: Government of Rajasthan, 2022)

The policies that were just described in the above Figure 24 prioritise environmentally responsible urbanisation while also enhancing and making the development planning environment in urban Rajasthan more accessible. On the other hand, none of the policies that are put out by the Department of Urban Development and Local Self Government clearly address adaptation measures in relation to climate change. The policy guidelines only provide for conservation actions in terms of guidelines for conserving open space/agricultural land/existing bio-diversity, and they encourage an increase in the green foot print by mandating plantation in areas where they are present. Additionally, the guidelines only provide for conservation actions where they are present. These might be thought of as introductory actions for advancing the topic on climate change further. (Government of Rajasthan, 2022)

In terms of promoting green construction a revised model building rules has been drafted by the department of urban development and housing (UDH). It is decided that the Green Building Concept will be used in the construction of multi-story structures that the Rajasthan Housing Board plans to undertake in the foreseeable future. The new regulation will apply to the project known as the Chief Minister Jan Awas Yojana, which is located in Jaipur, as well as the Indira Gandhi Nagar Yojana, the Chief Minister's state workers housing plan, and the All-India Services Residency, which is located in Pratap Nagar etc. (TNN, 2019)

It was recommended by the government of Rajasthan that developers should be rewarded by the state by being granted an additional floor-area ratio (FAR) of between 7.5% and 15% at no additional cost. In the same manner as other governments, Rajasthan plans to provide green construction certifications to its own structures. An official said that these structures will be divided into three different categories: platinum, gold, and silver. Buildings that achieved the platinum certification would be awarded an additional 15% FAR. In a similar manner, a gold certification would get a FAR of 10%, whereas a silver certification would receive a FAR of 7.5. (TNN, 2019)

Rajasthan is considered to be an example for other states since it already has 83 projects that have been registered with the Indian Green Building Council (IGBC) and has a footprint of 103 million square feet of green (TNN, 2019). Moving forward, there is both a need and a potential to either align or amend the existing policies in order to address these impacts, or to simultaneously formulate separate policies in order to focus on critical sectors such as urban water supply, transportation, storm water

drainage, and other such areas. Both of these options have the potential to be implemented. (Government of Rajasthan, 2022)

4.4. Energy efficiency initiatives

Improved construction and operational energy efficiency may lower the nation's demand for electricity 25% by 2030, according to a recent study. At the moment, the emphasis is on energy efficiency because of the obvious and immediate benefits of lower power costs and a smaller carbon impact. The Energy Conservation Act, 2001, was adopted by the establishment. An energy efficiency push may be launched in the nation with the help of the Act, which offers a legislative framework, institutional arrangements, and a regulatory system. Standards and labelling of appliances, Energy Conservation Building Codes (ECBC), Institutional Set-up (BEE), and the formation of an Energy Conservation Fund are all key sections of the EC Act. In the context of our research, the Building Code is relevant. (EPF, 2016)

On May 27th, 2007, the Indian government released the Energy Conservation Building Code (ECBC). Under the Energy Conservation (Amendment) Act, 2010, the ECBC establishes minimum energy requirements for new commercial buildings with a connected load of 100kW or a contract demand of 120kVA. It is a non-binding obligation that has been honoured more in the breach than the observance of it. Only a tiny portion of the country's building is being served by this technology, therefore adoption is still gradual. Some progress has been made in the BEE's efforts to raise public knowledge of these regulations. (EPF, 2016)

Electrical appliances that are energy-efficient and are used in households and commercial establishments could save approximately 20,000 megawatts of power annually, according to experts in the power sector. This would result in savings of $19.53 billion in capital investment on new power plants, in addition to savings on transmission and distribution infrastructure. When opposed to the commercial sector, the residential usage of electricity is significantly subsidised. As a result, the objective of reducing energy use in residential structures is seen as less desirable. As a result of inefficiencies in the electricity system, India has frequent power outages, which has resulted in an increased need for costly back-up diesel generators, for which there is presently a

market of around $585.8 million. The need for costly generators to assure supply dependability should emphasise the necessity of developing energy-efficient buildings and motivate stakeholders to push for energy-efficiency initiatives.

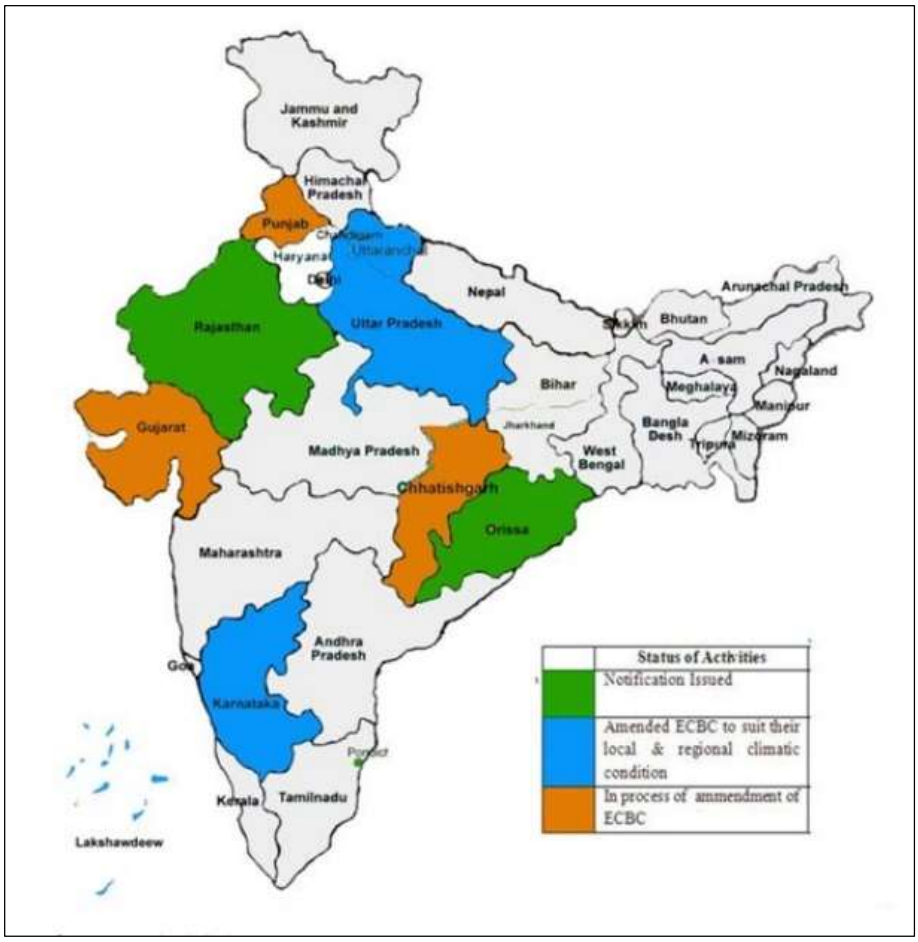

Figure 25: State level implementation progress in putting ECBC into effect. (Source: EPF, 2016)

Figure shows the ECBC is now in the phase of implementation known as the voluntary phase; however, only a select few states like as Orissa and Rajasthan have informed it that it would be applicable within their jurisdiction. It is essential to keep in mind that the ECBC takes into consideration only the operational energy of a building and not the embodied energy of the materials used in the construction of the structure. It is expected that buildings that comply with the ECBC will be anywhere from 20-30% more energy efficient than traditional structures. It is predicted that there is the potential to reduce annual CO2 emissions by 142 Mt by the year 2020 and 296 Mt by the year 2030 if energy-efficient measures are put into place in conjunction with the adoption of

ECBC and other standards. According to estimates provided by Environment Design Solutions (EDS), a company specializing in energy consulting, there is also a large potential for reductions in greenhouse gas emissions through energy-conservation measures 24% from lights and 12% from air conditioners. (EPF, 2016)

The implementation of R-ECBD in Rajasthan has taken a number of significant stages since its acceptance. Incorporating R-ECBD code criteria into state and municipal building bylaws laid the groundwork for implementation of R-ECBD A training programme for local governments and the construction sector in Rajasthan also helped the state strengthen its capability for R-ECBD implementation. In addition, municipal and state governments have devised policies to encourage the construction of ECBC-compliant structures. Buildings that meet the code are rising in number. New national and state government buildings, certified green buildings, major commercial buildings, and other structures that aim to benefit from compliance incentives are all examples of compliant buildings. (Tan et al., 2021)

4.5. Renewable Energy Developments

Rajasthan has a tremendous potential to tap, store, and recover solar electricity - much more than its present needs. Solar power is used to satisfy a small portion of the country's energy needs. The Jawaharlal Nehru National Solar Mission (JNNSM) promotes environmentally sustainable development while solving India's energy security problems. High unit prices have kept solar-powered systems and gadgets from being widely deployed. Cost-cutting measures are needed to increase the solar energy sector. MNRE's Scheme for Solar Off-grid (PV and thermal) provides financial incentives for solar energy installations. (EPF, 2016)

The BEE claims it will reach the FYP objective (to conserve 5% of energy consumption) since avoided generating capacity in December 2010 was 7,415 MW, comparable to two projected ultra-mega power plants in India (about 4,000 MW each). The real savings are substantially smaller, analysts believe. Under the Solar Building Programme, the MNRE gives INR. 50,000 towards the DPR of a solar passive building. MNRE pays 10% of the building's cost or INR 10 lakhs for solar passive structures. Only the government/semi-government offers these incentives. The 1998-99 programme began.

The Solar Buildings Programme will offer financial assistance for project studies and solar building construction, as well as workshops and seminars for engineers, planners, builders, architects, consultants, housing finance organisations, and prospective users. Solar building documents will be compiled and published. (EPF, 2016)

According to the BMTPC, sand-lime brick, fly ash brick, and cemented particle board do not have to pay excise duties. In order to encourage the manufacture of fly ash, phosphorus, and other substances that are beneficial to the preservation of forest wood and cement, such as gypsum and plants, tax incentives have been made available. Brick kilns that produce a lot of pollution have been made illegal to use in favour of more environmentally friendly alternatives like the vertical shaft brick kiln (VSBK) or the Fixed Chimney Bull's Trench Kiln (FCT) (FCBTK). By the year 2002, around 75 percent of polluting kilns had been converted to FCBTKs; nevertheless, these kilns have not yet been totally removed from all states. In addition, the government has regulated the use of fly-ash bricks near power plants and adopted emission regulations based on new technical breakthroughs. These measures were taken in order to reduce the amount of pollution caused by power plants. (EPF, 2016)

The major initiatives taken by government of Rajasthan are listed below:

- Rajasthan Solar Energy Policy, 2014 and 2019
- Rajasthan ‘s Policy for Promoting Generation of Electricity from Biomass, 2010
- Rajasthan Wind Policy, 2012
- Solar Energy Rural Electrification Schemes
- Solar Water Pump Programme
- Rajasthan Renewable Energy Transmission Investment Program – ADB

4.6. Finance for Green transformation

The building industry has been significantly influenced by the simple accessibility of house financing options. Over the course of the last decade, Residential real estate sector in Rajasthan has seen a significant amount of expansion. According to the National Housing Bank, the total amount of money spent on housing financing increased at an annual pace of thirty percent between the years 2002 and 2007. (EPF, 2016)

Following the economic downturn, the industry has shown some resilience, as seen by an increase of 18% year over year in the amount of housing finance disbursements in 2009–2010. However, environmentally responsible home financing is still in its infancy. There have been several examples of financial institutions taking the effort to provide environmentally conscious homeowners with customised product options. NHB and KfW collaborated in 2008 to launch a programme designed to encourage the development of residential housing that is more energy-efficient. The programme provides financial and technical assistance in the form of housing loans to individual borrowers through retail lending institutions, with the goal of facilitating the purchase and/or construction of energy-efficient residential houses and flats. More than 20,000 flats had been made available nationwide as a result of this program's assistance in the construction of 73 buildings located in 11 different housing complexes by the time it came to an end in 2012. (EPF, 2016)

The State Bank of India has begun offering a product on a national scale in an effort to encourage the construction of sustainable dwellings. Customers who purchase IGBC-certified green homes are eligible for a 0.25% reduction in interest rates as well as a waiver of loan processing expenses. In a similar manner, ING Vysya Bank developed eco-housing mortgages for Eco-Housing-certified developments. These mortgages permitted either a longer repayment duration or a suspension on payments for a period of three months. A one percent interest rate subsidy was made available by the banks for the purpose of encouraging customers to buy energy-saving appliances and other types of equipment. (Centre for Budget and Governance Accountability and Shakti Sustainable Energy Foundation, 2020)

The federal government provides financial incentives to builders and developers who design environmentally friendly projects. It is feasible for eco-housing projects to earn savings on the overall premium that they pay to the city or state ranging anywhere from 10 percent to 50 percent of the entire amount. Facilities that have received GRIHA certification are entitled to get refunds on their property taxes as well as discounts on their energy and water rates from the state, in addition to a discount of up to ninety percent on their registration costs. (EPF, 2016)

