Architecture for the Sustainability Design Thesis 2021

URBANIZATION AND CARBON POLLUTION
"THE INDIAN CASE-STUDY"

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Acknowledgement

First and foremost, I thank ALLAH for making me capable of working on and finishing this work, and then I thank my PARENTS, who are the true artists of my personality.

I would like to take this occasion to thank my mentors, MARIO ARTUSO and ANGIOLETTA VOGHERA, for their persistent discussions and critical examination of my themes, as well as for their thoughts and useful advice in advising throughout the course work of the thesis.

I am grateful to the other Academic Associates and grateful for their assistance during the course work.

I am also grateful to my parents and friends for their belief in my ability to complete my thesis work.

Abstract

One of the most important elements for a country with a large population and increasing urbanization is to overcome the global rising difficulties associated with climate change. Moving ahead with everyday effort can help us take a step closer to a healthy society and a better planet.

There are several ways for achieving this objective, but one of the most important is lowering carbon emissions, developing new construction framework and realizing the importance of sustainable lifestyle and much more.

At this point, addressing urbanization and carbon pollution issues comes into play. These are the tactics that can help the country from long-term problems and enhance people's living situations.

A sustainable building method can aid in the reduction of huge amounts of carbon emissions. Using pre-cast concrete, which can be reused, may be a better alternative. Making available numerous parts that may be moulded in a variety of ways can assist us in organizing building efforts and shape in a sustainable manner. Similarly, utilizing a fly ash brick as a building material can assist because of its 100% recyclable materials and characteristics.

This research focuses on urbanization and carbon pollution. Along with a glimpse into the effects of the Covid-19 epidemic, with the goal of finding solutions for forthcoming circumstances and trending drawbacks for a more sustainable growth of community.

Brief Content

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Abbreviations

BID	Business Improvement Districts
CCU	City Comprehensive Urban Plan
CEC	City Economic Councils
DBT	Direct Benefit Transfer
FAME	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles
FAR	Floor Area Ratio
GIS	Geographic Information System
HPEC	High Powered Empowered Committee
ICCC	Integrated Command and Control Centre
LAP	Local Area Plan
LEDP	Local Economic Development Plan
MAAS	Mobility as a Service
MoHUA	Ministry of Housing and Urban Affairs
NITI	National Institution for Transforming India
NMAM	National Municipal Accounting Manual

NMT	Non-Motorized Transport
NUP	National Urban Plan
NUPF	National Urban Policy Framework
OSR	Own Source Revenue
SDG	Sustainable Development Goals
SIUP	State Integrated Urban Plan
SLB	Service Level Benchmark
SPV	Special Purpose Vehicle
TDR	Transferable Development Rights
TPS	Town Planning Scheme
UMTA	Urban Mass Transport Authority
URDPFI Formulation	Urban and Regional Development Plan and Implementation
VCF	Value Capture Financing

URBANIZATION AND CARBON POLLUTION

"The Indian Case-study"

Chapter 01: Introduction

1.1 Aim

Due to numerous population growth, the globe is moving at an alarming rate toward urbanization, which is directly related to increase of production of the basic necessities. As production grows, so does carbon emulsion which is crucially contributing to global warming. The concept seeks to comprehend urbanization in terms of architecture and to promote carbon pollution reduction in order to improve living conditions in cultural groups.

The idea is to study and analyse the urbanization and carbon issues being faced in India in order to control the climate change and global warming in a sustainable direction. With the help of research, proposing an ideology to reduce the carbon footprint in order to urbanization in architectural form.

1.2 Objective

- To promote eco-friendly and sustainable concepts towards construction.
- Create or restructure a different type of outline towards urbanization.
- Exposure of new technologies and techniques in order to reduce carbon footprints.
- Introduction of sustainable strategies for proper utilization of resources and materials.
- Exploring the needs of people and proposing them the facilities in a better form to look forward with the better results.
- try to cover most of the Sustainable Development Goals (SDG) proposed by United Nations General Assembly in 2015 for the target of 2030.

Figure 1:Sustainable Development Goals *Source: THE 17 GOALS | Sustainable Development (un.org)*

1.3 Scope of Study

The scope is to understand and identify the issues being faced in this century and try to contribute the technology and ideas to lower the alarming number of impurities for the better standard of living.

In this scenario, urbanized areas contain 55 % of the world's population, with that figure predicted to rise to 68 % by 2050. According to projections, urbanization, or the progressive transfer of human settlements from rural to urban regions, has been combined. According to the new UN dataset, which began in 2018, global population growth will allow more than 2.5 billion individuals to become citizens.

The world's urban population has increased significantly, from 751 million in 1950 to 7.9 billion in 2021. Despite its lower level of urbanization, Asia has 54% of the world's urban population, followed by Europe and Africa, each with 13%.

As we all know one of the common and major problem for global warming and climate change is carbon-dioxide. Which is vastly spreading all over the globe with the various reasons and results. Basically, global warming occurs when Carbon dioxide (CO2) and other air pollutants accumulate in the atmosphere and bounce off the ground, absorbing the sun's heat and solar energy. Normally, this radiation goes into space, but these pollutants are likely to remain in the atmosphere for years or centuries, trapping heat and making the Earth hotter. These heat-trapping pollutants are especially carbon dioxide, methane, nitrous oxide, water vapor, and synthetic fluorine gases, these are referred to as greenhouse gases, and the effects of these gases are referred to as the greenhouse effect.

1.4 Limitation

- This research will be limited to study and analysis.
- The study is primarily concerned with the current urbanization and carbon problem.
- Due to the limitation of time, this thesis focuses very much on India.

1.5 Working Methodology

CHAPTER 02: Literature Study for Urbanization and Carbon Emission

2.1 What Urbanization?

The process through which a large number of people are permanently concentrated in a relatively small area, producing a city, is known as urbanization.[1]

The concept of what defines a city varies depending on time and place, but the most frequent interpretation is that the phrase refers to a population concern. The United Nations does not have its own definition of "city," but rather adopts the term given by each country, which might vary greatly. In the United States, for example, "urban place" refers to any location with a population of more than 2,500 people.

More than half of the world's population now lives in urban regions, mostly in highly populated cities. The urban environment, on the other hand, is a comparatively new occurrence in human history. This shift has altered the way we live, work, travel, and socialize. From the distant past to the present, this section gives an overview of global urbanization and forecasts for future developments.

2.1.1 General overview of urbanization and its modern growth.

The process of increasing urbanization was a feature of human history. The Neolithic era, which began approximately 10,000 BC, allowed humanity to create tiny permanent communities for the first time. Over 100,000 cities did not exist until ancient times, and even these were uncommon until the previous three centuries, when there was a constant population increase. More than 20,000 cities housed fewer than 3% of the world's population in 1800. By the mid-1960s, this had risen to nearly a quarter of the population. By the beginning of the twenty-first century, cities housed more than half of the world's population.[1]

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[1] *urbanization | Definition, History, Examples, & Facts | Britannica*

Small communities of ancient civilisation were feasible in both the Old and New Worlds due to the development of agriculture and transportation. Agriculture evolved into production, and surplus food was created. Transportation has been created to feed the surplus urban population from the countryside since the development of the wheel approximately 3500 BC, and this system continues to this day. So basically, people reside in adjacent capitals despite the modest size of these settlements. The distance is little more than a short walk, and no one is permitted to dwell near the water supply area. Because cities are continuously besieged, walls are fairly frequent, and it is tough to expand the barrier across a vast region. Archaeological discoveries have suggested that the population density in towns around 2000 BCE may have been as high as 128,000 people per square mile (49,400 per square kilometre). In comparison, the modern cities of Kolkata and Shanghai have a population of more than 70,000 people per square mile, which is considered highly dense.

With a few exceptions, the elite (nobles, government officials, clergy, and the wealthy) resided in the centre of the old city, near the most significant temples. Poor folks who lived further away were sometimes totally displaced by walls.

The biggest city of antiquity was Rome, which had a population of at least 800,000 people at its peak in the third century CE and spanned over 4 square miles (10 square kilometres). To feed this massive population, the empire built a network of aqueducts that brought drinking water from hills as far out as 44 miles away (70 km). Water is pumped through a magnificent main pipeline and pipeline network in private residences in the city, a level of equality rarely seen in the twentieth century. The Roman house was first made from dried clay up to timber frames, as was the case in other early towns. As the city expands, structures made of mud, bricks, concrete, and ultimately exquisite marble sculptures are added.

Due to the extreme concentration of a huge number of workers and their families in cities, the last industrialism resulted in modern living as urban life for the vast majority of the world's population. Economic development and population expansion fostered the development of urban centres of urban centres in the twentieth and twenty-first centuries, which can be expanded on mileage findings. This phenomenon has been seen in the United States, most notably on the northeast coast

and the coast of Southern California. Other partnerships include the Tokyo-Osaka-Kyoto complex in Japan, the region between London and the Midland cities in England, and the Dutch-Belgian region.

2.1.2 Impact of the industrial revolution

Although medieval towns were rarely as massive as Rome, the fundamental concept of this city construction persisted until the arrival of the industrial revolution. With the passage of time, commerce has become an increasingly essential aspect of city life, as well as one of the magnets that draws people from rural regions. The advent of mechanical clocks, windmills, and water machines, as well as printed newspapers, maintains the city dweller's connection. Cities have become places where all classes and human kinds coexist, resulting in a heterogeneity that has become one of the most well-known characteristics of urban life. In his renowned Apothegm, Samuel Johnson chose the aspect of this metropolis in 1777, "as a man of London was tired, he was bored of life; since there was in London, it could provide me everything that had me, London had me." Fewer than 100,000 people live there, and the majority of their streets are narrow and muddy.[1]

England is a good illustration of how cities were impacted by the Industrial Revolution. In 1801, around one-fifth of the British population resided in villages or towns with a population of more than 10,000 people. By 1851, more than half of the population might be deemed urban if two-fifths had been urbanized, including more than 5,000 small towns, which accounted for more than half of the population at the time. The first fully urban society was also the world's first industrial civilisation. By 1901, the year of Queen Victoria's death, the census reported that cities housed three-quarters of the population (more than 2,20,000 in more than 10,000 cities, and half in more than 2,20,000 cities). For a century, the majority of rural communities have become the majority of urban societies. As industrialisation proceeded, this pattern was replicated on a European and worldwide scale.

The Industrial Revolution, a technical boom, has resulted in a tremendous growth in the process of urbanization. Because there were more people in a limited region, the new factory could attract more workers, and the bigger workforce might become more specialized. Thousands of industrial

workers resided in Europe until the 19th century, many of them lived in deplorable conditions. Fascinated by the prospect of paid labour, rural migrants have discovered that they live in slums that are overcrowded and contaminated with waste, sickness, and vermin gathered in the city. If new cities are laid up in a grid layout that allows for limitless development, they are designed for business and with minimal regard for human requirements such as distance personal information protection and recreation.