Government programmes may be used to provide funding for construction projects and pieces of machinery that make use of renewable resources. The Ministry of New and Renewable Energy (MNRE) will provide a subsidy of thirty percent for the purchase of

all solar-powered household equipment. Off-list price reductions are available for a variety of solar-powered goods, including solar water pumps, solar water heaters, solar lanterns, and solar lighting for both homes and public spaces. LED Home Lighting Systems are now being offered as a gift at no cost to BPL households and participants of the MNERGA37 programme. (Centre for Budget and Governance Accountability and Shakti Sustainable Energy Foundation, 2020)

In the sector of micro, small, and medium-sized enterprises (MSME) that is responsible for supplying construction material and services, there is an almost total absence of financing. These are unstructured MSMEs, that often lack the resources required to either upgrade their already-existing technologies or transition to technologies that are more energy-efficient. At the moment, there is no fund that can satisfy this need. (Centre for Budget and Governance Accountability and Shakti Sustainable Energy Foundation, 2020)

4.7. Market uptake for green buildings

Starting to respond to the government's green building policy and international interest in green buildings, as well as to the constantly expanding market demand for green building products (even though this demand is primarily for government institutional buildings and commercial complexes). Environmentally friendly construction practises are becoming more popular among private developers, who are then advertising and selling their completed properties appropriately. As is obvious from the projects that are becoming registered for green building certifications from residential, commercial, corporate, and industrial structures, corporations are also playing a significant role in the promotion of sustainable buildings. They are boosting their brand by participating in corporate social responsibility initiatives, such as supporting green construction practices. This tendency is still mostly confined to business and office complexes rather than residential construction at this point. (EPF, 2016)

On the other hand, marketing for certain housing complexes increasingly promotes the fact that a building is green as part of their sales pitch, and the rising popularity of the green-building grading systems also shows evidence of a growing interest in the topic. Given that the majority of green buildings are marketed as luxury flats and structures,

it is fair to say that this is mostly a trend among those in the upper middle class. When combined with the right kind of marketing, this has the potential to generate a demonstration effect that will make environmentally friendly buildings appealing. (EPF, 2016)

It is a common misconception among construction workers that the higher cost of eco-friendly raw materials makes green structures too expensive to construct. However, they believe is being developed that the price tag won't truly be as exorbitant as it's been made out to be if environmentally friendly policies are included right from the start of the design and planning stages. In 2005-2006, the cost of constructing green buildings was around 5-6% more than the cost of constructing conventional structures. This was mostly due to the pricier goods and raw materials that were energy efficient. However, since there has been an increase in demand for these inputs, the prices have decreased. The prices are now practically comparable since environmentally friendly buildings may recoup the additional upfront investment in as little as two to three years via the reduction in the amount of energy and water they use. (EPF, 2016)

5. Research Methodology

The research methodology describes the processes and methods that were used to obtain the data that was sought for this thesis. The study is carried out in a flexible manner in order to strengthen the style of thinking and gather information about the issue area in a logical manner. The study effort may be broken down into four parts, each of which will be discussed in further depth below. The subsequent four steps are as follows:

- Phase of theoretical analysis
- Analytical phase.
- Results and conclusion phase

5.1. Phase of theoretical analysis

During this phase of the study, the topic of the research, which is " The assessment of challenges and risks associated with practising green transformation of the construction industry in Rajasthan, India." is thoroughly presented, and data is collected in relation to the research topic in order to establish the nature of the problem that will be investigated. The introduction, Green transformation: the concept, Green India: a Vision, Rajasthan: a flag bearer of green transformation and the literature review are all components of the project that are included in this phase. The stage may be broken down into three sections, which are as follows:

- Introduction
- Research Strategies and Methodologies
- Literature Survey

The term "green transformation" is explained in the introduction section, as a discussion of the trends and traditions among global nations. In addition to this, a description of the current situation regarding green construction potential and challenges in India are discussed.

The literature study in chapters 2, 3 and 4 provides an in-depth explanation of what exactly a green transformation is, as well as the global scenario and India's take on it. A quick introduction, the history of green construction, its application all over the world, and the present state of the industry are all covered in this part. In addition to that, it discusses the sustainable construction initiatives being taken in India as well as in the Rajasthan. The findings of the research are derived from the information gathered from the many sources i.e., journals, reports, policy documents, articles, research papers etc.

5.2. Analytical phase

The STEEP analysis is a component of the analytical phase. This study is used to determine the social, technical, environmental, economic, and political components of the Rajasthan. The findings obtained from the STEEP analysis are used as input in the subsequent SWOT analysis, which is also a component of the analytical phase. A SWOT analysis has been conducted to assess the benefits, drawbacks, opportunities, and threats associated with implementing green transformation of construction industry in Rajasthan. After doing a SWOT analysis, the next step conducted is case study research on the great green transformation of Germany to establish a understanding of he pathway using the facts of analytical phase and learning from the German model of transformation.

5.3. Result Phase

Following the in-depth discussion that took place in the SWOT analysis section and the case study section, recommendations are made at this phase. The method and actions that need to be performed in order to enhance the possibilities of green transformation of the construction sector are outlined in the recommendations. In the final phase we come to a conclusion on the data acquired from the analysis and literature review. The final portion is devoted to recommendations for various stakeholders.

6. Analysis

In this chapter of thesis STEEP analysis of Rajasthan provides the insights of the state, construction trends, demographics, lifestyle trends, environment, ecological and political scenario and their connection with construction trends and industry. The results from the STEEP analysis provides the necessary inputs to carry out the next following analysis SWOT. SWOT analysis is helpful in determining the potential strengths, weaknesses, opportunities ad threats to the green transformation of the industry in Rajasthan. Then the case study of Germany's great green transformation is done to explore the learnings towards venturing down the path of green transformation using strengths and opportunities while overcoming the various weaknesses and threats.

6.1. STEEP Analysis

One variation of the well-liked and straightforward strategic management approach for analysing the external environment is the STEEP analysis. It is based on the PEST analysis approach but also includes a further environmental facet. Business activities are significantly influenced by the external environment, yet management decisions and actions have no bearing on these influences. ("STEEP Analysis") In this project, STEEP analysis is used to get a better understanding of the Challenges and Opportunities of Rajasthan.

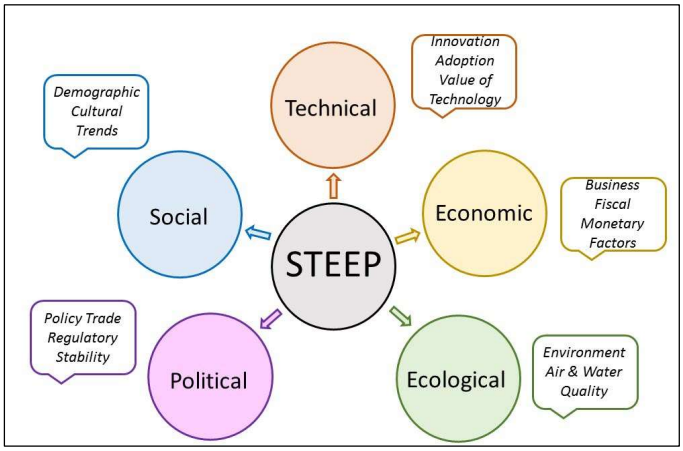

Figure 26: Factors of STEEP Analysis (Source: *STEEP Analysis Close*)

- **Social Factor**

  Consumer behaviour, demographics, religion, lifestyles, morals, and advertising are a few instances of social developments. (“What Is STEEP Analysis and 5 Steps to Conduct One”)

- **Technical Factor**

  The STEEP analysis's technology component places a strong emphasis on recent technical developments in Rajasthan. It takes into account elements such as new technologies, connectivity, and energy, transportation, investigation and creation, rules governing patents, and product standardization. (“What Is STEEP Analysis and 5 Steps to Conduct One”)

- **Economic Factor**

  The purchasing power of consumers is closely related to the state of the economy. This phase involves taking into account variables including interest rates, international trade, taxation, savings, inflation, subsidization, the number of employment available, and the nation's or state's entrepreneurial spirit. (“What Is STEEP Analysis and 5 Steps to Conduct One”)

- **Environmental Factor**

  The environmental component concerns environmental issues such as pollution, waste management, clean air and water, energy-saving technology, and societal attitudes toward the environment. (“STEEP Analysis”)

- **Political Factor**

  Factors could give businesses a lot of benefits and opportunities. Among these difficulties are political stability, state law, interference from the government, market regulations, trade agreements, tariffs or other restrictions, taxation, lobbying, and legal clarity. (“STEEP Analysis”)

6.1.1. Social factors

6.1.1.1. Demographics

India's largest state by land area is Rajasthan. Rajasthan also referred to as the "Land of Kings" or "Land of Kingdoms," comprises 342,239 square kilometers (132,139 square miles), or 10.4% of the entire land area of the nation. It shares a border with Pakistan along the Sutlej-Indus River basin and is situated on the western side of the nation, where it makes up the majority of the expansive and hostile Thar Desert (sometimes referred to as the "Rajasthan Desert" and the "Great Indian Desert"). Gujarat to the southwest, Madhya Pradesh to the southeast, Punjab to the north, Uttar Pradesh, and Haryana to the northeast are some of the other Indian states that border it. (Sharma)

6.1.1.2. Sex ratio

In Rajasthan, there is no correlation between the sex ratio and the state's overall development. There are currently 926 females for every 1000 males, which is a lower sex ratio than other Indian states like Kerala and Karnataka. According to the most recent data, only 10 districts in the state of Rajasthan have a sex ratio that is higher than 900. The sex ratio in Rajasthan has significantly reduced over the past 20 years, which has caused the government and authorities to become quite concerned.

6.1.1.3. Literacy

When compared to the national literacy rate, which is currently 74 percent, Rajasthan's literacy rate, which is currently 67.1 percent, is lower. The government is making every effort to raise Rajasthan's literacy rate, which was notably low twenty years ago. (“Demographics of Rajasthan | Population of Rajasthan”)

6.1.1.4. Education

the middle of the Great Indian Desert, Rajasthan, which means" the Land of the Kings," is all about history, chivalry, warriors, glory, and tragedy of fairy-tale proportions. Rajasthan is a vibrant state where tradition and modernity coexist side by side. People are receptive to change and western principles while also being proud of their past. Today's Rajasthan provides amenities that are on par with those found elsewhere in the world. The "Education City of India," Kota in Rajasthan, is the hub and location of testing for the national level entrance exams for higher education. Rajasthan has a 66.11 percent literacy rate, with males accounting for 79.19 percent and females accounting for 47.76 percent. (“Education in Rajasthan, Rajasthan Education”)

As the industrial sector expanded quickly, the government's concern for the infrastructure of education increased. Numerous public and private institutions in Rajasthan offer professional and vocational training. Such institutions place a strong emphasis on practical aspects. Consequently, they provide long-term benefits to students. Innovative ideas have been developed and are continually being developed to promote education. All of Rajasthan's districts have access to computer buses to improve computer literacy. (“Rajasthan Education System | Higher Education in Rajasthan”) There is no denying that Rajasthan has outstanding academic potential because it has the required infrastructure and setup for prospective learners.

6.1.1.5. Lifestyle trends

Rajasthan is the name given to the region in the northwest of the Indian subcontinent. Rajasthan, a kingdom embraced by the majestic Aravallis ranges, is well-known for its illustrious Rajput monarchs, whose tales of bravery, passion, and loyalty have been weaved into old tales and tunes and reverberated across the barren yet charming state. Rajasthan has contributed a significant role in the subcontinent's development. Western Rajasthan, now known as Pakistan, is where the world's first significant human advancement was developed. Rajasthan was also the scene of countless invaders' unrelenting anger as they destroyed the Central Asian mountains. The history, ethnicity, and

culture of Rajasthan were impacted by the invasions of the Indo-Aryans, Persians, Greeks, Afghans, Mongols, Scythians, Huns, Parthians, and Mughals. (Tours)

To create laborious work, wooden furniture, blue earthenware, tie and colour, Sanganer prints, Zari weaving, Bagru prints, and block prints, Rajasthan employs skilled craftsmen. The express is a customer's paradise because such beautiful handmade items are frequently found at low prices. In the region that is renowned for its kings, there is so much to learn. The many undiscovered treasures in Rajasthan include the music, expressions, dance patterns, and celebrations. The multifaceted state of betrayal is waiting patiently for you to figure out how to move through its sand. (Tours) Farmers or the pastoral class come next because agriculture is the main source of employment in that area. They engage in everything from farming to raising cattle. They are followed by artisans, painters, sculptors, and potters. Tribal groups like the Bhils, Sahariyas, and nomadic Kathodis make up the final group of people. (“Rajasthan People - People in Rajasthan - People and Lifestyle of Rajasthan - Rajasthani People”)

6.1.2. Technical Factors

6.1.2.1. Construction trends

India's biggest state is Rajasthan. Villages are home to the majority of the population. They continued to live in traditional homes until the 1980s because they were resilient to environmental changes, high temperatures, and violent windstorms. Beginning in April and peaking in June in Rajasthan's north-eastern region, the Andhi is a unique sort of storm activity. Although these conventional homes were built using materials that were readily available in the area and following conventional construction methods, they are responsible for significant losses in both life and property. However, the geographical limitations that existed in the past have been removed in the modern-day by new technological advancements and the accessibility of building materials. But the current housing situation in rural Rajasthan has reached a difficult stage. The use of traditional methods, craftsmanship, and materials is no longer necessary. Because contemporary resources like cement, steel, and bricks are so readily available, even the most distant regions of Rajasthan can advance. However, these ineffective

methods for rural modern homes do not function well in the local climate or environment, and there is no guarantee of their success in the face of environmental impacts and natural disasters. (Sharma et al.)