2.1.3 Humans living in urban areas

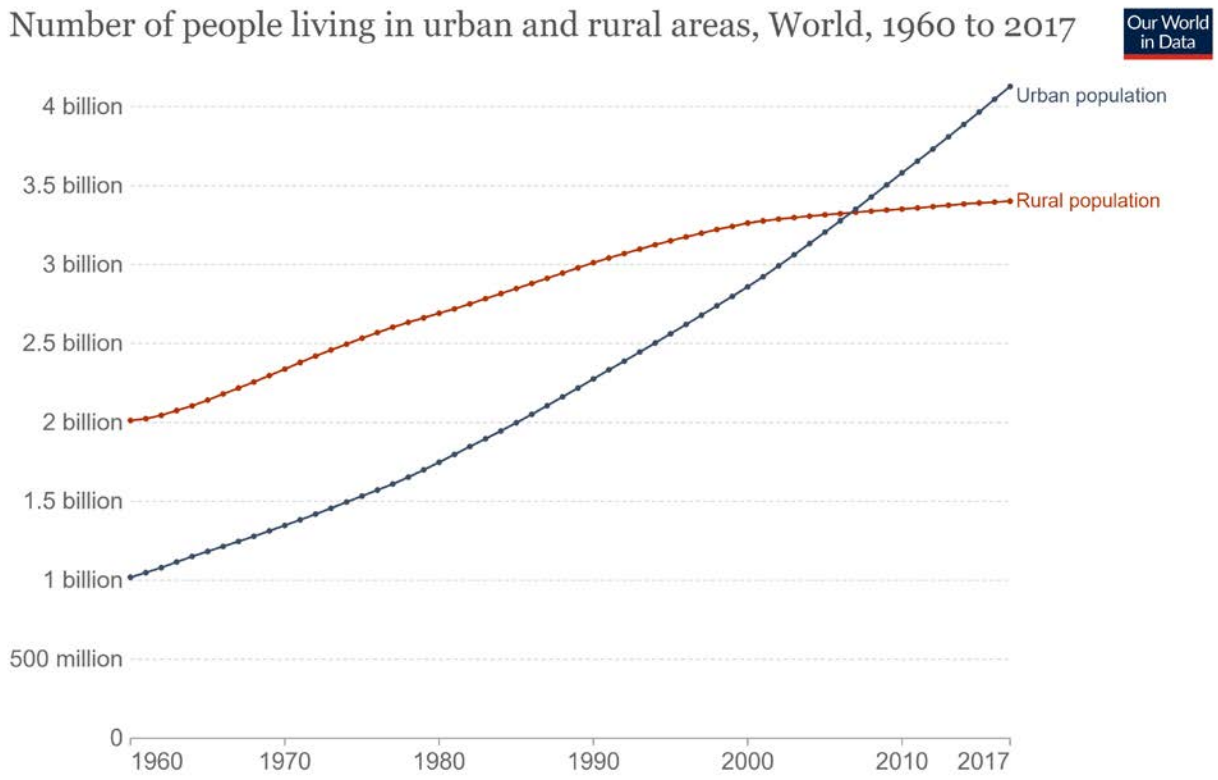
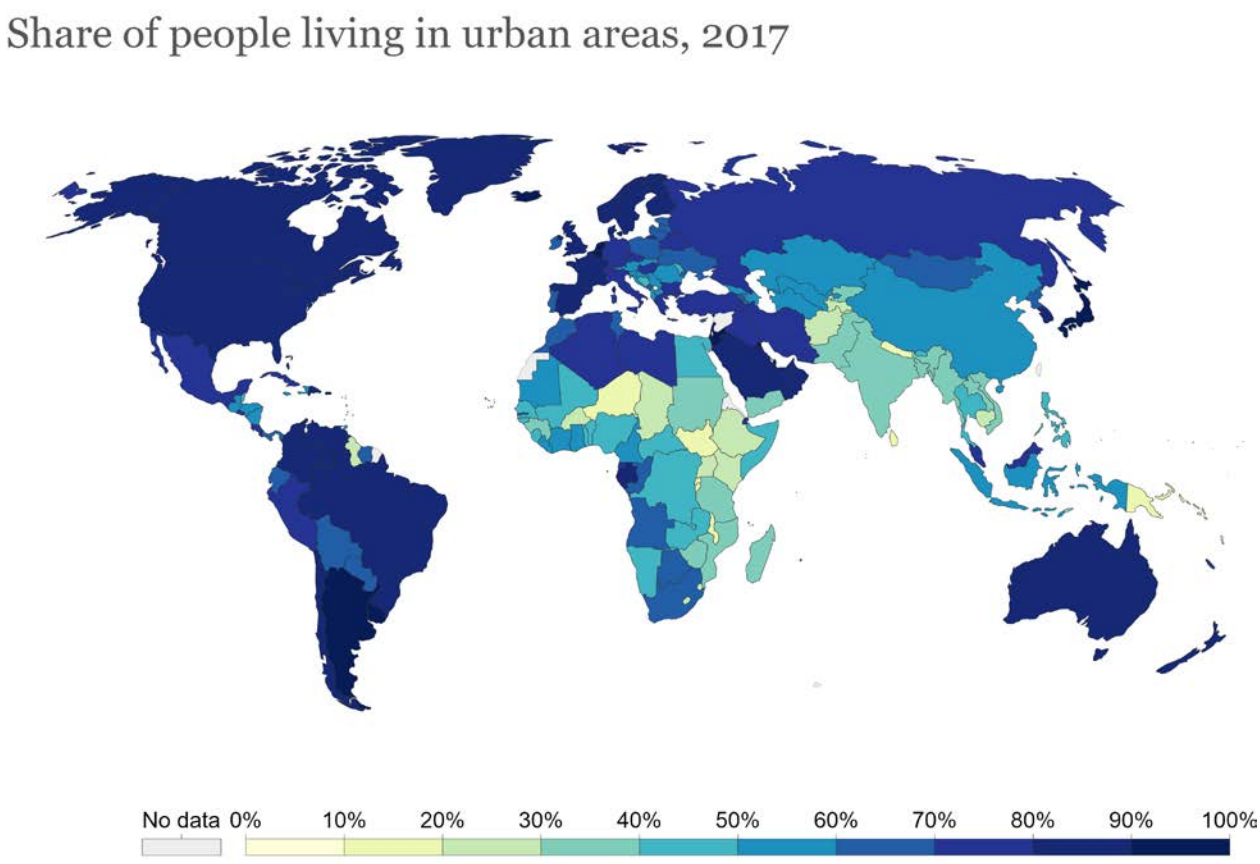


chart 1: Number of people living in urban and rural areas *Source: Urbanization - Our World in Data*

More than half of the world lives in the urban areas, i.e., more than 4 billion people. Most people in the globe lived in tiny villages during the majority of human history. This has altered drastically throughout the ages, particularly in the last few decades. A substantial portion of the population has migrated from rural to urban regions. The visualizations depict figures estimated from the United Nations World Urbanization Outlook for the number of people living in urban and rural

regions throughout the world. In 2017, cities holed up 4.1 billion people. This indicates that more than half of the world's population (55%) lives in cities. According to UN estimations, this was the year in which urban people surpassed rural numbers.[2]



Map 1: Share of people living in Urban Areas *Source: Urbanization - Our World in Data*

How does the proportion of people living in cities differ from one country to the next?

The map below depicts the proportion of the world's urban population. More than 80% of the population in most high-income nations (Western Europe, America, Australia, Japan, and the Middle East) lives in cities. In the majority of badly damaged nations (Eastern Europe, East Asia, North Africa, South Africa, and South America), 50-80% of individuals do. The bulk of people in many middle and low-income nations still live in rural regions. However, this is fast changing. As

[2] *Urbanization - Our World in Data*

in individual nation to observe how the pace of urbanization varies through time. In many nations, there is a rapid shift to populous cities and cities.

2.1.4 Humans living in slums

What is SLUM?

A slum is a residential neighbourhood with poor housing that is neither dangerous or unsafe but is socially unpleasant due to neglected or overcrowded conditions. Although this definition includes houses, the word is usually reserved for a bigger area, province, or, more broadly, a city. Slums, like the impoverished people who live in them, have always existed, but they have become increasingly common with the growth of industrial cities. Increasing wages, as well as stronger building and health standards, would assist to almost eradicate them in industrialized nations, where the major housing challenge now is a lack of affordable homes. Slums are becoming increasingly common in underdeveloped nations, typically in the form of squatter communities. Slum is a culturally defined and pejorative phrase with social and physical connotations. Outsiders sometimes misinterpret it, generally through initiatives such as slum removal, and it is frequently used to justify public action in the problem, which is often despised and rejected by locals. Since the 1970s, desirable intervention has progressed to Slum. Slum debate has long been a source of contention.[3]

Less than one-third of city dwellers live in slum homes. The level of life in the city centre is of course an essential indicator of health. The percentage of the urban population living in slums is an indicator of living standards. Slum furniture refers to a group of people living under one roof who lack any of the following conditions: better water access, improved hygiene access, adequate living space, and housing durability. [2]

The percentage of the urban population living in slums is shown per nation. This information is accessible beginning in 1990. According to the most recent figures, between 10 and 30 % of metropolitan populations in most Asian and Latin American nations live in slums (there are a few more countries as well). Slum equipment was particularly common in Sub-Saharan Africa. Accordingly, most cities have more than half of their population living in slums, with some (Sudanese, South Sudan, Central African Republic, and so on) having more than 90 % of their population living in slums. [2]

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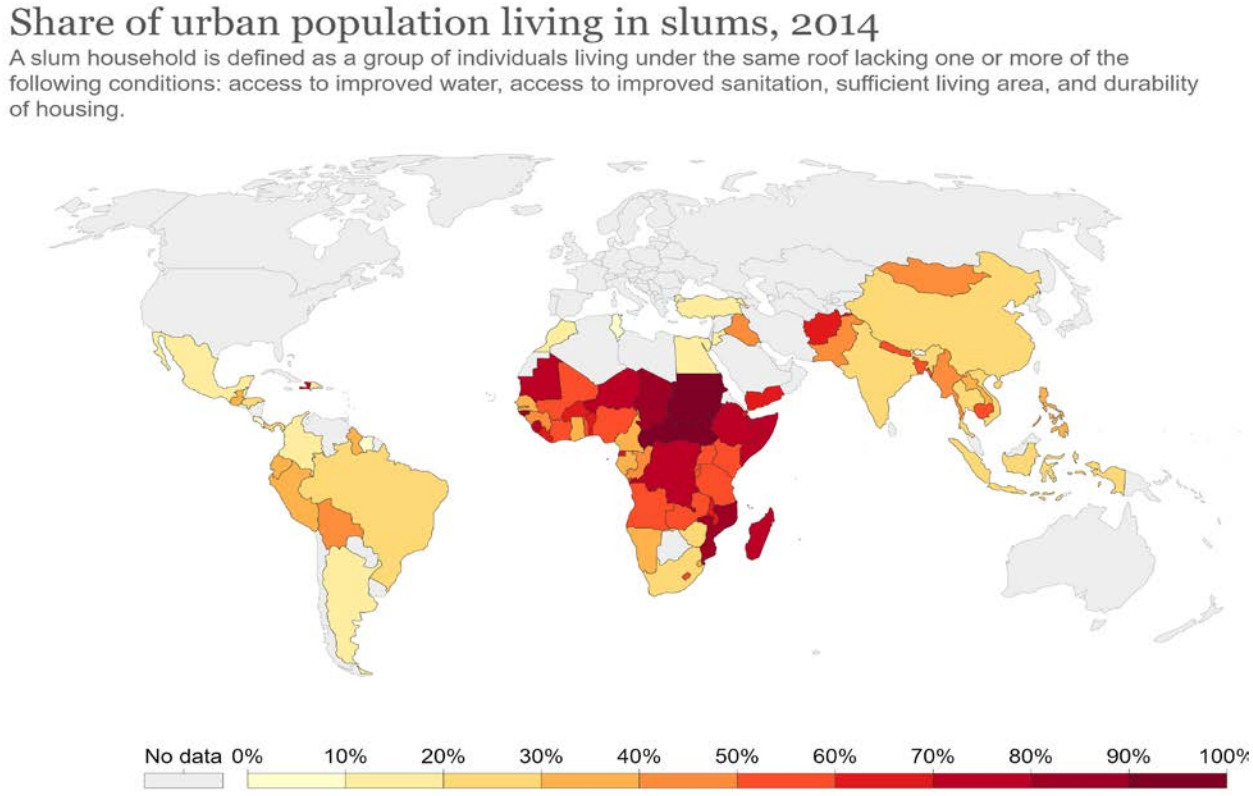
[3] *Slums - an overview | ScienceDirect Topics*