The government created accommodations for the idea through a number of programs, notably the Jawaharlal Nehru National Urban Renewal Mission and its derivative, the Urban Infrastructure Development Scheme for Small and Medium Towns. For the state of Rajasthan to meet its development objectives, the government has prioritized the growth and development of important urban infrastructure and services. In terms of urban infrastructure, water supply, sewage, and drainage were top concerns. (Rajasthan Urban InfRastRUctURe Development PRoject a 2-Decade Alliance to Advance Statewide Urban Change Project Lessons, ResuLts)

Housing Commissioner Pawan Arora announced that the multi-story buildings that the Rajasthan Housing Board will be constructing in the future will be designed on the green building idea, taking into consideration the needs and wants of the future. According to him, it will be introduced in Jaipur as part of the Chief Minister's Jan Awas Yojana, the All-India Services Residency, Pratap Nagar, the Indira Gandhi Yojana, and the Chief Minister's State Employee Housing Program. He discussed the advantages of green building; how projects built with this idea will contribute to reducing climate change, and how consumers will be able to purchase affordable housing at a lower cost. (Pioneer)

Traditional building methods are being quickly replaced by new structures built with modern methods and modern building materials in Rajasthani villages as they move toward modernization. This is also supported by the decreased rate of kutcha dwelling construction. Traditional practices lead to sustainable development because local resources are used and have lower embodied energy. Only the design chosen was impacted by climate control. It appears to be a courtyard in the middle, encircled by high walls, a balcony, and tiny wind vents to let air in while keeping dust out during sandstorms. Traditional home construction has adhered to a cost-effective housing typology that focuses on using contemporary building materials while upholding fundamental architectural principles. Natural stones are widely available locally in Rajasthan's northern and eastern regions. As a result, we can utilize flat stone Patti slabs instead of R.C.C. slabs, which need less energy to produce and don't need steel, cantering, or

shuttering. It is less expensive than R.C.C. roofing. In Rajasthan, there are inexpensive stone slabs that can be used. The stone slabs only need to be lifted to the roof and set on the beams, making it a quicker operation. Due to the thick walls created by stone masonry, it offers greater climate control. Because the wall is thicker, it provides more thermal comfort. Construction of walls requires a lot of effort and benefits the local economy. Plaster on the wall is not necessary for dressed stone masonry. In Rajasthan, it is also a common construction technique. Instead of employing R.C.C., small stone slabs can also be fixed as stone lintels; steel or concrete are not required for either the lintels or the slab. Large stones are put into concrete in a rectangular moulded to reduce the need for cement. After remoulding, the blocks are allowed to dry for two weeks before being used to build masonry walls. (Sharma et al.)

6.1.2.2. Energy trends

The expansion of household comforts, fast industrialisation, and economic growth are all factors that are leading to a significant rise in the amount of energy that is consumed worldwide. Access to energy that is not only cheap and dependable but also environmentally friendly is another factor that is essential for the long-term prosperity of any nation. Rajasthan is the state that is leading the way in terms of making India's electrical infrastructure more cost-effective, ecologically friendly, and economically viable. Additionally, the state is working to improve India's potential for using renewable energy sources. In addition to being the most extensive geographical area in the country, Rajasthan also boasts the highest annual average of 300 to 330 days that are free of cloud cover and enjoy clear skies. Because of the state of Rajasthan's high radiation levels, its strong winds, and its access to enormous arid expanses, solar parks may be created there. It is possible that the area of Jodhpur is home to the largest solar park in the world (2.25 GW). The state of Rajasthan has the capability of producing 9.8 gigawatts worth of non-conventional power, which accounts for 45 percent of the state's overall power generation capacity. Despite the fact that renewable energy sources only account for 17.6 percent of the state's total on-grid output, this capacity is responsible for 56.5 percent of the state's total grid-connected electricity. According to projections, the target of 175 gigawatts (GW) of renewable energy that Rajasthan

has set for the year 2030 is anticipated to be surpassed by 22.6 GW. This development will result in the addition of a total of 18 GW of new solar energy as well as 4 GW of additional onshore wind energy. According to the state's economic assessment for 2019–20, the total installed generating capacity in Rajasthan has increased to 21,175.90 MW, which is an increase from the previous level of 21,175.90 MW in 2018–19. Figure 26 presents a visual representation of the distribution of renewable energy capacity derived from a variety of sources. (Renewable Energy Sources in Rajasthan for Sustainable Development)

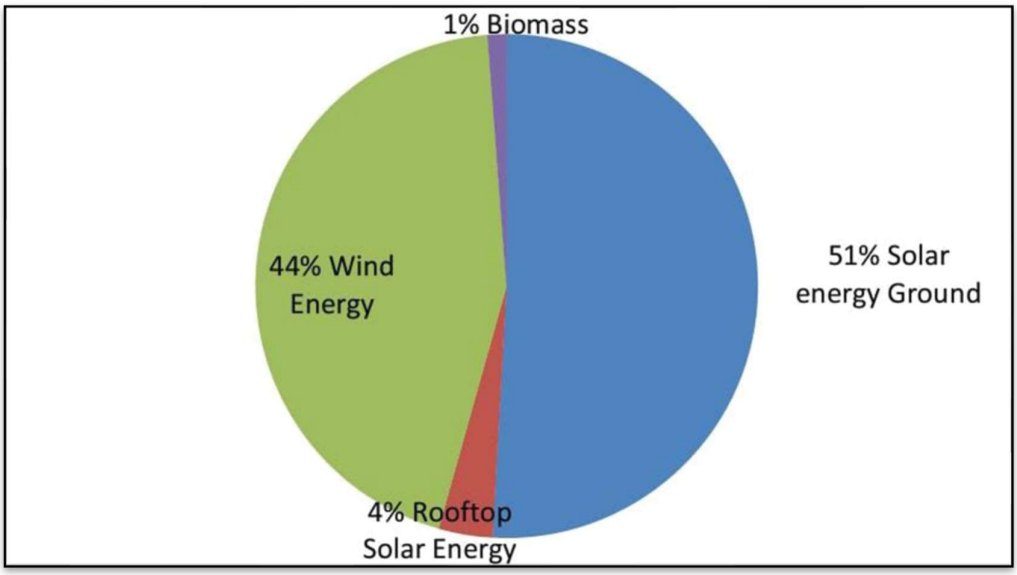

Figure 27: Source-wise total Renewable Capacity of Rajasthan

(Source: Renewable Energy Sources in Rajasthan for Sustainable Development)

A higher global quality of life, accelerated industrialization, and an expanding global economy are all factors that are leading to a significant increase in the amount of energy that is being consumed worldwide. Another issue that is crucial to the long-term prosperity of any nation is the availability of energy that is affordable, dependable, and safe for the environment. In terms of making India's electrical infrastructure more ecologically and economically sustainable, Rajasthan is now in the vanguard as a leading state in India. The government of India is also working to improve the country's capacity to exploit renewable energy sources. In addition to having the biggest geographical

territory in the country, Rajasthan also has the highest annual average of days without cloud cover and brilliant sky, which ranges from 300 to 330 days on average. Due to the high radiation levels, strong winds, and access to huge arid plains, solar parks may be created in Rajasthan. Rajasthan is located in India. The area of Jodhpur is home to what is claimed to be the largest solar park in the world (2.25 GW). According to the entire energy producing capability of the state of Rajasthan, the state has the potential to generate 9.8 gigawatts (GW) of power from non-conventional sources. Although renewable sources provide just 17.6 percent of total on-grid output, their capacity accounts for 56.5 percent of the state's total grid-connected power capacity. According to the projections, the target of 175 GW of renewable energy that the state of Rajasthan has set for the year 2030 would be exceeded by 22.6 GW. As a direct consequence of this new construction, there will be an increase of 18 GW in solar power capacity and 4 GW in onshore wind capacity. According to the state's economic assessment for 2019–20, Rajasthan's total installed generating capacity has increased to 21,175.90 MW, up from the previous level of 21,175.90 MW in 2018–19. This represents an increase from the previous level of 21,175.90 MW in 2018–19. The distribution of renewable energy capacity produced from a variety of sources is illustrated in Figure 27. These sources include wind, solar, and hydropower, among others. (Renewable Energy Sources in Rajasthan for Sustainable Development)

Table 1: Increase in Solar Power Installation in Rajasthan

YEAR	CAPACITY ADDED (MW)	CUMULATIVE CAPACITY (MW)
2014-15	942.10	942.10
2015-16	327.83	1269.93
2016-17	543.00	1812.93
2017-18	519.84	2332.77
2018-19	894.02	3226.79
2019-20	1911.12	5137.19

(Source: Renewable Energy Sources in Rajasthan for Sustainable Development)

Wind energy is created by a combination of factors, including the spinning of the earth, solar energy, the cooling effect of water, the temperature differential between land and sea, and other factors. It draws its electricity from a diverse collection of sources. Because of advancements in turbine technology, wind power is becoming an increasingly practical option for generating energy. It is projected that by the year 2020, India would

have a total installed capacity of 38.124 GW, which will place it as the fourth-largest wind power generator in the world. The administration of Rajasthan is placing a significant amount of emphasis on the development of alternative forms of electricity production throughout the state. A policy titled "Policy for Promoting Generation of Electricity from Non-Conventional Energy Sources" was introduced by the "Government of Rajasthan" in 1999 with the intention of encouraging the use of renewable energy sources. After some time had passed, the "Government of Rajasthan" came out with an official "Policy for Promoting the Generation of Electricity from Biomass, 2010.". (Renewable Energy Sources in Rajasthan for Sustainable Development)

6.1.3. Economic Factors

6.1.3.1. Economic growth

Rajasthan is a major producer of lignite, rock phosphate, copper, sandstone, limestone, marble, gold, and silver. Rajasthan is India's second-largest cement manufacturer and offers a variety of chances for organic and contract farming. It's intriguing to learn that Jaipur is home to the biggest centre in the world for cutting and polishing gemstones. With up to 34.59 million visitors annually, Rajasthan presents several potentials for the country's luxury tourism industry to grow. The gross state product (GSDP) of Rajasthan grew by 12.83 percent between 2004–05 and 2014–15, and small businesses and the industrial sector as a whole contributed 2.5 percent to Rajasthan's GDP. Rajasthan is rich in metals including lignite, gypsum, mica, copper, and zinc. The state's textile sector is expanding quickly and is home to significant cotton production. Caustic soda, sugar, ball bearings, vegetable oil, woollen products, rugs, and cement are some more private enterprises in Rajasthan that are on the right track. One-tenth of the salt produced in India comes from the state. 90% of India's mineral deposits are in Rajasthan. (“Economy of Rajasthan”)

Out of the twenty million hectares of land that is being cultivated, only a marginal twenty percent of the land is being irrigated. It is important to note that the agricultural sector accounts for 22% of Rajasthan's economy in this case. Wheat, barley, gramme, bajra, vegetables, fruits, pulses, gramme, oil seeds, maize, ground nuts, and spices are

among the main crops grown in the state. The crowd is sown in June and July and harvested in September and October. The two primary irrigation methods used in Rajasthan are tanks and wells, and the state cultivates fruit all year long. The two primary irrigation methods used in Rajasthan are tanks and wells, and the state cultivates fruit all year long. According to the Resurgent Rajasthan Partnerships Summit 2015, which took place in Jaipur on November 19 and 20, deals worth Rs 1.5 lakh crore have been made with companies operating in the mining, petroleum, solar, textile, and solar energy sectors. Rajasthan is actively pursuing numerous investments to establish itself as a top investment location in India due to its favourable climate. Rajasthan will see an increase in the number of textile units opening up after receiving investment proposals worth Rs 5000 crore in the industry. This would lead to the creation of over 25,000 new jobs in 2016 and 2017. The state boasts a sizable pool of highly skilled workers who are contributing to the improvement of its economy. Rajasthan already has a single-window clearance system (SWCS) in place in addition to the Bureau of Investment Promotion (BIP), which was established to concentrate on projects worth more than US$ 2.2 million. (“Economy of Rajasthan”)

6.1.3.2. Unemployment

The nation's unemployment rates are at an all-time high, and in some places, the situation is so bad that every second or third graduate is unemployed, according to the Center for Monitoring the Indian Economy's most recent data. On the other hand, numerous states have relatively low unemployment rates. According to the survey, out of all the Indian states, Rajasthan has the highest jobless rate. In the seventh-largest state by population, every second graduate lacks the resources to make even a subsistence living. With 20.67 lakh graduates unemployed, Rajasthan has the highest percentage. In addition, Rajasthan has the biggest number of unemployed persons overall, 65 lakhs, which is roughly 1.5 to 3 times greater than the states with the highest populations. College graduates' unemployment has climbed four times in Rajasthan over the past four years, while it has increased more than three times in Delhi, the nation's capital. There aren't many fresh job openings in India for candidates to take, and this depressing situation has particularly harmed the country's educated youth.

States like Himachal Pradesh, Jharkhand, and Haryana, which are quite comparable to Rajasthan, are also suffering greatly from this dearth of work possibilities, with every third graduate being unemployed. According to the CMII data, there are twice as many unemployed women living in urban areas of the nation as there are in rural ones: every fifth woman. When looking at it from the standpoint of gender and place of residence, urban women have the highest rate of unemployment, followed by their counterparts in rural areas, and urban men, and the lowest rate is seen among rural men. (Datta)

According to a survey by the Centre for Monitoring Indian Economy, Rajasthan's unemployment rate jumped 5.9 percentage points, reaching 17.7 percent in April 2020. (CMIE). Longer-term, the jobless rate increased from 1.6 percent in September 2017 to its present level (Figure 28). (“Business News, Shares and Stock Markets News Live - Latest IPO, Mutual Funds, Budget, Income Tax, and Finance News”)

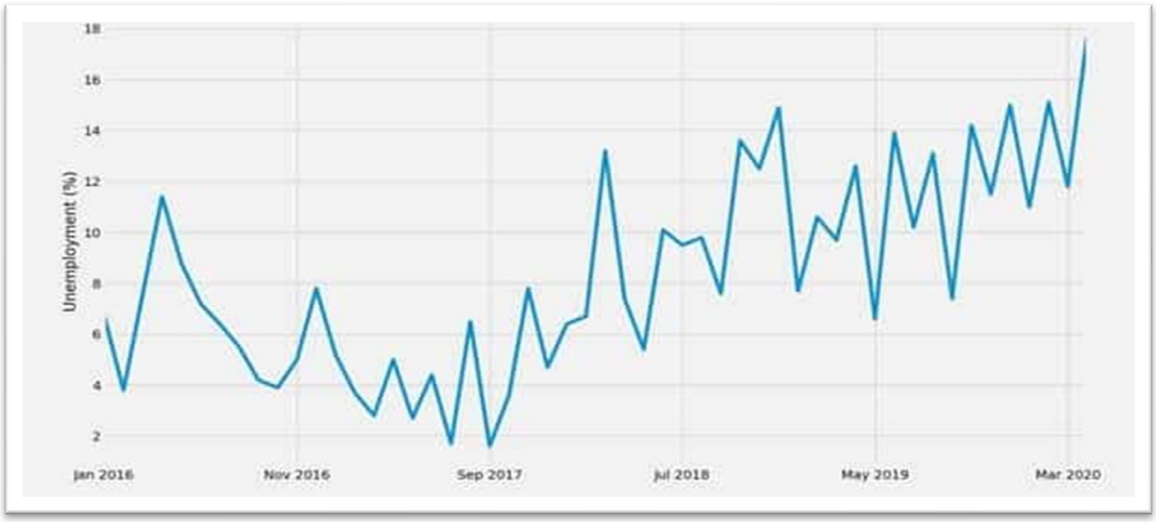

Figure 28: Monthly Unemployment Rate in Rajasthan (Source: Analytics)

The focus is on green jobs. It was also clear from debates that had moved from a small number of households' coffee tables to Finance Minister Nirmala Sitharaman's Budget Speech regarding the recently announced Union Budget. In order to develop green jobs, the Budget gave high priority to sectors including artificial intelligence, geospatial systems and drones, semiconductors and their ecosystem, clean transportation systems, the space industry, and green energy. (“Green Jobs” Key to Employment Crisis?”)

6.1.4. Ecological factors

6.1.4.1. Environmental Impact

The largest state in the country is Rajasthan. The state is divided diagonally into the western, arid part, and the eastern, semi-arid region by the Aravali Range, which runs from northwest to southwest. The majority of the state's western region, or about 61%, is made up of desert. The state only has 1.1 percent of the nation's total water resources despite having 5.5 percent of the population and 10.5 percent of the land area. The 13 other rivers in the state are not perennial, except the Chambal. The only source of annual renewable water supply is sparse precipitation. The state is hence vulnerable to frequent droughts. (“Rajasthan Environment”)

Key Environmental Challenges in Rajasthan

Rajasthan needs to solve several environmental issues to maintain equitable and sustainable economic growth. These include:

- The rise in water demand.
- Mineral deposits in forested areas whose exploitation has been prohibited by forest policy.
- Reducing pollution in the face of urbanization and industrialization.
- The expansion of the population and the ongoing influx of migrants into urban areas.
- Strike a balance between conservation efforts, which aim to preserve the natural processes that sustain biodiversity, and the exploitation of forests for products of economic value (such as food, medicines, and lumber).
- A plan for supplying the rural people with electricity for lighting and cooking.
- The growth of the tourist sector also presents a problem because it puts a lot of strain on public services (such as transportation, water, and sanitation), land use, wildlife, and forests, as well as the socio-economic structure of the State.

- State governments, as well as the federal government, are becoming more concerned about climate change.
- The connection between the environment and poverty. (*Microsoft Word - Rajasthan Environment Book Free Sample.docx*)

Objectives Of Rajasthan Environmental Policy

- The National Environment Policy of 2006 and the State Environment Policy have the same goals and guiding ideas. The SEP aims to, broadly speaking:
- Conserve and Improve Environmental Resources by safeguarding pivotal ecosystems and natural and man-made lineages; Maintaining Equitable Access to Environmental Resources for All Sections of Society; Ensuring Wise Use of Environmental Resources to ensure Inter-Generational assets; and Safeguarding Environmental Resource Efficiency to Maximize Productivity and Lessen Environmental Deterioration.
- Ensure the Environmental Sustainability of Key Economic Sectors by incorporating environmental considerations into economic and social growth policies, plans, programs, and projects to prevent these from depleting the very resource base on which they rely.
- Ensure transparency, prudence, accountability, time and cost-effectiveness participation, and regulatory independence in the environmental management and regulation processes to improve environmental governance and capacity. The plan should also provide more funding for environmental protection and encourage successful collaboration among all stakeholders. (Microsoft Word - Rajasthan Environment Book Free Sample.docx)

6.1.5. Political factors

Rajasthan has a rich history with several rulers and kingdoms in the past who have left an amazing history behind, in addition to having a robust tourism industry. Since the establishment of the British colony in India, the politics of the State have been carried out by rulers and politicians during the last millennium. Since Rajasthan was granted

statehood on March 30, 1949, the state's government has been active. For the time being, nevertheless, let's learn more about the administration of Rajasthan, its political past, and its power over the State. Its rich history will endure for generations to come. The Indian National Congress and the Bhartiya Janata Party, the two major political parties, have made Rajasthan's politics extremely complex ever since it became a state. Since its creation, the Rajasthan government has had to take steps to integrate the princely state that has seen several kingdoms occupy it throughout the last millennium, leaving a legacy in the shape of historical sites and descendants. Rajasthan has been able to draw tourists from all over the world thanks to its vibrant culture, extensive history, and enduring legacies of previous dynasties. The State has a long history that goes back 5000 years. (“Government of Rajasthan”)

6.1.5.1. Government Approach

To promote the idea of green buildings, the Rajasthan government intends to make it essential for structures larger than 500 square meters to incorporate solar panels, greenery, and rainwater harvesting systems. To make even the current government buildings more energy-efficient, the government is reportedly considering hiring energy specialists. (“Rajasthan to Promote Green Buildings”)

Since before independence, the Public Works Department (PWD) has played a significant role in the growth of the state. The department's primary responsibilities include developing and maintaining roads, bridges, and government structures. The department also serves as the State Government's technical advisor on these issues. Irrigation and public health engineering were initially PWD units. These units were subsequently given independent companies to handle an expanded area of work in the relevant field. Since the Department's founding, it has strived via its ongoing pursuit of excellence and setting benchmarks for engineering feats. The Gramm Gaurav Path Scheme's major goal is to build cement concrete roads and drains at each Gram Panchayat Headquarters to create a nice and clean environment and to offer commuters roads that are damage-free. The roads built under this plan range in length from 0.50 km to 2.00 km. At each Gram Panchayat Headquarters, a road with a length of 1 km on average is taken. (“Home”)

6.2. SWOT Analysis

One of the most fundamental and widespread approaches to strategic analysis is the use of a SWOT analysis. The SWOT analysis hasn't lost any of its lustre after more than half a century of usage, despite the fact that most management approaches and procedures are ultimately phased out and replaced by new ones. This is due to the fact that it may be used in any circumstance and adjusts to the particulars of any objective in a flexible and adaptable manner. It has applications in a variety of fields, including sales and marketing, as well as finance, manufacturing, and research and development. (CEOpedia, 2019)

SWOT is an abbreviation that stands for Strengths, Weaknesses, Opportunities, and Threats. This method's name comes from this acronym. A framework that may assist in evaluating and comprehending the internal and external variables that may provide opportunities or hazards for a strategy, project, or target is referred to as a SWOT analysis. Internal elements may be broken down into strengths and weaknesses. They are features of a project or goal that offer it a relative edge over other projects or goals (or disadvantage, respectively). On the other hand, opportunities and risks come from the outside world. These are examples of external forces. Opportunities are aspects of the external environment that the management team has the ability to capitalise on to enhance the performance of the project. The term "threat" refers to aspects of a company's external environment that have the potential to put the company's competitive advantage(s) or even its ability to continue operating as a going concern in jeopardy. (CEOpedia, 2019)

The purpose of the SWOT analysis is to determine both the internal and external elements that are favourable and unfavourable to the achievement of the objective. In most cases, a PESTEL analysis, a STEEP analysis, a Porter's 5-forces analysis, or another evaluation framework is utilised in combination with a SWOT analysis. The findings from a SWOT analysis will assist the analyst community inform the model assumptions that they use. It is able to provide fresh insights on what the present scenario is and assist you in developing the approach that is most appropriate for any given circumstance. (CEOpedia, 2019)

In this study, a SWOT analysis is used to determine the strengths, weaknesses, opportunities, and threats that are being faced for the transformation of the construction industry in Rajasthan towards green construction methodologies in order to make a leap towards becoming a green economy. The results of this evaluation can be found in the following section. In the prior part of this research, the STEEP analysis was carried out to get the necessary supporting inputs and insights to perform this SWOT analysis.

6.2.1. SWOT Analysis for Green transformation of construction sector in Rajasthan

Table 2: SWOT analysis of green transformation for construction industry in Rajasthan, India.

Strengths:	**Weaknesses:**
1. Cost-benefit of green construction 2. Government Initiatives 3. Resource efficiency 4. Green Value 5. Employment potential	1. Initial cost escalation 2. Lack of awareness and skilled professionals 3. Lac of recycling and waste management infrastructure 4. The absence of performance-based incentives or regulation
Opportunities:	**Threats:**
1. Emerging construction market 2. Urbanization & housing trends 3. Vernacular construction 4. Abundancy of solar light 5. Urban policy 6. Corporates & Private developers	1. Political scenario 2. Motivation and coordination bureaucracy 3. Education structure 4. Availability of resources 5. lacks the technical expertise to execute projects

5.2.1.1. Strengths:

S1- Cost-benefit of green construction

To fully understand the financial and logistical advantages that come with sustainability, one has to have a long-term perspective. The financial advantages of environmentally responsible building practises become apparent throughout the course of a project's lifetime. It is a common misconception that incorporating environmentally friendly policies and procedures into a building's design and planning phases would result in significantly higher costs. In 2005-2006, the cost of constructing green buildings was around 5-6 % more than the cost of constructing conventional structures. This was mostly due to the pricier goods and raw materials that were energy efficient. However, since there has been an increase in demand for these inputs, the prices have decreased. Green buildings, on the other hand, are now able to recoup their initial higher costs in as little as two to three years via the cost reductions they achieve in their overall energy and water use.