It can be shown that the fraction of urban inhabitants living in slums is falling with time in most nations. For example, from 1990 to 2014, the share of slum households in the urban population dropped as follows (55 to 24% in India, 44 to 25% in China, 77 to 50% in Nigeria and 37 to 22% in brazil). [2]



Map 2: Share of people living in slums. *Source: Urbanization - Our World in Data*

2.1.5 Forecast of humans live in urban areas

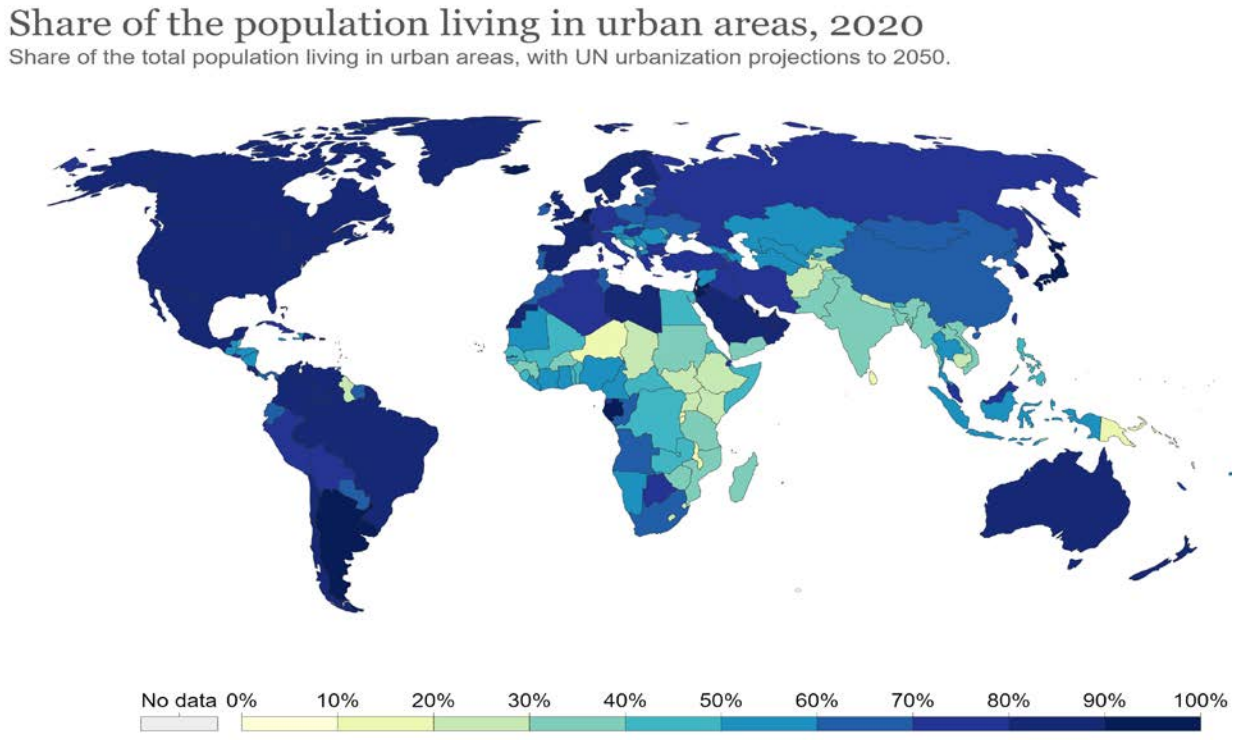
By 2050, more than two-thirds of the world will live in cities. Global urbanization has accelerated in recent decades, particularly in the last 50 years. The United Nations Global Urbanization Outlook forecasts the global proportion of cities until 2050. These forecasts are depicted on a map. The proportion of cities varies among nations, but is anticipated to rise over the next few decades. By 2050, urban regions are anticipated to house 68 percent of the world's population (up from 54 percent in 2016). In actuality, few nations are anticipated to have a greater proportion of rural

regions than urban ones by 2050. It spans Sub-Saharan Africa, Asia, the Pacific Islands, and Guyana in Latin America.[2]

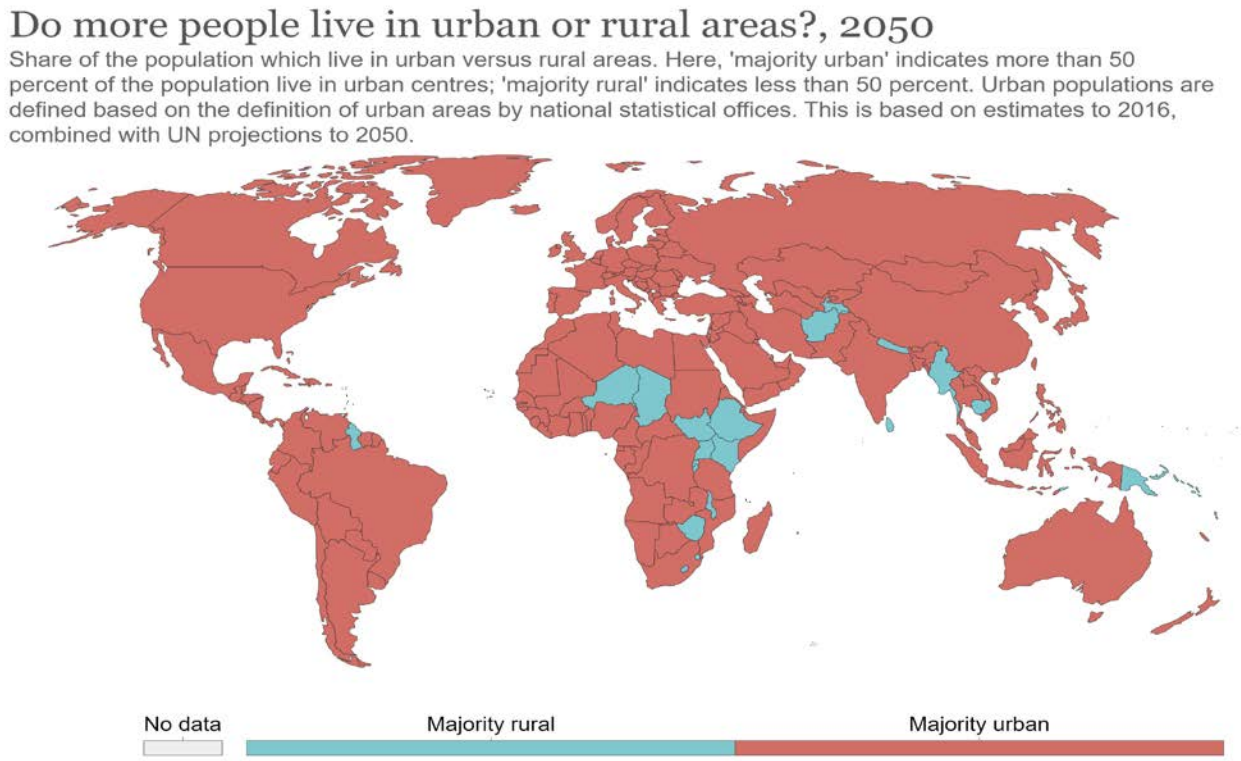
Why is it that the worldwide total is just over two-thirds if most countries are anticipated to live in cities? This appears to be low, but this is because the percentage of cities in the world's most populated nations is relatively low (more than half or less). For example, India's (which is predicted to be the most populated country in the world) city share in 2050 is expected to be just 53%.

The other maps displayed here offer an overview of glimpses of how the globe is likely to progress and grow more urbanized in the future. This reflects whether the majority of people in a certain country live in cities or in rural regions.

It was largely a high-income country in Europe, the Americas, Australasia, and Japan as a whole in 1950, and it was primarily an urban area. A century later, most nations are expected to see an increase in the number of people living in cities by 2050.



Map 3: Share of population living in urban areas in future *Source: Urbanization - Our World in Data*



Map 4: Urban vs Rural majority in future *Source: Urbanization - Our World in Data*

2.1.6 Worlds population

The global population is increasing at a pace of around 1.05 % each year (down from 1.08 % in 2019, 1.10 % in 2018, and 1.12 % in 2017). Currently, the average annual population growth rate is expected to be 81 million. Annual growth peaked in the late 1960s at around 2%. Since then, the pace of rise has nearly halved and will continue to fall in the coming years. [4]

As a result, the world's population will continue to expand in the twenty-first century, but at a considerably slower rate than in the past. In 1959, the world's population was doubled (up 100%) (3 billion), and it remained that way for the next 40 years (until 1999). (6 billion). It is now projected that it will take about 40 years to rise by more than 50% to reach 9 billion by 2037.

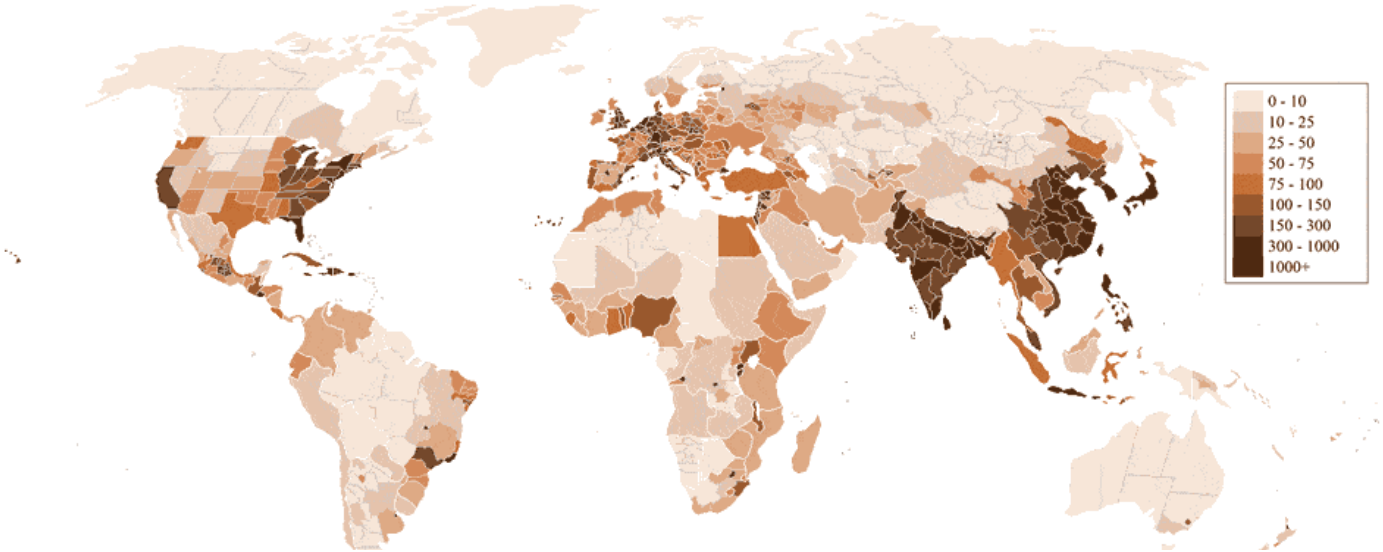
[4] World Population Clock: 7.9 Billion People (2021) - Worldometer (worldometers.info)

According to the most recent global population projections, the world's population will exceed 10 billion by 2057.