In addition to this, the advantages of using environmentally friendly building approaches are as follows:

Tangible benefits

- Savings on water may range from 30 to 50 percent.
- Savings on energy can range from 20 to 30 percent.

Intangible benefits

- Improved air quality.
- Optimal exposure to natural light.
- Health and wellbeing of the building's residents.
- protection of the nation's dwindling natural resources.
- Improved ability of the project to attract customers.

Government Initiatives

India is currently the second largest country in the world, and it has a green building footprint that is equal to 4.68 billion square feet. This indicates that India has the potential to soon become the leader in this field. The state of Rajasthan has assumed a leadership role in this area and has the potential to play a big part in assisting the country in achieving the objective of the IGBC. The government is providing support for the environmentally responsible development. Rajasthan is considered to be an example for other states because it already has 83 projects that have been registered with the Indian Green Building Council (IGBC) and has a footprint of 103 million square feet of green buildings.

There are many different offers and incentives that can be taken advantage of for a wide variety of projects, including residential developments, industrial units and parks, research and development endeavours, warehousing and logistics parks.

S2- Resource efficiency

Green buildings are not only less harmful to the environment, but they also consume less energy and water. A green infrastructure makes the most efficient use of natural resources and the health benefits they offer throughout the entirety of an infrastructure's life cycle, beginning with the selection of a location and continuing through design, construction, operation, and maintenance. The management of rubbish is a significant issue in urban India, and this plan incorporates infrastructure for the aim of addressing that issue.

Green homes in Rajasthan save their residents between 40 and 50 percent of the energy they consume and between 20 and 30 percent of the water they use when compared to traditional buildings. The constraints on land usage, the availability of energy supplies, and access to cultural facilities are only some of the problems that may be helped by implementing ecological practises. The innovative implementation of novel design concepts, as well as new materials, renewable energy sources, and other forms of energy, can result in increased liveability and a reduction in operational costs. Green building infrastructure provides a strong basis for the transformation of the construction sector in Rajasthan. This is because the state suffers from a serious lack of energy and water supply.

S3- Green Value

This customer is a powerful and influential force, and they are committed to the possible environmental gains that the project may offer. It is the combination of typical green technologies and other design aspects, such as waste management, water recycling, and rainwater harvesting, as well as the use of renewable energy sources, that contribute to the enhancement of the green value. Other design aspects that contribute to the enhancement of the green value include an efficient design that optimises natural ventilation, minimal heat ingress for thermal comfort and good indoor air quality, limiting the use of non-renewable resources, and using more environmentally friendly, recyclable materials.

S4- Employment Potential

The expansion of the green building sector has the potential to bring about huge economic growth by defining new development sectors, which will, as a result, bring about a new wave of job opportunities. Regulations and standards concerning environmentally friendly building practises need to be strictly adhered to and put into practise on the ground as the industry continues to expand. The positive demand will not only result in the creation of direct employment opportunities for engineers, designers, and architects, but it will also have a significant positive impact on the entire ecosystem.

When compared with the development of traditional fossil fuel energy sources, the transition to a low-carbon economy is typically characterised by a higher degree of capital- and labour-intensiveness. This has the potential to positively impact the production of material net new jobs. The path that India will take to achieve its goal of reaching net-zero emissions by 2070 may make it possible for the country to generate more than fifty million new employments.

The transition to sustainable energy ecosystems will be the source of the greatest increase in employment opportunities (more than fifty percent of the overall estimated net job creation). This transition will be led by the expansion of renewable power generation, which will be followed by the development of power networks and electrification infrastructure (including in the transportation and manufacturing sectors). The next major source of employment creation would be the Green Buildings, Infrastructure, and

Cities pillar, which has the potential to offer up to 25 percent of the predicted job creation for India. This would make it the second largest source of employment generation in India. Despite this benefit, however, there will be a net loss of jobs in the coal mining and processing industries, as well as in coal power generating and crude oil extraction, processing, and refining industries.

5.2.1.2. Weaknesses

W1- Initial cost escalation

Higher costs and the increased expense of using sustainable building materials is one of the primary issues that is becoming a barrier to the widespread adoption of green building methods. Both the customers and the developers are hesitant about expanding their spending. Because the construction of green buildings requires many different kinds of equipment, many developers are apprehensive about including green elements in their buildings because of the expense involved. Even though green infrastructure is anticipated to deliver considerable financial advantages and cost-savings over the long run, most developers are hesitant to pay the high expenses involved with green certification. Due to the risks associated with the construction market the priority is still to keep the initial project cost as low a possible is still on the top.

W2- Lack of awareness and skilled professionals

The advantages and significance of sustainable construction techniques are still not widely understood, not just by customers but also by developers. People still have the impression that it is an expensive choice. The majority of developers, to this day, do not have enough knowledge of many of the green building materials available, thus they continue to rely on conventional construction practises. People have a tendency to be resistant to change, which makes it tough for them to go outside of their comfort zones and choose an alternative technique of construction. One of the most significant challenges to the development of the green construction business in Rajasthan is the widespread ignorance that exists among the general population.

For industry people it is challenging to keep up with the ever-evolving technological landscape and novel approaches to building. One of the primary reasons for the sluggish adoption of environmentally friendly construction practises is a shortage of competent professionals and available labour. There is a shortage of necessary knowledge and skills for green building construction across the board, across all of these groups: policymakers, architects, engineers, contractors, and labourers. Additionally, the state's existing educational system and curricula do not provide sufficient room for the expansion of environmentally friendly construction practises in the state.

W3- Lac of recycling and waste management infrastructure

The NITI Aayog estimates that the construction industry accounted for 20% of total material demand in 2007, putting India in second place globally in terms of material consumption. Between 1997 and 2007, the construction industry's material consumption increased by more than 1 billion tons, making it the fastest-growing industry in terms of absolute material consumption. Material consumption is expected to climb by more than two-fold by 2030, due to population growth, urban expansion, and rising ambition levels. More attention is needed in the industry, according to NITI Aayog, which claims that 70% of the structures that will exist by 2030 are yet unbuilt. In Rajasthan, it is illegal to properly dispose of construction and demolition (C&D) debris. Concrete, earth, steel, wood, and plastics, among other types of waste, aren't even separated into separate streams. Because of the limited amount of space available on most building sites, garbage is not segregated and is instead deposited beside the road.

To effectively manage C&D garbage, urban local governments could not take a comprehensive strategy that included improving waste collection, waste transportation, constructing a treatment facility for C&D waste, and promoting recycled goods on the market. As a result of a lack of understanding, there is a risk to sustainable development.

W4- The absence of performance-based incentives or regulation

There is a lack of performance-based incentives or regulation for green building because it is "voluntary" to go green in the first place; this needs to be addressed. Buildings that adhere to energy and water efficiency standards, recycle waste, and work to

continuously improve the quality of the indoor environment in urban infrastructure do not have effective incentives offered to encourage greater adoption of sustainable design, construction, and operation. Green building concepts and sustainability techniques aren't adequately acknowledged, which means that organisations that adopt these practises aren't adequately rewarded for their efforts. Cities and towns should be encouraged to redevelop in order to encourage developers to use green building techniques and methodologies.

5.2.1.3. Opportunities:

O1- Emerging construction market

The biggest state in India, Rajasthan is also one of the states with the most diverse cultural traditions. The real estate industry in Rajasthan is thriving, and as a result, it is profitable to invest in property here since the majority of homes are offered at prices that are reasonable and are located in areas that are handy. Properties suitable for residential and commercial use may be found on the Rajasthan real estate market.

The tremendous commercial potential of the real estate market in Rajasthan has already attracted big interests from some of the major real estate developers in India, who are entering these areas to invest on properties that are readily accessible for a low price and generate substantial profits. As India's population continues to rise, the demand for real estate in the state of Rajasthan, which is now the eighth most populous in the country, will continue to rise as well. Because of the excellent conditions that now exist in the real estate market in Rajasthan, an increasing number of investors are selecting to invest in property located in this state. Due to the fact that Rajasthan is equipped with some of the conditions that are considered to be the most favourable for property investment, it is emerging as the only state that is anticipated to have the greatest number of investments in property, both domestically and internationally making it a suitable place to promote the green construction practices.

O2- Urbanization & housing trends

Over the course of the past several years, consumers' awareness of their impact on the environment has grown significantly. Modern customers are aware of the impact their consumption habits have on the environment and are committed to buying products that are environmentally friendly. As a direct consequence of this, developers are embracing a wide variety of green building approaches and projects. In addition to providing a healthy living environment, green houses are built to minimize heat gain and maintain a high level of indoor air quality, both of which are critical to the well-being of their residents. People have become aware of this because of the rise in the number of people who are working from home in recent years. Green homes are designed to ensure adequate ventilation, indoor-outdoor air circulation, and minimal heat ingress for thermal comfort.

The majority of modern homebuyers in Rajasthan have the same sentiment, which means that they are aware that there are financial benefits associated with owning a green building house over the long run, but that the cost is also quite significant. During this time, he remains vigilant about the health, quality of life, and ecology of the surrounding area. Therefore, if a house might help him maintain his health, he would be quite interested in hearing more information on environmentally friendly structures when developers present their designs.

O3- Urban policy

Investors are finding it advantageous to invest in Rajasthan because of the state's stable political climate, which encourages progressive urban policies. The absence of property tax is one of the most enticing aspects of owning property here. Investors are coming to Rajasthan because property taxes can be extremely costly, depending on the size of the property. In Rajasthan, stamp duty, a charge imposed on property papers, is quite cheap. The benefits accrue to both the purchasers and the sellers of real estate. Comparatively speaking, the costs of starting a business or purchasing real estate in Rajasthan are quite cheap. Investment in this area makes sense because of the relatively low start-up expenses.

The state's urban development and housing (UDH) department has drafted new model building ordinances to encourage the construction of environmentally friendly structures. At no cost to developers, the government of Rajasthan has planned to increase the floor-area ratio (FAR) by up to 15%. In addition, the Rajasthan government plans

to make rainwater collection, solar panels, and green roofs with plants and trees essential for buildings larger than 500 square metres in order to promote green building. In addition, the government plans to hire energy specialists to help them retrofit all of its current federal buildings. Group Housing Schemes (GHS) are permitted on ground no smaller than 750 square metres, according to the city's rules. For group housing plans in Jaipur, the road must be at least 18 m wide. Additionally, ten percent of all residential units must be set aside for residents from the most economically disadvantaged neighbourhoods.

O4- Corporates & Private developers

The market is reacting to the policy direction that has been set by the government, to the growing interest in environmentally friendly structures, and to the progressively increasing market demand. A growing number of private developers are considering making investments in environmentally friendly building practises and marketing their completed projects accordingly. In addition, corporations are playing a significant role in the promotion of environmentally friendly buildings as part of their corporate social responsibility (CSR) efforts, which in turn promotes the reputation of the corporations. This tendency is still mostly confined to business and office complexes rather than residential construction at this point.

On the other hand, marketing for certain housing complexes increasingly promotes the fact that a building is green as part of their sales pitch, and the growing popularity of the green-building grading systems also shows evidence of a growing interest in the topic. Given that the majority of green buildings are marketed as luxury flats and structures, it is fair to say that this is mostly a trend among those in the upper middle class. When combined with the right kind of marketing, this has the potential to generate a demonstration effect that will make environmentally friendly buildings appealing.

O5- Vernacular construction

The state of Rajasthan is well-known for its extensive history as well as its well-preserved ancient buildings. The idea of constructing using natural materials may be traced all the way back to the beginning of the society. The traditional architecture of

Rajasthan has a strong relationship to the state's natural beauty as well as its artistic and scientific heritage. Due to the fact that this is a desert and a hot zone, making the best possible use of the resources that are available has always been a primary concern.

In building activities, it is common to witness the use of mud, lime, cow dung, husk, natural additions, clay, earthen pots, and other similar materials. The traditional architecture has a tendency to develop throughout the course of time so that it can more accurately represent the environmental, cultural, and historical context in which it resides. It is also significant in the design of modern things.

Vernacular architecture in Rajasthan refers to the unpretentious and practical design of rural homes in the region. These homes were constructed using regional resources and were intended to fulfil the requirements of the residents of the area. The architects who constructed these homes did not get any professional training in architectural design, and as a result, their work reflects the vast diversity of Rajasthan's environment, locally accessible construction material, and the complex variations in local social norms and craftsmen. It has been noticed that the vernacular style of architecture accounts for ninety percent of all construction in the rural areas of Rajasthan.

It was made by local craftsmen for the common, day-to-day usage of the people who live in the area. Lime and mud add a more environmentally friendly value to the home when they are used. In compared to the manufacturing of cement, the production of lime results in extremely little emissions of carbon dioxide. Lime and mud are two ingredients that are not difficult to get by in low-income and rural settings. These are able to provide efficient protection from the high heat of Rajasthan even for the neediest groups, which are unable to afford mechanical techniques for air conditioning. This is because these may be used to cool the air. There are several options for recycling such materials available to consider. Moreover, people of Rajasthan are aware about the potential benefits of the sustainable buildings which is again a significant advantage.

O6- Abundancy of solar light

Rajasthan's empty terrain and steady sunlight make it suitable for solar energy. Sunlight provides the greatest energy. Rajasthan is India's third-largest solar generator.

Rajasthan has several solar energy-related business prospects. Rajasthan has the Great Indian Desert. It's in the northwest. A few foggy days make the state ideal for solar electricity. A wide, sunny area abounds. The state is sparsely populated when the sun shines. Solar power systems and plants in less populated locations might be viable, bringing clean energy to distant people without electricity.

Rajasthan's environment has long been suited for renewable energy, and policies have helped the sector flourish. In addition to infrastructural support, the laws offer several incentives for renewable energy projects. The Rajasthan Investment Promotion Scheme 2019 and other initiatives boosted investment. RIPS 2019 prioritises renewable energy. Rajasthan's government has also approved net metering for rooftop solar up to 500 kW for all users. Due to a midday power imbalance, Rajasthan imports electricity from other states. The state might become a net exporter of power if it invests in renewable energy efficiently. Exporting power interstate would increase India's energy security and load balancing capabilities. If Rajasthan realises its solar power potential, it may be one of the major contributors to India's 450GW renewable energy ambition by 2030 — and a model for other states.

5.2.1.4. Threats:

T1- Economic threats

The built environment has been significantly laden with a rise in price of major important building materials over the last year, which has resulted in cost uncertainty on a significant scale within the construction sector. The majority of the price increase can be attributed to the parallel increases in the cost of essential building materials such as cement, reinforcement steel, structural steel, stones, and so on. Because of the knock-on effect that the COVID-19 procedures and their related expenses have had, the labour cost has also increased by 12–15 percent, in addition to the increase that occurs on a regular basis. Since the year 2020, the price of steel has increased by between 45 and 47 percent, reaching Rs 62,300 per metric tonne. The price of copper has increased by between 70 and 75 percent, reaching Rs 7,45,000 per metric tonne. Next in line are aluminium prices, which have increased by between 55 and 50%, reaching Rs 2,03,385 per metric tonne; PVC items, which have increased by between

80 and 90%, reaching Rs 1,65,000 per metric tonne; and, last but Among the primary contributors to this cost rise are, to mention just a few examples: a growing raw material scarcity; rising global material costs; production issues in the industries of steel, cement, aluminium, copper, and PVC; logistical challenges; and rising fuel prices. The beginning of the pandemic, which led to an abrupt halt in economic activity throughout the world, made it abundantly clear that the market for commodities would experience a time of volatility. We believe that one of the primary factors that drives real estate decisions is cost. When looking at the overall development of the project as well as the costs associated with the project, it has been noticed that the cost of materials almost accounts for close to sixty percent of the total cost of construction, and that these materials have been increasing at an unpredictable rate. The desire to embrace green building technology, which adds more initial cost to the projects, will be further impacted by inflation, uncertainty, and price hikes, all of which will lead to price increases.

T2- Motivation and coordination of Bureaucracy

The administrative procedure for approving the use of new and advanced technology in building projects is convoluted, unresponsive fragmented, and counterproductive. The drawn-out procedures of approval that both developers and individuals need to go through in order to get acceptance of the building methods that they will use for their projects. This drawn-out approval process presents a number of obstacles, particularly to the project's many stakeholders. a lack of suitable incentives for the development of green construction, ineffective application and execution of building and energy standards, low quality of commissioning buildings, etc. are all examples of factors that have a negative impact on the interests of a stakeholder. As a consequence of the limited scale of the markets for environmentally friendly buildings, green grading techniques are not widely used. As a direct consequence of this, the premium and resale value of environmentally friendly buildings are not particularly appealing to investors.

T3- Availability of resources

Rajasthan is a hot and dry region and a big area is a desert. The availability of the resources can be a big threat. With an annual rainfall of just 25-30 centimetres. A finite amount of surface water and dwindling reserves of groundwater are the only sources

of water left. Drinking, farming, and industry are all seeing a steady increase in demand. The state's future is in jeopardy because of poor management of this scarce resource. 72 % of the current commercially usable surface water supply has already been used by the state. Due to a lack of water supplies and irregular rainfall, the round water is overexploited. This has led to a rise in salt content, which has rendered the water unfit for human consumption and construction.

Rajasthan, India's biggest state, is home to 69 million people and covers 342,000 square kilometres. Over 17,000 megawatts of electricity may be generated in the state. In Rajasthan, there is a significant electricity shortage. Residencies, businesses, and farms all need power outages, which the government must plan ahead of time. Industries may rely on electricity for up to 8 hours a day, while farmers only receive 4 hours a day at the most. Because of rising demand and a consequent scarcity of coal for the state's thermal power facilities, Rajasthan recently had a severe power outage. As a result, there was a widespread blackout throughout the state. In the evenings, industries were instructed to cut their electricity use by half.

In Rajasthan, it has been difficult to find riverbed sand that has been legally mined. the following year in November in the absence of a scientific replenishment study, India's Supreme Court (SC) has prohibited 82 large lease holders from mining sand and stone. The ban on sand mining and violent attacks on police officers remained in place throughout the entire year of 2018. There have been reports that the ban has slowed down some development plans. The cost of sand is rising. Between November 16, 2017, and January 30, 2020, the State of Rajasthan has registered 2411 FIRs in relation to illegal mining, according to the Supreme Court's statistics. (Mukherjee, 2021)

T4- lack the technical expertise to execute projects

It would seem that the individuals working in the industry in the state have very limited understanding about environmentally friendly building materials and methods. Lack of acquaintance with environmentally friendly technology has a negative impact on the overall result of the project, as well as performance and general motivation.

The traditional idea of how a building should be built does exist; however, many builders do not want to participate in sustainable construction because of the perceived dangers involved. The majority of the time, environmental auditing adoption, which is

a desirable practise for sustainable construction, is not done due of a lack of awareness.

In India, the building industry is still focused on finding the most straightforward routes to take. We are prone to adopting labour-intensive building technology, we utilize materials that cause a lot of dust and pollution, and we are energy hogs. As a result, we consume more energy than is helpful to the ecology that is located around us. For the sake of our comfort, we tend to adhere to the tried-and-true techniques, rather than embracing the more environmentally friendly technologies that are available for the construction of buildings and choosing for the more innovative and environmentally friendly building methods and materials.

T5- Financial threats

Green building uptake is hampered by high initial costs, a lack of available resources, and a constrained budget. Additionally, the industry is hindered by a lack of easy financing, a lengthy repayment time, and the inability to accurately quantify the advantages. Potential impediments to green construction include high upfront costs and long payback periods. Banking institutions are concerned about borrowers' ability to repay their loans because of an unclear rate of return on green investments. When it comes to this industry, there is a divide between the people who spend money and the people who get a return on their investment. Eco-friendly construction is all about conserving resources and enhancing their efficiency. Green construction investments might be difficult to quantify because of this.

6.3. Case Study - The Great Green Transformation of Germany

Groups of architects, engineers, and construction businesses may be found in various places around Germany, all working together to advance the creation and implementation of an integrated digital planning and construction strategy. It is desired to have the participation of companies from all around the world in the process of transforming BIM from a vision of the future into a common practise within the construction industry. A "Road Map for Digital Design and Construction" has also been produced by BMVI.

This "Road Map" encourages the use of BIM as a standard planning tool for all government infrastructure projects by the year 2020, in addition to its usage in the private sector. This project also included participation from the commercial sector. According to research conducted by the Fraunhofer Institute for Industrial Engineering, one third of the businesses polled that are now engaged in the completion of projects with a value of more than 25 million EUR have already used BIM. On the other hand, due to the prohibitively expensive nature of the software, a significant number of German planning firms of a smaller scale are reluctant to implement the digital planning approach. As a result of these advances, the door has been opened for international businesses to supply the construction sector with BIM software that boasts a cost-benefit ratio that is favourable. (Buehler et al., 2016)

The green economy has been tested by a number of countries, but only Germany has gone down this route. While the country's environmental industry employs a large portion of its workers, it has a significant market share of green technology. Economic development has been decoupled from Germany's environmental imprint since greenhouse gas emissions have dropped in absolute terms. Germany's successful alignment of lucrative and sustainable growth has gained it widespread acclaim, making it an excellent role model to emulate. (Buehler et al., 2016)

Due to the country's high population density and scarcity of natural resources like Rajasthan, Germans have always been pushed to adopt sustainability in nearly every aspect of economic activity, from land usage to transportation, which has contributed to this success story. Reconstruction and reunification of Germany's post-war infrastructure, as well as the replacement of obsolete industrial facilities, are examples of historical transition processes. (Buehler et al., 2016)

Moreover, the greening of the German economy is unquestionably the result of a long-term effort, especially in the last few decades. A former German government minister said that environmental and resource conservation policies lie at the heart of the country's recent economic success, saying that "green policy is simply smart industrial policy." The transition in Germany would not have occurred without the policy decisions that preceded it. This case study on Germany's endeavours towards energy tax reforms, green infrastructure, sustainable mobility and promoting renewables gives significant new perspectives on how to create and execute green policies. (Buehler et al., 2016)

6.3.1. Energy concept and tax reforms

In 1999, the German Government enacted the Ecological Tax Reform Act, that forced progressive increases in the tax rates on fossil fuel and imposed a new levy on electricity. In September 2010, the German federal government officially adopted its new Energy Concept paper, which lays out a comprehensive framework for German energy strategy through the year 2050. The Energy Concept of Germany promises to alter the supply of energy and gives a road map to an age that is really and completely renewable. As a result of this concept, Germany's position as a significant energy exchange partner in Europe will be further strengthened. One of the most significant issues that the 21st century will provide is the task of ensuring a supply of energy that is not only dependable but also economically and ecologically sustainable. The objective of the Energy concept is to ensure that Germany will become one of the most energy-efficient and environmentally friendly economies in the world while still achieving a high level of prosperity and enjoying competitive energy rates. At the same time, Germany must maintain a high degree of energy security, an efficient environmental and climate protection system, and the provision of an economically viable energy supply in order to keep its industrial base competitive over the long term. (Federal Ministry of Economics and Technology (BMWi), 2010)

The pricing of energy through taxes and other fiscal tools has, historically speaking, had a significant role as prime focus of Germany's energy policy mix. When compared to the costs in the vast majority of other locations, the cost of gasoline in Germany is noticeably more expensive than it is in most other countries. Higher tax rates on oil and other fuels are nearly completely responsible for the difference in price. These higher tax rates are part of a system of excise taxes that originated in Germany before World War I and has since been standardised across Europe.