Table 1: World population by region

S. No	Region	Population (2020)	Yearly change	Density (P/Km²)	Net change	World Share
1	Asia	**4,641,054,775**	0.86 %	150	39,683,577	59.5%
2	Africa	**1,340,598,147**	2.49 %	45	32,533,952	17.2%
3	Europe	**747,636,026**	0.06 %	34	453,275	9.6%
4	Latin America and the Caribbean	**653,962,331**	0.9 %	32	5,841,374	8.4%
5	Northern America	**368,869,647**	0.62 %	20	2,268,683	4.7%
6	Oceania	**42,677,813**	1.31 %	5	549,778	0.5%

Source: World Population Clock: 7.9 Billion People (2021) - Worldometer (worldometers.info)



Map 5: World population density (people/km2) *Source: World Population Clock: 7.9 Billion People (2021) - Worldometer (worldometers.info)*

2.2 What is Carbon Emission?

The release of carbon into the atmosphere is referred to as carbon dioxide emissions. When we talk about carbon emissions, we're really talking about greenhouse gas emissions. It is a key contributor to climate change. Because greenhouse gas emissions are frequently measured in terms of carbon dioxide equivalents, they are sometimes referred to as "carbon dioxide emissions" when addressing global warming and the greenhouse effect. Since the Industrial Revolution, there has been an increase in the use of fossil fuels, which is directly connected to the rise in atmospheric CO2 levels and the resulting rapid rise in global warming. [5]

As population and production expand, so do energy consumption and anthropogenic carbon emission factors, and the need to minimize carbon emissions grows in importance. Large energy transfers through transmission networks were necessary to connect energy generation and consumption. This energy stream has a simulated carbon cycle. This article presents the idea of "carbon flow in networks" and develops a technique for estimating the carbon flow of carbon dioxide emissions in the network to better comprehend this cycle and account for the link between energy consumption and carbon dioxide emissions. The authors highlight the significance of this new idea not just as a feasible method, but also as an original theoretical perspective, using a factual study of China's energy mix.[6]

2.2.1 Principle of action

Carbon dioxide, the primary greenhouse gas responsible for global climate change, continues to rise month after month. Greenhouse gases have maintained the Earth's temperature liveable for humans and millions of other species by trapping heat from the sun. However, these gases are now out of balance, threatening to radically alter which living species can live on this planet. [7]

Carbon dioxide, the most harmful, ubiquitous, and greenhouse gas, has the greatest atmospheric levels ever measured. Greenhouse gas levels are quite high, owing mostly to the combustion of fossil fuels and their release into the atmosphere. Gas absorbs solar energy and retains it close to

[5] *Carbon Emission - Definition from ecolife.com*
[6] *Carbon Emission Flow in Networks | Scientific Reports (nature.com)*
[7] *Carbon dioxide in the atmosphere is at a record high. Here's what you need to know. (nationalgeographic.com)*

the earth's surface without allowing heat to escape into space. The greenhouse effect refers to the phenomena of heat trapping. The origins of the greenhouse effect notion may be traced back to the nineteenth century, when French mathematician Joseph Fourier estimated in 1824 that the Earth would be significantly colder without its atmosphere. Svante Arrhenius, a Swedish scientist, was the first to link the increase in carbon dioxide gas with the warming effects of fossil fuel combustion in 1896. Almost a century later, according to US climate scientist James E. Hansen, "the greenhouse effect has been observed and is affecting our climate now." [7]

Today, scientists use the phrase "climate change" to characterize the complex changes induced by greenhouse gas concentrations that are actively altering the Earth's meteorological and climatic systems. Climate change encompasses not just an increase in average temperature, known as global warming, but also a variety of consequences such as changes in the number and habitat of severe wild species, as well as sea level rise. Global governments and organizations, such as the IPCC (Intergovernmental Panel on Climate Change), a United Nations institution that studies the latest science on climate change, measure greenhouse gases, study their consequences, and implement remedies. [7]

More than 30 years of behavioral research has shown that the presence of economically appealing technology, especially when accompanied by extra financial incentives, is insufficient to promote behavior change. Behavioral implications may be divided into six fundamental concepts that will contribute to RAER success. These regulations outline how to remove key impediments to mitigation activities. Some are well-known and regularly used, while others are infrequently used. The following are the design principles:[8]

1. Prioritize High-Impact Actions
2. Provide Sufficient Financial Incentives
3. Strongly Market the Program
4. Provide Valid Information from Credible Sources at the Points of Decision
5. Keep it Simple
6. Provide Quality Assurance

[8] *Design Principles for Carbon Emissions Reduction Programs | Environmental Science & Technology (acs.org)*

These six principles are reminiscent of Kermit's adage, "Being green is not easy." The government's major difficulty in meeting the short-term carbon reduction objectives for the household sector is to make it as easy as possible. Many past energy efficiency and energy saving projects suffered from a failure to pay attention to the concepts of convenience and quality assurance. [8]

Outside of the residential sector, there is also a significant energy efficiency gap. Profit margins, or "hurdle rates," of more over 30% are required by average corporate managers for energy efficiency initiatives. This is significantly higher than the projected return on other investments, implying that non-financial considerations have a role in corporate investment decisions. Additional study on energy efficiency solutions in the commercial and industrial sectors will be needed to identify all of these aspects and establish guidelines for implementing energy efficiency programs for these sectors. We think that well-planned initiatives will enable these sectors to carry their fair part of the cost of meeting short-term emission reduction objectives.[8]

2.2.2 Global gas emissions

The following are the primary greenhouse gases generated by human activities across the world:[9]

1. **CO2 (Carbon Dioxide):** The usage of fossil fuels is a significant source of CO2. CO2 emissions can also have a direct human influence on forests and other land uses, such as deforestation, land reclamation for agriculture, and soil degradation. Similarly, via tree planting, soil enhancement, and other activities, land may remove CO2 from the sky.
2. **CH4 (Methane):** All CH4 emissions are caused by agricultural operations, waste management, energy usage, and biomass combustion.
3. **N2O (Nitrous Oxide):** Agricultural activities such as fertilizer use contribute significantly to N2O emissions. N2O is also produced during the burning of fossil fuels.
4. **F-gases (Fluorinated Gases):** Industrial operations, refrigeration, and the usage of different consumer items have all contributed to F-gases emissions, which include hydrogen fluorocarbons (HFC), perfluorocarbons (PFC), and sulphur hexafluoride (SF6).

[9] *Global Greenhouse Gas Emissions Data | US EPA*

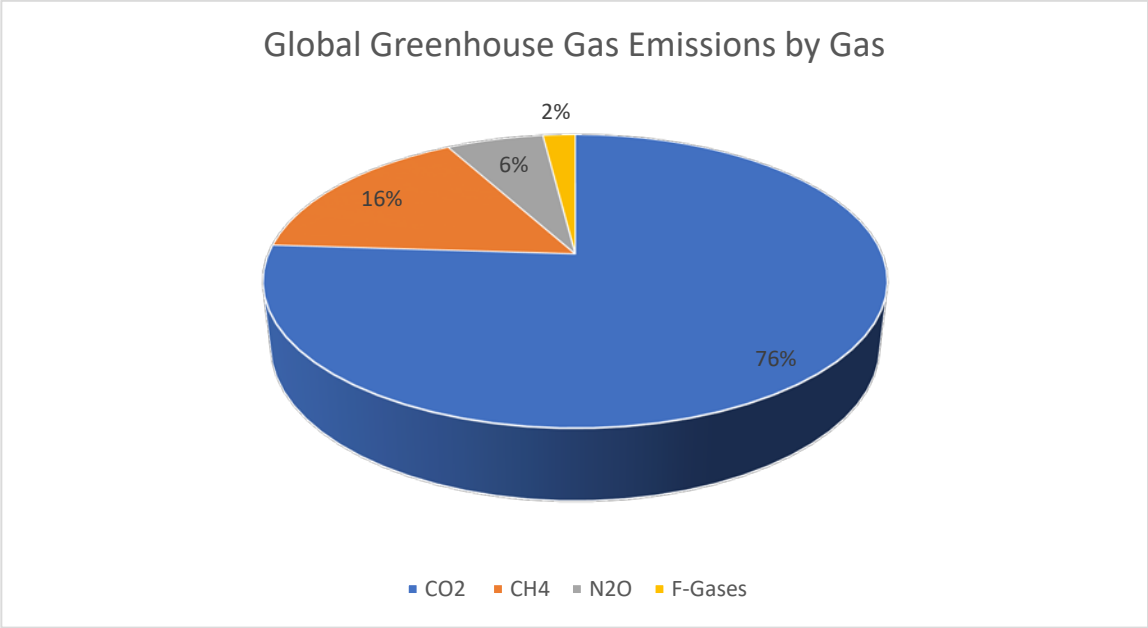


chart 2: Global greenhouse gas emissions by gas
Source: Global Greenhouse Gas Emissions Data | US EPA

2.2.3 Global emission of CO2 in economic sector

1. Electricity and heat generation: which accounted for 25% of worldwide greenhouse gas emissions. The greatest single source of global greenhouse gas emissions is the burning of coal, natural gas, and oil for power and heat.
2. Industry: 21% of global greenhouse gas emissions. Fossil fuels burnt in energy facilities are the primary source of industrial greenhouse gas emissions. This sector comprises emissions from non-energy-related chemical, metallurgical, and mineral conversion operations, as well as waste management activities.

   (Note: Emissions from industrial power usage are excluded and are dealt with by the electricity and heat generating sectors.)
3. Agriculture, forestry, and other land use: Account for 24% of total world greenhouse gas emissions. Most agriculture (crop and livestock farming) and logging contribute to greenhouse gas emissions in this sector. This estimate excludes CO2, which the ecosystem sequesters through biomass, dead organic matter, and soil carbon and removes from storage, accounting for roughly 20% of emissions from this sector.

4. Transportation: Accounts for 14% of worldwide greenhouse gas emissions. Greenhouse gas emissions from this sector come largely from fossil fuels used for road, rail, air, and marine transportation. Almost all of the world's transportation energy (95 percent) is derived from petroleum-based fuels, principally gasoline and diesel.
5. Buildings: Greenhouse gas emissions in this sector are created through on-site energy generation, building heat, and the use of fuel for home cooking, accounting for 6% of world emissions. increase.

   (Note: Emissions from building power usage are excluded and are handled by the electricity and heat generating sectors.)
6. Other forms of energy: 10% of total world greenhouse gas emissions, this source of greenhouse gas emissions is unrelated to the generation of power or heat, such as fuel extraction, refining, processing, and transportation.