The German government's revamping of its energy tax structure has resulted in a gradual increase in the cost of energy. Social and economic factors generated several exclusions when drafting the original statute. It was decided to incorporate certain

exclusions in order to maintain both the industry's competitiveness as well as the welfare of lower-income families. Energy tax reform has had a very minimal effect on government finances in comparison to other levies in existence. (Buehler et al., 2016)

Germany's use of fossil fuels has decreased steadily since the country's energy tax reform was implemented. Other businesses have been spurred to adopt energy-efficient practises and technologies, including renewable energy sources, as a result of the anticipated spike in energy prices. Approximately 24 million metric tonnes of CO2 are estimated to be saved each year as a result of a 3% reduction in CO2 emissions. 9. A significant chunk of energy tax reform revenue was returned to taxpayers in the form of a gradual reduction in the amount of social security contributions that taxpayers were required to pay. In 2003, for example, the €16.1 billion collected by the tax reform was utilised to minimise and stabilise the costs of nonwage labour, which resulted in a 1.7% reduction in pension contributions. 10. Due to lower hiring costs, the energy tax reform has helped to promote employment and has resulted in the creation of an estimated 250,000 additional jobs. Fewer funds have been used to implement renewable energy projects and to upgrade existing facilities. (Buehler et al., 2016)

The most important lesson from the German experience is that the tax reform was a success, despite initial expectations that the rise in energy costs would have a negative impact on the German economy. The German economy has grown more robust to variations in global oil and gas prices thanks in part to the rapid expansion of exports of energy-efficient technology. Overall, the economy has become more efficient, which has resulted in decreased energy prices for both consumers and businesses. Economic growth was boosted by better working conditions and more long-term viability. (Buehler et al., 2016)

6.3.2. Green infrastructure

For the last four decades, northern Europe, and Germany in particular, has been a hub for the development and implementation of environmentally friendly technologies that

are intended to improve the quality of life in metropolitan areas. The adoption of green roofs and other forms of environmentally friendly infrastructure in Germany has been encouraged by a convoluted mix of financial incentives and regulatory mandates promulgated at a number of different administrative levels. In addition, federal rules mandate that state governments in Germany develop landscape plans. As a direct consequence of this, the individual states that make up Germany have developed a diverse set of strategies for the protection of the environment. A significant number of these strategies have included components that initially encouraged and then mandated the development of green infrastructure and its ongoing upkeep. (Buehler et al., 2016)

As well as this, German federal and state courts began issuing judgments in the 1970s mandating increased transparency and equitable cost structures for stormwater services. Today, these judgements are still in place. As a result, stormwater management costs in Germany are calculated based on an estimate of the amount of stormwater load generated by a home's premises. Individual parcel assessments are the name given to this approach (IPAs). If you want to encourage people to install green infrastructure on their properties, you can use IPAs, which are used in Germany to assess fees that are directly related to the conditions that exist on specific parcels. This approach creates incentives for people to incorporate green infrastructure on their properties. Because IPAs may be used to assess fees based on specific parcel circumstances in the United States, here is an example. (Buehler et al., 2016)

Not only is Germany the most important construction market in Europe, but it also has the greatest building stock in the European Union. This building stock is responsible for forty percent of Germany's total energy consumption. Figure 29 indicates that in the year 2050, Germany hopes to have achieved its goal of having a nearly climate-neutral building stock as part of its continuous transition to a sustainable energy system. (Buehler et al., 2016)

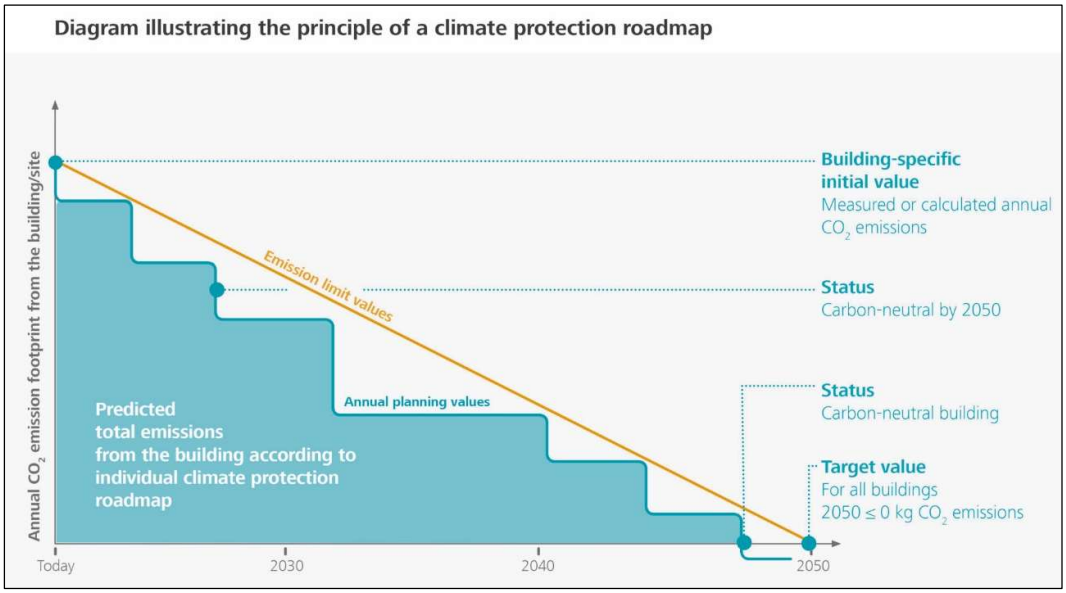

Figure 29: Building sustainability roadmap for Germany (Source: Lemaitre, 2020)

Because of the rise in demand for building materials, businesses are being pushed to promote items that can be purchased locally, methods of construction that make use of environmentally friendly ways, and recyclable goods. Even those that make construction materials using environmentally friendly methods receive positive attention. When it comes down to it, there is no reason for anybody, anywhere to have to suffer as a result of the extraction of resources. This indicates that the exploitation of resources should never include the use of forced labour or the labour of children. Illegal mining of materials should be avoided at all costs, as should any potential contamination of groundwater supplies, for instance. The rawer materials that are sourced ethically or are replaced with secondary resources by the creators, the higher score they will earn. (Lemaitre, 2020)

The recently approved German Resource Efficiency Programme, which is an all-encompassing initiative that focuses on the responsible utilisation of raw materials. The objective of Germany's economic policy is to reduce the country's impact on the environment while simultaneously enhancing the long-term viability and international competitiveness of its business sector by decoupling economic expansion from the consumption of natural resources to the greatest extent possible. For example, it includes advice for small and medium-sized businesses on environmental management systems, support for environmental management systems that incorporate resource

aspects into standardisation, greater emphasis on resource-efficient products and services in public procurement, the strengthening of voluntary product labelling and certification systems, and increasing closed-cycle management. (Buehler et al., 2016)

The German economy has become much more resource, energy, and carbon-efficient as a result of these and other ambitious environmental programmes which have been implemented in Germany. According to the findings of the Environmental Performance Review of OECD (The Organisation for Economic Co-operation and Development) from 2012, In the OECD, Germany is among the highest rates of resource productivity. For the bulk of the 2000s, Germany was among the countries to achieve a sheer drop in GHG emissions while maintaining a rising GDP. (Buehler et al., 2016)

Many of Germany's biggest cities, such as Berlin and Munich, lead the pack in terms of "sustainable cities, encompassing planning, transportation, and green building," and the race within Germany to see which city can be deemed the greenest is strong. All new residences must have renewable heating systems mandated by the government as a result of this green impact. Even though Germany is the only large economy in history to have had a green party in power, its effect may be seen in a wide range of other federal policies. (Notaras, 2010)

Because of this, nations of the developing world, in addition to those of the developed world, have much to gain from Germany's investments in both society and technology. If the world is going to be able to deal with the expected rise in emissions over the next several decades, it will be essential for fast-developing nations who now lack the capacity to develop and scale out these technologies to get technological know-how and financial assistance. One of these nations is India, which is interested in drawing on German knowledge since it has set a target to get 10 percent of its power from renewable sources by the year 2012. In general, Germany has created a political environment that is receptive to environmentally friendly concepts and, more crucially, that puts these concepts into action at both the national and municipal levels. (Notaras, 2010)

6.3.3. Sustainable mobility

The German federal, state, and municipal governments are responsible for determining whether or not the country's transportation infrastructure can be maintained sustainably. Taxes on gasoline, sales taxes, and restrictions imposed by the federal government raise the cost of driving and owning a car, which in turn drives up consumer demand for vehicles that produce less pollution and are more compact. When compared to the United States in 2008, sales taxes on autos in Germany were three times higher, while taxes on gasoline were nine times higher. However, in contrast to the United States, households in Germany do not have to spend more money on transportation despite the fact that fuel taxes are significantly higher. The average German car is smaller, more fuel-efficient, and driven less miles per year than the average American vehicle. Therefore, in 2008, transportation accounted for around 14 percent of household expenditures in Germany, whereas in the United States it accounted for approximately 19 percent of household expenditures. Investments in local public transportation are eligible for designated matching funds provided by the federal government of Germany. In addition to being used for initiatives involving local public transit, walking, and cycling, flexible federal matching grants for local transportation upgrades are also available. 54 German states are responsible for the distribution of federal subsidies to regional rail networks and for the state wide coordination of public transportation services. 55 There are minimal parking standards that must be met for new projects in several German states. The foundation for more environmentally friendly transportation is provided by the federal government and by state governments, but cities have played a vital role in the development and implementation of new legislation. (Buehler et al., 2016)

The city of Freiburg, which has a population of 220,000 people, has been at the forefront of efforts to promote environmentally friendly transportation since the late 1960s. Since that time, the number of trips taken by bicycle has increased by a factor of three, the number of people who take public transportation has increased by a factor of two, and the percentage of trips taken by automobile has decreased from 38 to 32 percent. In spite of significant expansions in both the economy and the population during the early 1990s, the degree of motorization has remained relatively unchanged, and CO2

emissions from transportation have decreased on a per capita basis. Up until the late 1960s, Freiburg actively encouraged the development of green fields, enlarged roadways, removed trolley lines, and constructed parking spaces for automobiles. The city became more spread out as a result of a significant growth in motorization and a decrease in the number of people using public transit. The public perception has turned away from growth that is concentrated on automobiles as a result of air pollution, traffic deaths, and traffic congestion caused by autos, as well as other environmental problems. (Buehler et al., 2016)

The city of Freiburg was able to create a transportation system that is more environmentally friendly by doing the following:

- Successfully integrating land-use planning and transportation planning.
- Regionally coordinating and integrating public transportation.
- Encouraging the use of bicycles.
- limiting the use of automobiles.
- Encouraging citizen participation at every stage of the process.
  (Buehler et al., 2016)

6.3.4. Promoting renewables

The energy policies of Germany, which is a member state of the European Union (EU), are determined by a combination of the country's own law and the legislation of the EU. In formal terms, each of the 27 countries that make up the EU are responsible for regulating energy policy inside their respective national boundaries. On the other hand, the stipulations of EU treaties addressing the internal market of Europe, free competition, and environmental protection have resulted in the creation of a European energy strategy. As a part of a larger climate and energy bill that was passed in 2009, a significant piece of law pertaining to renewable energy was enacted. The Renewable Energy Directive of the European Union requires each member state to increase its share of renewable energy sources, such as solar, wind power, biomass, or hydroelectric, in order to raise the overall share of renewable energy from 8.5 percent in 2010 to 20 percent by 2020 across all sectors like heating and cooling, transportation fuels, power generation etc. In comparison to its prior goal of weaning itself off fossil fuels "far before

2040," Germany's current objective is to meet all of its power demands with supply derived from renewable sources by the year 2035. (Buehler et al., 2016)

In 2009, renewable energy contributed 16.1 percent of Germany's total electricity consumption. Wind power was the primary contributor to this percentage, but solar photovoltaics and biomass were also important. It is more instructive to look at the rate of change rather than the exact percentage in a nation with a population of more than 80 million people. The present ratio is grown significantly from just 4.7 percent in the year 2000, and it was anticipated to reach 30 percent by the year 2020. The Renewable Energy Sources Act in Germany is largely responsible for bringing about this transition. The Act established a feed-in tariff system, which mandates that grid operators pay for renewable energy that is fed into the power supply. This payment is required in order to comply with the system. (Buehler et al., 2016)

The Renewable Energy Act (EEG) underwent significant revisions in 2014, and ever since then, it has served as the primary impetus for the Energy Transition. There is no other piece of law that has been replicated as frequently as Germany's Renewable Energy Act, as stated on the website for the German Energy Transition. The legislation provides renewables priority on the grid and assures that investors in renewable energy receive remuneration regardless of the price of power. In addition, the law gives renewables precedence on the grid. This has resulted in reduced bureaucratic red tape and an increase in investment, both of which have contributed to a decrease in the cost of renewable energy. (Buehler et al., 2016)

Other economies that are more market driven, such as the United States and Australia, as well as economies that are more dependent on fossil fuels, have resisted the implementation of feed-in tariffs, which are essentially government subsidies designed to encourage investment in the renewable energy sector. There is a significant consensus about the need to handle climate change, and throughout the political spectrum in Germany, all of the main parties favour an industrial transformation toward a low-carbon economy. In addition, there is widespread agreement that climate change must be addressed. This strategy is beneficial to constituent groups on both the progressive and conservative sides, such as the industry of renewable energy and the farming community, respectively. It is generally accepted that robust environmental policies are the

primary driver of ecological modernisation and the origin of new business prospects. (Buehler et al., 2016)

6.3.5. Technology and Building Information Modeling

Germany is the most important construction market in Europe and is home to the most extensive building stock on the continent. The expansion of technology and BIM is one of the elements that has contributed to the tremendous growth that has been seen in the construction industry in recent years. Building with less impact on the environment is a worthy objective, but it is not always simple to do. In a constrained economy, the choice of construction methods and strategies can all too frequently result in long-term profits and short-term costs coming into conflict with one another. A primaeval soup of information is created as a result of the sheer volume of paperwork, which might range from two-dimensional paper drawings to spreadsheets containing technical data. This information is in need of a spark in order to bring sustainable design solutions to life. (Buehler et al., 2016)

Building information modelling, often known as BIM, is a potential tool that the green building movement needs. The technology is being embraced by architects and engineers (A/Es) who are looking to produce higher quality designs and collaborate more effectively because it can help harness the characteristics and performance of design concepts. This allows A/Es to compare sustainable alternatives in order to strike a balance between energy and resource efficiency and project costs. (Bernstein, 2017)

In the German construction business, digitalization has come in the form of tracking systems for construction machines, digital construction files, and drones that hover above building sites to inspect the progress of development. Building information modelling, often known as BIM, is one of the numerous developments that is altering the way buildings are designed, constructed, and managed. It is anticipated that BIM will have the most profoundly transformative effect. BIM is utilised to varying degrees by 70 percent of the building industry in Germany. Nevertheless, the vast majority are architectural firms and design studios. Since 2017, building information modelling (BIM) has been required for any projects costing more than €100 million. In addition,

beginning of the 31st of December in the year 2020, BIM became obligatory for the execution of all public contracts pertaining to the construction of federal infrastructure. (Buehler et al., 2016)

Architects, engineers, construction companies, and scientists are working together in a number of clusters throughout Germany to improve the new integrated digital planning and building approach. As BIM moves from a futuristic notion to an industry standard, businesses from across the globe are being encouraged to join in the process. BMVI has also established a "Road Map for Digital Design and Construction," which supports the use of BIM as a standard planning tool for all government infrastructure projects by 2020, in addition to the private sector. This was a joint effort between the business sector and the government. One-third of companies questioned by the Fraunhofer Institute for Industrial Engineering are already utilising BIM on projects worth more than 25 million EUR, according to the study's results. Because the software is so high-priced, many smaller German planners are hesitant to switch to a digital approach to planning. Consequently, there are now opportunities for foreign enterprises to provide BIM software with an attractive cost-benefit ratio. (Buehler et al., 2016)

6.3.6. Key findings of the study

It's time to make room for the new, so out with the old

Nuclear power is incompatible with a long-term renewable energy goal. Germany's final nuclear plant will shut in 2022. They started in January. Renewables, gas turbines, and conservation will cover power deficits.