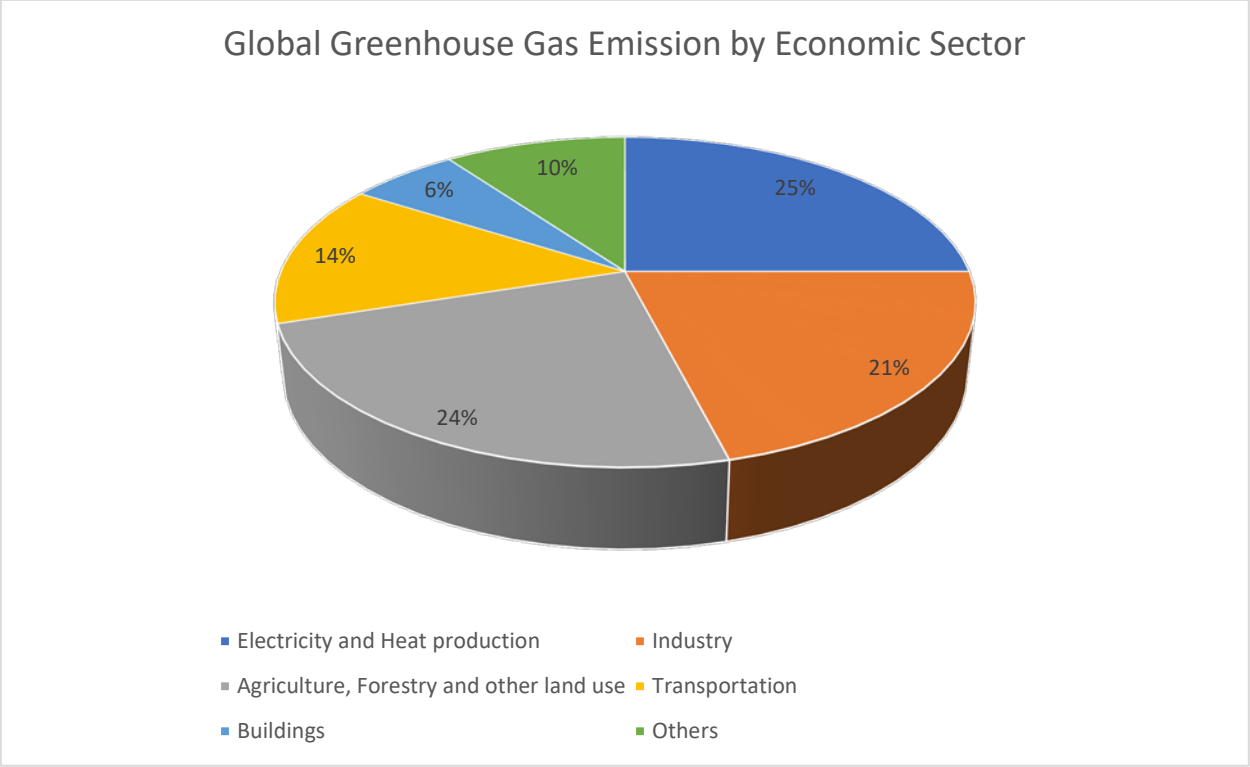


chart 3: Global greenhouse gas emission by economic sectors
Source: Global Greenhouse Gas Emissions Data | US EPA

2.2.4 CO2 Emission by country

China, the United States, the European Union, India, Russia, and Japan were the leading emitters of carbon dioxide (CO2). These figures include CO2 emissions from the combustion of fossil fuels, cement production, and gas flaring. As a result, these factors are responsible for the vast bulk of worldwide CO2 emissions. This estimate excludes emissions and sinks related with changes in land use. Changes in land use, on the other hand, can have a significant impact. Agriculture, forestry, and other land use are projected to account for more than 8 billion metric tons of CO2 equivalent, or roughly 24 percent of total worldwide greenhouse gas emissions. Changes in land use due to human activities absorb CO2 and partially offset logging emissions in other regions in places such as the United States and Europe. [10]

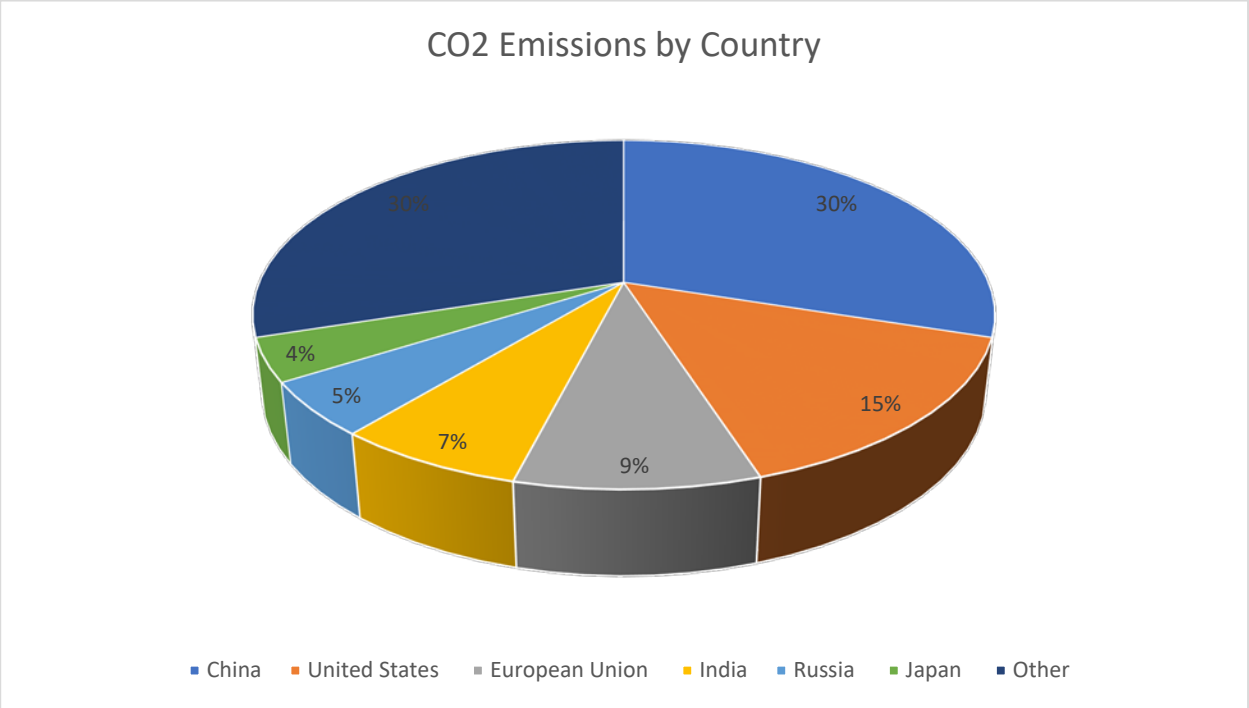


chart 4: Co2 Emission by country *Source: Global Greenhouse Gas Emissions Data | US EPA*

[10] *CO2 emissions - Our World in Data*

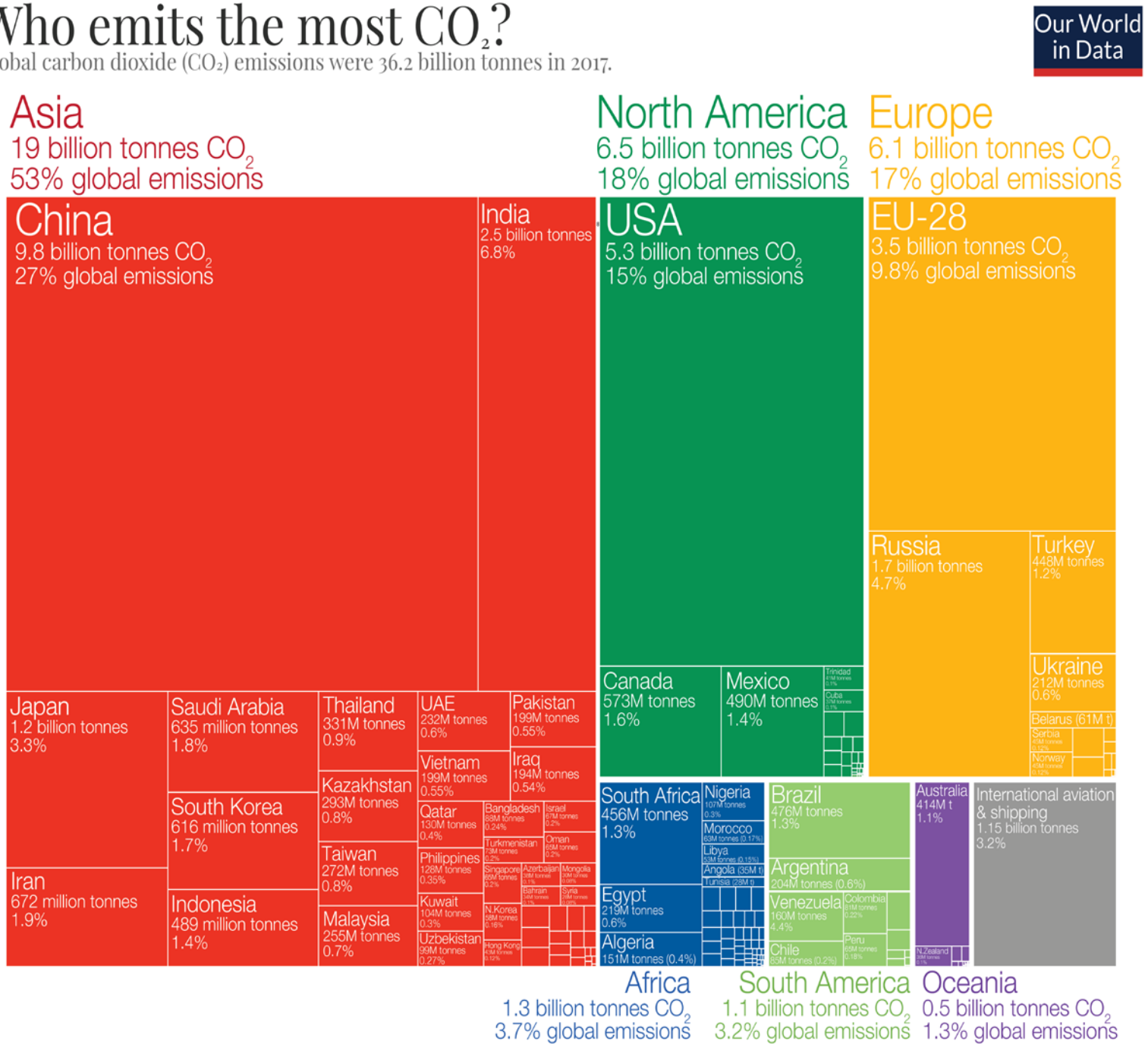


Figure 2: CO2 Emission by Country

Source: CO2 emissions - Our World in Data

2.3 Copenhagen Agreement for Carbon Emission

The United Nations Foundation Convention on Climate Change, approved in 1994, serves as the agreed-upon framework for the international climate change debate. "The ultimate aim... is to achieve... stability of greenhouse gas concentrations in the atmosphere at a level that would preclude hazardous anthropogenic interference with the climate system," according to the paper. The Framework Convention was implemented in the 1997 Kyoto Protocol, which agreed on enforceable emission limitations for 2008-2012 for both high-income nations and countries transitioning from socialism. The actuality of global warming policy, on the other hand, lags considerably behind scientific guidance. This is demonstrated by the collision of covered emission. In 1990, the Kyoto Protocol addressed 66% of industrial CO2 emissions. However, given the absence of US ratification and reductions in the proportional emissions of affluent nations, the Kyoto Protocol now covers just 27% of world emissions. [11]

The goal of the 2009 Copenhagen conference was to reach another post-Kyoto accord. The summit ended without a final agreement due to extensive cost sharing and distribution of emission reductions. This, however, resulted in an accord known as the "Copenhagen Accord." The pact intends to limit world average temperature rise, "recognizing the scientific point of view that the increase... should be less than 2 degrees Celsius." Those seeking for a silver lining in the ambiguous conclusion said that poor countries had signed on to the accord. A deeper examination reveals, however, that underdeveloped nations have adopted relatively little. They committed to "communicate" their "nationally suitable mitigation efforts necessitating international assistance," but they did not set enforceable objectives for underdeveloped nations. Most nations had revealed their plans by mid-2010.[11]

The truth behind the deal is dismal. First, even if high-income nations completed their pledges, they would most likely fall short of the 2° C objective, as illustrated below. Meanwhile, movement toward a more binding deal has been sluggish, to say the least. The global agreement is now subject

[11] *William D. Nordhaus - Economic aspects of global warming in a post-Copenhagen environment - February 4, 2010*

to credible litigation from the United States. Further delays in the implementation of a climate policy by the United States might have a detrimental influence on other countries.[11]