The Renewable Energy Act

Since 2014, when the Renewable Energy Act (EEG) was revised, it has boosted the Energy Transition. Germany's Renewable Energy Act has been copied more than any other law, according to the German Energy Transition website. The law gives renewable energy precedence on the grid and guarantees investors payment regardless of

power price. The law grants renewables grid priority. Cut red tape and more investment have reduced the cost of renewable energy.

The Renewable Heat Act

Buildings utilise 40% of the world's energy, mostly for heating. The Renewable Heat Act aims to increase renewable heating to 14% by 2020. All newly constructed buildings must comply with the Act, while the Market Incentive Program helps restore older buildings. Despite the recent economic slump, funding for this law has been restored. The Energy Conservation Ordinance aims to increase the rate of building repair so that all structures meet current criteria within 33 years.

The Cogeneration Act

Cogeneration recovers and uses the heat created when creating energy. Germany's 2002 Cogeneration Act requires 25% of the country's power to come from cogeneration by 2020. Cogeneration enhances total efficiency.

Alternates of transportation

Public transportation and bicycles reduce Germany's dependency on fossil fuels. Over 200 long-distance bike paths total 70,000 km of well-maintained routes across the country. Freiburg's environmental strategy promotes bike-friendly traffic layouts. 88% of Germany's population lives within walking distance of a bus or rail stop. Younger generations drive less than their parents due to the popularity and accessibility of vehicle sharing. Increasing fuel efficiency of existing automobiles is another important priority.

Recycling

Expats in Germany are aware with the country's intricate recycling system and the nasty looks they receive if they don't sort properly. A serious commitment to waste management is vital to the Energy transition, as non-recycled trash is typically burned, causing extra emissions. Environmental groups have urged further system optimization to boost energy efficiency.

Conscious designing

The Eco-design Directive (ErP), was created to regulate environmentally harmful products. The ErP was an EU effort that set requirements for energy efficiency. This law covers consumer electronics, refrigerators, freezers, light bulbs, and electric motors, but not cars and structures. This helped to reduce power consumption by 12% by 2020.

Energy conservation

Germany's aspirations for a more efficient future include efficiency and conservation as well. Energy-Conservation Ordinance was designed to handle this issue and give financial incentives for the refurbishment of older buildings to meet the Passive House Standard. Even in Germany, a strategy for more energy-efficient construction is being devised right now.

Charging for bad

Since 1951, Germany has had a tax on petroleum products, and in 2007, when the law was revised, the tax rate was increased to 65 cents per litre. The funds obtained from the tax are used to defray the expenses incurred in other areas. When it comes to the so-called "eco-tax," money are put toward lowering payroll taxes with the intention of making German employees more competitive on the worldwide stage. Not only gasoline and diesel for automobiles are subject to the eco tax, but also heating oil and fossil fuels that are used to produce power.

7. Conclusion

This thesis's objective was to study the possibility of green economic transformation, with a particular focus on the Indian state of Rajasthan. This was to be achieved by conducting an analysis of the current state of green and environmentally responsible building practises; the recommendations that were to result from this analysis were to be aimed at the development of a framework that is capable of facilitating the handling of risks and challenges, thereby facilitating the evolution of the industry toward smart, optimised, innovative, and environmentally responsible building practises in Rajasthan.

In the last phase of this thesis, the data and lessons gained from the analytical section, as well as the lessons acquired from the literature research, are utilised to generate critical conclusions and suggest probable future steps. This phase also incorporates the inclusion of various facts, observations and findings from the analysis and case study of the great German transformation to present the assessment of present scenario and recommend a way forward for the efficient framework for Rajasthan.

Rajasthan's traditional architecture features modest, efficient rural houses. Vernacular architecture uses regional construction materials and a layout adapted to the area's residents. Utilizing local materials, considering the local climate, and engaging the people accomplish a holistic design approach. Due to modernisation in the rural housing sector, more contemporary materials are being used in traditional design, which has a major impact on the environment due to its high energy consumption. The biggest difficulty is that new homes are neither ecologically sustainable nor affordable. Poorly planned modern building procedures led to poorly ventilated or unventilated homes. Modern houses built without proper knowledge of modern building materials have caused construction expenses to rise. Local architecture and cultural legacy should be protected, and new technology should be applied in a minimalistic way that adds value to conventional systems. Rural residents may build cheap, sustainable homes using local materials and traditional methods. Traditional methods of adding thermal mass and roof treatments, lime plasters can be combined with the modern-day green building techniques for the urban areas.

Construction is one of India's fastest-growing businesses, accounting for 10% of GDP (GDP). The "Housing for All" initiative requires the construction of 20 million urban residences and 10 million rural homes. Increasing numbers of firms have pledged to being "carbon neutral," indicating a positive mood. Environmentally friendly residential and commercial building practises in India and Rajasthan make economic sense. In light of the crisis, green buildings have the potential to create nine million skilled jobs by 2030 in the renewable energy and construction industries. The government and financial sector may offer fuel for green building, helping India realise its potential in this field.

The literature review about Indian roadmap towards green economy explain all five pillars and four facilitators of India's green transformation require the continued advancement of India's three growth drivers—technological development, financial innovation, and strong political leadership. This applies nationwide. Due to these three considerations, India can combine its growth goals and environmental crises to solve both problems.

In recent years, technological progress cut the cost of building solar energy generating facilities, financial innovation allowed the front-loaded costs of these plants to be modified, and political leadership ensured that these plants were incorporated into the existing power network. India has the world's lowest per-unit renewable energy installation cost due to technology, money, and leadership.

It's time to apply technology, economics, and leadership to the other pillars. India will exhibit global leadership by reshaping its mobility sector, land use, and cities according to a new green development paradigm. As India adapts to the new paradigm, this will happen. India's green economy will have a multiplier effect, paving the road for egalitarian, low-carbon prosperity. Rajasthan as a state will be benefited by the federal policies and developments.

First in India, ECBC was put into place in Rajasthan in March of 2011. RECBD was made mandatory for all newly covered commercial buildings in September of the same year. According to the Rajasthan State Pollution Control Board (RSPCB), a new environmental construction and building code was added into its environmental guidance manual for construction and building projects. A reference to R-ECBD was added to the state's building codes in 2012, and the process for approving a building's

occupancy was revised to incorporate it as well. Apart from that, Rajasthan has put in a lot of work building up the necessary infrastructure for enforcing the code. Many different types of buildings are in line with the code in Rajasthan. Because certain ULBs have begun to reject noncompliant projects, building owners and developers do not want to risk delays, major commercial buildings are taking the lead. As a result, high rise and commercial buildings are taking the lead on this issue.

The green building laws that are in place and those that are in the planning stages give a good degree of direction, which will make it easier for green buildings to make up a larger portion of the overall construction market. The difficulty is in effective implementation and adoption of them. Germany has created a political environment that is receptive to environmentally friendly concepts and, more significantly, puts these concepts into reality at both the national and municipal levels. The baseline that is most relevant for comparison with other major developed economies is Germany. One of these nations is India, which is interested in drawing on German knowledge since it has set a target to transform it economy to green. Germany' s Energy concept and tax reforms are great motivations to formulate and implement policies with great effects. The approaches towards green infrastructure, sustainable transportation, regulating building codes, developing renewable energy infrastructure and technological developments can help Rajasthan to develop and implement and strong framework for its green transformation.

The legislative standards are supplemented by the voluntary codes and green building rating systems, such as GRIHA, IGBC, and GEM, among others. These schemes go above and beyond the minimal requirements and encourage excellent practise. IGBC and GRIHA are partners with a number of different departments and key agencies in the process of moving the green building movement ahead in the country.

As a consequence of coordinated efforts, the Ministry of Environment and Forests (MoEF), the Government of India, as well as various State Governments and Urban Local Bodies, are providing financial incentives for the construction of environmentally friendly structures. These agencies also work in partnership with private and corporate developers to educate industry experts, students, and consumers on green practises and to promote the adoption of such practises. These are also assisting the industry in establishing standards for environmentally friendly building materials and goods. In order to accomplish this goal, alternative construction materials will need to be

evaluated, certified, and rated. The certification of materials would serve to improve the market by providing consumers with certainty, therefore contributing to the creation of an optimal climate for the growth of environmentally friendly infrastructure.

7.1. Recommendations

To reinvigorate the next reformation, it will be necessary for several sectors of society, including the government, the commercial sector, investors, civil society groups, and independent consumers, to work together to transform the future. Following are the recommendations for various stakeholders realised as a potential outcome of this study:

7.1.1. Administration

The government has already taken a number of praiseworthy efforts toward facilitating the green transition of the country. However, as this article demonstrates, there is still a significant amount of work to be done. An ambitious vision for a net zero economy, defined objectives and roadmaps for each sector, a framework of guidelines and reward systems to stimulate creativity and transformation, a sensible approach to carbon pricing, and a collaborative approach for stakeholder involvement will be required for the government to successfully anchor green transformation of the construction industry and economy.

The recommendation is to create model regulations for environmentally responsible construction practises and encourage their usage and Ensure compliance. Raise lawmakers' and officials' levels of awareness and knowledge on the subject at the state and local levels.

- It is recommended that incentives be connected to performance rather than design or aim. Simultaneously the testing and certification of green products and construction materials is needed to be facilitated.

- We need to raise people's awareness at the government level, at universities and colleges, and within professional organisations. The proper training and certification are to be provided by schools that specialise in technical training or develop suitable courses.

- The final recommendation is to bring more attention to various financial institutions. It is possible to develop market drivers by giving specific concessions to encourage and promote green building among financial institutions, re-financing agencies, funders, and other types of organisations.

7.1.2. Investors

Investors can make a significant contribution to reducing carbon emissions on a worldwide scale. If investors demand more carbon transparency from the firms in which they invest, encourage climate-positive corporate action, contribute cash to green finance activities, and extend investment time horizons, long-term capital investments in sustainability can be adopted.

7.1.3. Enterprises

The green transformation provides corporations a potential to build value. The transition to a zero-net-emissions economy in India would affect every firm and industry. Change won't be easy or painless. In the fight against global warming, Indian corporations must set aggressive decarbonization goals, measure and publish their carbon footprints, examine every aspect of their operations to reduce carbon intensity,

participate in cutting-edge decarbonization research and development, develop innovative business models, and make significant financial investments in the agenda.

7.1.4. Citizens and members of civil society

The shift to a greener economy in India will require significant participation from India's population and civil society. Together with the media, civil society groups will be tasked with informing and educating the general public about climate change, as well as continuing to contribute to the national dialogue on the topic.

It will be necessary for individual citizens to be willing to make changes such as switching to more environmentally friendly items, adopting diets that are more sustainable, reducing their transportation footprint, voting for, and supporting, a green national agenda.

8. Declaration of Authorship

I hereby declare that the attached Master's thesis was completed independently and without the prohibited assistance of third parties, and that no sources or assistance were used other than those listed. All passages whose content or wording originates from another publication have been marked as such. Neither this thesis nor any variant of it has previously been submitted to an examining authority or published.

Berlin, 05.07.2022

Location, Date

Signature of the student

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