Given these developments, it is worthwhile to evaluate the possibilities for climate change and economic consequences, both where restrictions are being imposed, as stipulated by the Copenhagen Accord, and where the current deadlock remains. This paper summarizes the results of the RICE2010 Model, an updated version of the Regional Integrated Climate and Economy Model (RICE Model). The model is a regional, dynamic, integrated global economy and climate change assessment model that takes a comprehensive approach to economic development, emissions, the carbon cycle, climate change, damage, and emission control. The model allows for the calculation of internally consistent predictions of the influence of different political regimes.[11]

Copenhagen international accord to reduce costs and carbon prices resulting from the submissions: [12]

Individual nations have made recommendations for greenhouse emission reductions for the year 2020 as part of the Copenhagen Agreement. This document examines the influence of these submissions on emission reductions, the carbon price, and the clear cost. Annex I (industrialized) nations' applications are projected to achieve a total reduction target of 12-18% below 1990 levels. The applications of the seven rising economies are expected to cut emissions by 11-14 percent below the baseline, depending on foreign (financial) support. The worldwide switching costs in 2020 are anticipated to be in the range of $60-100 billion US dollars, assuming that at least two-thirds of the Annex I emission reduction objectives are met within. Although the costs are comparable as a share of GDP with Annex I as a group and the seven emerging economies as a group, even with significant international transfers from Annex I countries to emerging economies to finance their repayment costs, Annex I countries bear the lion's share of these costs. If the limitation of reaching two-thirds of the emission reduction objective in its own country departs in its own country, he would quadruple the worldwide carbon price while also reducing global switching costs by about 25%. [12]

[12] *Michel G.J. den Elzen - Abatement costs and carbon prices resulting from the submissions - 3 December 2010*

Chapter 03: Global Urbanization and Carbon Issues

3.1 Urbanization Issues

3.1.1 Significant urbanization difficulties

Cities already house more than half of the world's population, and the World Health Organization expects that this proportion will continue to increase. People migrate to cities for a variety of reasons, including family ties and career possibilities. Urbanization has altered a country's or region's economic, social, and political structure, resulting in a number of significant negative consequences.[13]

1. **Lack of jobs -** As a result of urbanization, there is a labour shortage. Businesses and governments are unable to satisfy the expectations of a fast-increasing population. As a result, unemployment will soar, and individuals will seek government assistance and benefits. Governments lose money and offer less electricity, health care, education, public transportation, trash management, and physical protection. Poverty is spreading, and economic progress is stifled.
2. **Air pollution -** The burning of gasoline in cars produces fine dust in the air. Particulate matter is made up of soot, dust, lead, and smoke. They are extremely dangerous to one's health. In children, lead alone can cause brain damage, learning problems, and early death. According to the World Health Organization, the fine dust concentration would be less than 90 micrograms per cubic meter. Fine dust concentrations exceed the observed value in cities with populations of 8 million or more.
3. **Biodiversity threatened -** Natural regions of new, endangered flora and wildlife are destroyed as cities expand. Various, no matter how little, have a significant influence in the movement of the planet. Humans would have suffered if these changes in life had not occurred. Biodiversity protects water and soil from pollution, retains and reuses nutrients,

[13] *5 Major Problems of Urbanization (synonym.com)*

decomposes and absorbs contaminants, and aids communities in recovering from calamities more quickly. People benefit from biodiversity in other ways, such as medicine, food, and clean air. Access to these resources is being hampered by urbanization.

4. **Disease -** Because to urbanization, there has been a decrease in physical activity and nutrition, which is harmful to one's health. Noncommunicable illnesses, such as heart disease, are expected to account for 69 percent of all fatalities in poor nations by 2020, according to the World Health Organization (WHO). Infectious illnesses are another danger connected with urbanization. Bacteria and viruses are transported from one country to another by air travel. Furthermore, persons who relocate to rural regions have lower immunity to diseases than long-term city inhabitants and are more likely to become ill.
5. **Crime -** Rapid urbanization has an impact on crime rates. Residents with varied views and habits who are abruptly put together have little time to adjust or adapt to conflicting perspectives, resulting in violence. When governments are unable to avoid widespread poverty, the incidence of stealing and other crimes rises. Frustration and alienation from diminishing social standing, as well as restricted access to education, money, and other resources, drive young individuals to join criminal gangs.

3.1.2 Urbanization impact on the physical environment

According to the US Census Bureau, the world's population has surpassed 7 billion people and is still growing. According to the United Nations, the world's population doubled in only 50 years. Human demand for space and resources will increase as population growth accelerates. Rapid population expansion has a huge influence on the physical environment, generating pollution, influencing climate change, and endangering species variety. [13]

1. **Pollution** - A wide range of human activities contaminate our land, air, and water. As the world's population rises, so does the quantity of rubbish and waste we generate. Landfill sites are becoming scarce, and a large amount of waste is piling up in natural areas. The ocean current has caught two pieces of massive plastic garbage in the Pacific Ocean, according to the Smithsonian. To fulfil demand, industrial and agricultural activities are

expanding, which increases pollution produced by such methods. For example, the production of computers, mobile phones, and other IT goods results in the release of heavy metals such as lead, which endangers human health and the environment.

2. **Climate change** - Industrial activities, such as the use of fossil fuels for energy, emit greenhouse gases into the atmosphere. More people require energy for habitation, food production, and transportation as the population expands. According to the US Environmental Protection Agency, industrial operations, transportation, and energy use account for more than 80% of greenhouse gas emissions in the United States. Greenhouse gases, such as carbon dioxide, contribute to climate change by trapping heat in the atmosphere and transferring organisms, causing weather patterns to alter.
3. **Species diversity** - Humans compete with other species for space, and human growth frequently results in the loss of natural habitats. The population is increasing by 250,000 people every day, according to the Centre for Biodiversity. This fast expansion is putting a strain on land, water, and food supplies, leading to the extinction of numerous species. The human population was much larger 200 years ago when there were just a billion people, and the animal population has since vanished. Woodland bison no longer roam West Virginia, and the Arizona Merriam herd of Merriam's elk has vanished.
4. **Water scarcity** - According to the United Nations, human water usage has increased at a higher pace than population growth during the last century. Water shortage is becoming an increasing problem as more people utilize water throughout the world. According to the United Nations, more than one billion people do not have access to safe drinking water. While there is enough fresh water on Earth to feed 7 billion people, it is not distributed uniformly or easily. Some places around the equator lack water supplies to feed the local population, and there is no sanitation or drainage infrastructure to provide the African region's water resources.

3.1.3 The environmental damage caused by modern technologies

People's lives have been altered by modern technology. Most individuals now carry cell phones with them everywhere they go so that they may call friends and relatives. Cars and trucks have made it possible for individuals to travel more freely around the country. Home appliances have

lowered the amount of time we spend performing housework. People's lives have become more convenient as a result of modern technology, yet it has also affected the environment. [14]

1. **Electronics** - People's lives have been altered by modern technology. Most individuals now carry cell phones with them everywhere they go so that they may call friends and relatives. Cars and trucks have made it possible for individuals to travel more freely around the country. Home appliances have lowered the amount of time we spend performing housework. People's lives have become more convenient as a result of modern technology, yet it has also affected the environment.
2. **Cars** - Cars pollute the environment in a variety of ways. They occasionally work with leaking oil. Oil spills may pollute the environment and kill animals and plants. Furthermore, water poured onto adjacent rivers by oil refineries can cause water pollution and harm ecosystems. When you drive, your automobile generates pollutants like carbon monoxide and tiny particles like soot. Automobile air pollution can contribute to global warming by creating smog and holes in the ozone layer.
3. **Power** - Every time the lamp is turned on, electricity is consumed. Coal, gas, and oil are used to generate electricity. Fine particles from the combustion of coal are discharged into the atmosphere. Pollution is also caused by coal mining. Mine runoff can contaminate nearby watersheds, compromising drinking water quality and ecological health. Oil-fired power stations generate air pollutants such as carbon monoxide. Petroleum-powered power plants use a lot of water as well. The removal of water from lakes and rivers can have an impact on ecosystems. Natural gas must be taken from the Earth, which has the potential to devastate ecosystems.
4. **Appliances** - Washing machines and dishwashers not only make life simpler, but they also use important resources. Electronics require electricity and fossil fuels to function. Washing machines and dishwashers use a lot of water and can affect the ecosystem of a stream or lake, according to the National Geographic Green Guide. Fluorocarbons, which are responsible for ozone layer depletion and global warming, are found in refrigerators

[14] *Bad Effects of Modern Technology in the Environment (synonym.com)*

and freezers. Finally, an equipment disposed of in a landfill can seep dangerous elements into the environment as well as the valley below it.

3.1.4 Population impacts on ecosystems

Significant study on the world's ecosystems has been conducted, with all worries concerning human influence on the environment being addressed. Many things can disturb these ecosystems, but the population has the greatest impact. [15]

1. **Population** - A population is defined as a collection of creatures of the same species that exist in the same place at the same time and may mate. Local wolves, deer, and populations are some examples.
2. **Size** - The most potent element influencing ecosystems is population size. The bigger the population, the greater the strain on the environment. If the population grows too high, ecosystems can collapse.
3. **Cycles** - The population is through a cycle of expansion and decline. When the population grows too quickly, resource scarcity usually results in population rivalry. This allows the species and environment to recover while avoiding lasting harm.
4. **Limiting Factors** - A variety of constraining constraints guarantee that the population does not get too big. One is physical space, which is particularly crucial for plant populations. Another is food store.
5. **Resistance -** The population falls when environmental resistance (short of food, water, or other resources) exceeds the species capacity to reproduce.

3.1.5 Urban development problems

The strategy and procedure for the growth of big cities is known as urban development. Urban development concerns often include urban planning, the influence of urban development on the urban collapse ecology, the sociological impact of urban development, and the economic implications of all of these aspects. Researchers examine these topics in order to better understand

[15] The Effect of the Population on the Ecosystem (synonym.com)

the circumstances that allow cities to thrive and to propose strategies that can contribute to beneficial urban growth.[16]

1. **Housing -** As the population expands, so does the need for homes. This can have a variety of consequences for the growth of urban areas. It has the potential to induce urban sprawl in particular. This occurs when a major metropolitan region begins to encroach on underdeveloped or rural settlements. Furthermore, as a city with huge income disparities, population expansion tends to generate unequal living circumstances, forcing impoverished slums and housing conditions to relocate to inferior regions.
2. **Urban sprawl -** When urban sprawl overwhelms a less densely populated city or a rural region in the suburbs, it is said to have occurred. Areas defined by urban sprawl reduce land usage and, in general, highlight a lack of public transportation. The ill-advised growth of cities tends to pose environmental concerns that generate problems, since individuals living in the suburbs tend to pollute more. In addition, ill-advised urban growth can endanger or destroy natural ecosystems.
3. **Urban decay and gentrification -** When a city is engulfed in turmoil and disaster, it is said to be corrupted, and this typically entails growing levels of unemployment, poverty, crime, and political alienation. It is also distinguished by widespread weakening, withdrawing or condemning of structures, and access to social welfare activity. Gentrification is commonly used in urban planning to counterbalance the decline of cities. This encourages affluent residents to purchase real estate and invest in impoverished regions, with the expectation that it would enhance the lives of everyone in the area. However, some gentrification initiatives have been condemned for displacing the poor.
4. **Economic development -** As cities increase in size, the wealth disparity grows, causing economic issues. One such issue is the development of slums as a result of unequal access to economic opportunities, which separates the affluent and the poor in metropolitan areas. Slums are often defined by sluggish economic activity and a lack of opportunity for inhabitants. Declining property prices, which occur when rich individuals and businesses

[16] *Urban Development Problems (synonym.com)*

relocate to such regions, worsen slum issues and frequently trap inhabitants in a cycle of poverty. Policies that encourage business growth in slums can assist to address these issues.

5. **Safety and sanitation -** Sanitation is a major issue in every city since it may contribute to the spread of illness among the numerous people who live nearby. In addition, crime rates are expected to grow when population density increases. To fight this, the most frequent and fundamental public services are street cleaning and rubbish collection, and police presence is increasing. Improving education throughout the city is a common action done. This helps to reduce crime and encourage basic personal hygiene practices.
6. **Urban decay -** When portions of a city are destroyed, this is referred to as urban decline. High unemployment, high crime rates, depopulation, barren landscapes, constructing Bolyo Jim, and divided families are all signs of urban decline. There is no one cause of urban decline; instead, a number of variables such as poor urban design, redlines, poverty, suburbanization, and racism all interact.

3.2 Carbon Issues

3.2.1 The impacts of greenhouse effect

According to the IPCC, human greenhouse gas emissions are higher than ever, greenhouse gas concentrations in the atmosphere are soaring, and the Earth is heating up. Between the pre-industrial period and the present, the average global temperature has risen by 1.8 degrees Fahrenheit (1.0 degrees Celsius), with around two-thirds of this increase occurring in the previous few decades. According to the IPCC, the 30 years between 1983 and 2012 will be the warmest in the previous 1400 years (in the evaluable Northern Hemisphere). And the five years from 2014 to 2018 were the world's warmest on record. If the present warming trend continues, global warming is expected to reach 2.7 degrees Fahrenheit (1.5 degrees Celsius) over pre-industrial levels between 2030 and 2052.[17]

[17] *Greenhouse Effect 101 | NRDC*

Anthropogenic greenhouse gas emissions are altering the Earth's climate system in a variety of ways. That is:

- Heat waves, typhoons, droughts, floods, and other extreme weather phenomena are becoming more often and/or severe.
- Excessive precipitation is exacerbated, soaking wet areas and making dry places more drier.
- Sea level rise is caused by melting glaciers and sea ice, as well as rising sea temperatures (warm water can expand and contribute to sea level rise)
- Changes in ecosystems and natural habitats, geographic expanse, seasonal activity, migration patterns, and a diverse range of terrestrial, freshwater, and marine species

Not only do these changes endanger plants and wildlife, but they also endanger people. Higher temperatures allow insects that transmit illnesses like dengue and deer fever to reproduce. Heat waves are becoming increasingly dangerous to people. People might double when food resources are depleted due to droughts and floods. According to a 2011 National Commission of Inquiry

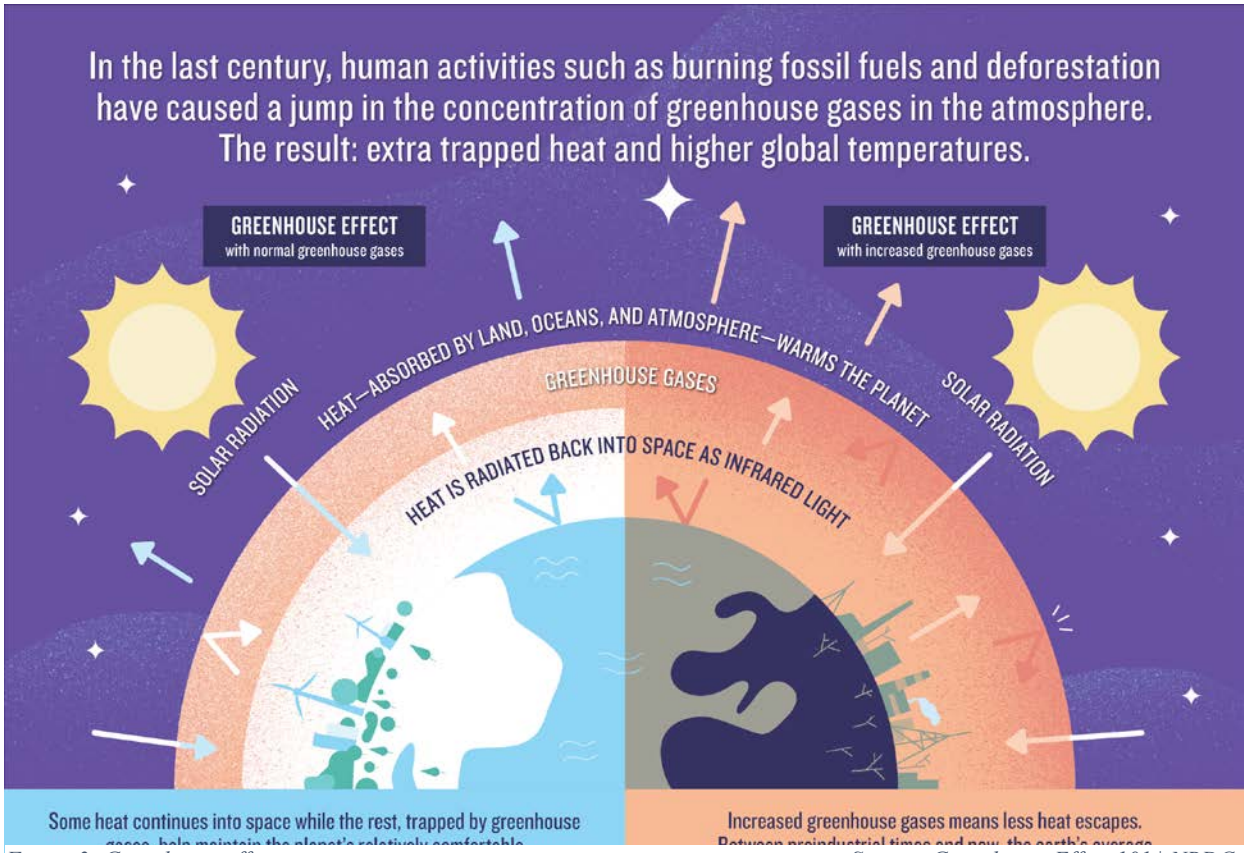


Figure 3: Greenhouse effects *Source: Greenhouse Effect 101 | NRDC*

report, each degree of global warming reduces yields by 5 to 15%. Food insecurity can cause mass migration and political unrest. In addition, in January 2019, the Pentagon issued a study describing the dangers to US military facilities and activities across the world posed by the consequences of climate change, such as floods and drought.

3.2.2 Consequences to the planet

The rise in the earth's average temperature is altering the planet's living circumstances. The primary effects of this phenomena are discussed further below.[18]

1. **Thawing of glacial masses -** Glacier retreat has its own set of repercussions. Some of these are a decrease in albedo (the amount of solar energy reflected off or returned to the atmosphere by the Earth's surface), a worldwide rise in sea level, and the emission of huge methane plumes. They are awe-inspiring for all Earths.

2. **Flooding of island and coastal cities -** The worldwide average sea level rose 19 cm between 1901 and 2010, according to the Intergovernmental Panel on Climate Change (IPCC, 2014). Sea level is expected to increase 15 to 90 centimetres over its current level by 2100, endangering 92 million people.

3. **Hurricanes will be more devastating -** The intensification of the greenhouse effect does not create these catastrophic climatic occurrences, but rather intensifies them. Hurricane development is linked to water temperature; hurricanes can only form on water that is at least 26.51degrees C.

4. **Migration of species -** Many animal species are compelled to move in order to withstand changes in major climatic patterns that occur when temperatures gradually rise. Humans, too, must move. According to the World Bank, the number of people displaced from their homes as a result of catastrophic drought and severe flooding might reach 140 million by 2050.
5. **Desertification of fertile areas -** Global warming has a significant influence on the process of soil devastation, which kills all biological potential in afflicted areas and renders them barren soils. It contributes to As the UN recognizes on World Desertification Prevention Day in 2018, 30 percent of the land has been destroyed and its true worth has been lost.

[18] *Greenhouse effect: what it is, how it occurs and consequences - Iberdrola*

6. **Impact on agriculture and livestock -** Global warming has already shortened the growing season in many regions of the world. Similarly, temperature and season variations influence the establishment of illnesses that can harm insects, invasive plants, and crops. The same may be said for cattle. Climate change has a direct impact on many key species, including reproduction, metabolism, and illness.

3.2.3 Impact on human health

It also has a direct influence on human health in the following ways:[18]

1. **Food shortages -** Climate change, according to the Food and Agriculture Organization of the United Nations (FAO), poses major concerns regarding food supply. A previous biennial assessment on the global situation of food and agriculture warns that decreasing agricultural productivity would result in food shortages. It has the greatest influence on the sub-Saharan African and South Asian food shortages.
2. **Spread of diseases and pandemics -** According to the World Health Organization (WHO), in addition to the immediate concerns of pollution, infectious illnesses such as malaria, cholera, and dengue fever will spread to more regions of the world as a result of global warming. Severe heat, on the other hand, worsens and aggravates cardiovascular and respiratory issues.

3.2.4 How climate change devastates the environment

Climate change is visible everywhere, from weather patterns to farming to entire plant and animal ecosystems. Scientists are already documenting the effects of these climate-related changes, which are already influencing our everyday lives, largely as a result of man-made global warming. In fact, the years 2015 to 2018 were the four warmest on record. In this article, we will look at three critical elements of a warming world. [19]

1. **More heat changes ice, weather and oceans –** These are just a few instances of how additional heat may change climatic conditions and weather patterns.

[19] *How climate change plunders the planet | Environmental Defense Fund (edf.org)*

- **The cryosphere - Earth's frozen water is dissolving** - The Earth's snowpack's, glaciers, seas, and freshwater ice are fast melting due to the heated atmosphere. Melting glaciers and polar ice sheets are causing unprecedented sea level rise. When sea ice melts, darker water exposes itself, which absorbs more sunlight than ice and speeds up the continuous circulation that warms, melts, and heats the sea.
- **The ocean is turning hotter, expanding and more acidified -** Because it absorbs 90% of the excess heat, the environment becomes hot. Because of this shift, the water expands and raises sea levels, robbing corals of their vibrant hues. Meanwhile, almost one-third of carbon dioxide emissions make ocean water more acidic and disintegrate marine creature shells, producing chemical changes. The ocean is about 40% more acidic than it used to be.
- **Weather is getting more extreme -** Heat waves are becoming increasingly common all across the planet. Extreme weather events such as hurricanes are exacerbated by increased water evaporation, which acts as storm fuel. As sea levels rise, storm waves may do even greater harm. Droughts and forest fires are getting increasingly severe in naturally dry places.

2. **Human life and prosperity suffer as a result -** Our health, economy, livelihoods, infrastructure, and much more are all under risk:
    - **Climate change poses a significant danger to agriculture -** It has a lot to do with when, where, and how we grow our food, as well as general weather trends. Farmers all across the world are trying to keep up with shifting weather patterns and increasingly volatile water sources. Weeds, illnesses, and pests that reduce production are more likely to assault farms. Crop yields are also threatened by extreme occurrences, such as flooding and limited water availability.

    - **Warmer, dirty air has an impact on our health -** In polluted locations, a warmer atmosphere promotes the production of ozone with soil, commonly known as smoke. Smog stimulates Hen attacks asthma and causes pulmonary reactors to fire. Smoking for

forest fires minimizes further air pollution. The harsh summer heat means that more people will die as a result of the heated procedure. Warm freshwater makes it simpler for immortal agents (such as bacteria) to grow and pollute drinking water.

- **Infrastructure and transportation are both hazardous -** Hot temperatures, floods, and other extreme weather events can destroy infrastructure, interrupt travel and commute, and disrupt energy supply.

3. **Natural habitats become hostile -** Land and sea environments have altered, making it more difficult for certain species to survive while allowing others to move in and take their place. Some ecosystems are at danger of collapsing. The following are three well-documented examples of natural transformations.
   - **The ice that Arctic creatures require is dwindling -** As sea ice melts, ice-dependent animals such as sea elephants and polar bears struggle to live. The 2008 polar bear was the first mammal to be listed as endangered on the endangered species list as a result of global warming.
   - **Coral and shellfish are suffering -** Coral reefs are extremely sensitive to slight variations in water temperature. The heat affects the birds, which feed the corals and give vibrant colours. The birds then left, and the corals died of starvation. This is known as the bleaching phenomena. Coral reef collapse disrupts the overall ecosystem since coral reefs provide home for many other species, such as fish. Furthermore, because very acidic seas disrupt natural calcium balance, creatures with cemented skin, such as shellfish and coral, may not have enough calcium to develop.
   - **Forests are more prone to deadly infestations -** Tree-killing insects can thrive in warmer winters and longer summers. Trees that are susceptible to long-term drought, on the other hand, have a weaker defence system. Warm weather, fragile trees, and a healthy insect cycle might all be to blame for the catastrophic extinction of 70,000 square miles of Rocky Mountain conifers.

3.3 Effects of Urbanization on Carbon Emissions (EUCE):

The influence of urbanization on CO2 emissions (EUCE) is complicated, and very little study has been done in depth to show how different elements affect and develop and evolve. A worldwide scientific visualization analysis was performed in this work using the Citespace and VOSviewer software to simulate potential effects and future trends in urbanization on CO2 emissions. The spatial period distribution of publications, collaboration, present hotspots, and future trends of EUCE were conducted out using publications from 1982 to 2018. The findings revealed that between 1992 and 2018, global rising tendencies of EUUCE investigations, including China, the United States, and the United Kingdom, were published on the first third relevant research in the United States, during the quickest growth in China. Population movement, consumption of consumption, land use and LUlCC cover (LUlCC), energy savings, and noncarbon greenhouse gases such as CH4 and N2O are the primary research subjects. In addition, focusing on CO2 footprint has become a hotspot for carbon reduction. The ecosystem service provided by urban green spaces progressively emerged as a study topic. Furthermore, energy transformation technology is critical to reducing carbon emissions and has emerged as a major worry in future growth. Furthermore, the timeline visualization analysis shows that all of the study subjects on EUB are interrelated and interconnected, reflecting the necessity for multidisciplinary integration in scientific research. In conclusion, our research has resulted in a quantitative representation of the current situation and future EVU tendency patterns, which will be beneficial for future research and policy recommendations.[20]

Method:

VOSviewer is a bibliometric analysis tool created in 2009 by Nees Jan van Eck and Ludo Waltman of the University of Leiden in the Netherlands (Van Eck and Waltman 2009). VOSviewer may investigate a study subject and the whole research area from a holistic standpoint. In general, various node colors indicate distinct categories of subjects on a visual map, and font size denotes the frequency of a certain topic. Citespace (Chen 2010) is a Java-based program that translates to

[20] *(PDF) Identify the effects of urbanization on carbon emissions (EUCE): a global scientometric visualization analysis from 1992 to 2018 (researchgate.net)*

"citation space.". It is a multidimensional time-sharing and dynamic citation visualization analysis program created for scientometric demands and knowledge visualization, professionally evaluating the fundamental knowledge contained in scientific publications. It may discover sources of research, scientists, hotspots, and their evolutionary route by graphically presenting the position and size of each node, as well as through different functionalities. Furthermore, Citespace enables capability to study relationships between various units of knowledge, such as authors, institutions, nations, and so on, and may allow collaborative analysis via a collaborative web view. Furthermore, CiteSpace and ArcGIS may be linked to display the geographical distribution of authors or research institutes based on their location (Liu 2013; Yuetal.2019). In this study, we performed our bibliometric analysis of carbon dioxide emissions from urbanization, which included the following parts: basic bibliometric analysis, collaborative network analysis, and analysis of identifying important trends, in order to obtain a comprehensive analysis of research hotspots and trends in carbon dioxide emissions from urbanization research. [20]

The publication's basic bibliometric analysis:

The fundamental bibliometric analysis can offer an overview of the study field. The yearly publishing and dissemination of research nations / areas of WOS analysis tools and GIS were carried out in particular. Cyspace software processed the entire offer from each nation or area. [20]

An examination of the scientific cooperation network:

Interdisciplinary interaction and cooperation are always at the heart of high-impact research (Joon and KOO 2016). As a result, an examination of scientific collaboration is beneficial in demonstrating the trajectory of a particular discipline's development. In general, scientific collaboration may be identified when many authors, institutes, or nations appear in the same paper. The use of VOSViewer software carried out both inter-country and inter-author collaboration in order to define the most important research groups in the Eve field in this study. [20]

Identification of key themes and references:

The frequency of the term false frequency or the reference rate number typically reveals the meaning of an idea or the effect of an article. A coword or string network, on the other hand, can continue to demonstrate the reciprocal link between these themes and literature. As a result,

cowords and a string network must be performed in order to better grasp the knowledge structure of the study topic. The CitualSpace burst recognition function is used to determine the research impact during the subject's development (Yu et al., 2017). The nodes whose incomplete circuits turn red in Burst analysis, the outstanding words implying that a particular period rapidly rises in a short time, implying a shift in a research direction to some extent. To comprehend the evolution of research in Evus from 1992 to 2018, the event event was done on the conditions extracted from the title and abstract area using Vosviewer software extracted from the title and abstract area. A coreference study of Citaspace was also created in order to gain a more thorough examination of the topic in many fields. Furthermore, CitaSpace's time zone analysis is a two-dimensional network, both of which serve the research subjects and the publishing time of said study diagram images. With a brief summary, it is possible to visually represent the research furnace and the derivative connection, as well as provide an accurate projection of the future development direction. [20]

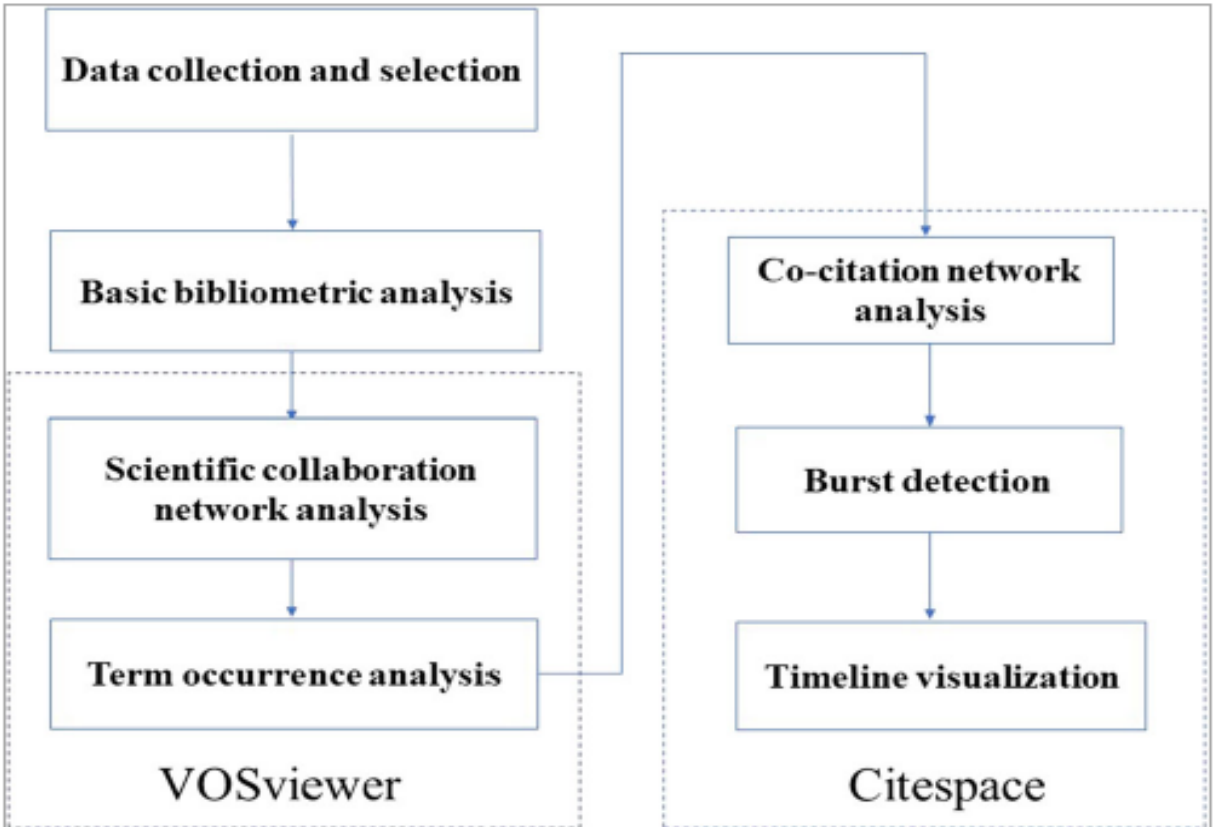


Figure 4:Flowchart of the Study
Source: (PDF) Identify the effects of urbanization on carbon emissions (EUCE): a global scientometric visualization analysis from 1992 to 2018 (researchgate.net)

Chapter: 04 Urbanization and Carbon Emission Case-Study of The China

4.1 China, Country in East Asia.

4.1.1 Why China?

China, the world's most populated country and is highly urbanized. The government acknowledges the benefits and possibilities of urbanization and is dedicated to encouraging and regulating city expansion in a fair and orderly way.

Urbanization is critical to China's economic and social growth, yet the conventional urbanization paradigm is unsustainable. After a simple examination of the prerequisites for creating a new urbanism, the fundamental concept of the new urbanization is outlined in this white paper. The core paradigm of New Urbanism is to advocate for inclusive, cooperative, and sustainable development in China's cities, led by a scientific development perspective. Population urbanization is a critical issue. Drivers of industrialisation include information, agricultural industrialization, and new industrialization. Economic growth is the path of progress because of productivity. [25]

4.1.2 Introduction

China is an East Asian country that shares the South China Sea with the East China Sea and Goryeo. In adjacent nations, there are 14 sovereign states. China has a varied topography, with deserts in the west and plains in the east, with primarily mountains in the middle. The Yangtze and Yellow rivers are two of the major rivers that run from west to east. The government is a communist country. The president is the head of state, and the award is the government's adversary. China has a market-based system that was changed in the 1970s by the central planning system. China is a participant in the Asia-Pacific Economic Cooperation (APEC) and the Asia-Pacific Trade Agreement (APTA).[21]

[21] *China: Introduction >> globalEDGE: Your source for Global Business Knowledge (msu.edu)*

Following the implementation of reform and opening-up policies, China's urbanization increased. In 2020, urban regions will house 60.6 percent of the entire population, a considerable rise from 17.92 percent in 1978. According to the OECD, there are now 15 megacities in China classified as Functional Urban Areas as of 2010. (FUA).

4.1.3 China's unprecedented urbanization

Although urbanization in China began around 4,000 years ago, genuine Neolithic communities began to develop in river valleys around 1000 years ago, but urbanization is presently occurring on an unprecedented scale. By the end of the 1940s, China had 69 cities. There were 670 cities in 2007, and the number has nearly doubled since then. Migration and natural village growth have resulted in the extension of small villages that have been classed as cities, resulting in progress in urbanization. 89 of these cities have a population of over one million people, far less than other big nations of similar size, such as the United States, which has 37 and India, which has 32. China is anticipated to play a significant role in a rapidly urbanizing globe. Specifically, because of its magnitude and rate of change. China's urban population was 191 million in 1980. Excluding immigration, that amounted to 594 million people in 2007. [25]

Currently, cities hold almost half of China's population. As officials gather in June for the World Cities Summit, China's rapid urbanization will most likely be the focus, both in terms of coping techniques and the rewards and problems the nation has faced. According to Justin Lin, World Bank Chief Economist, "as more people relocate to urban areas, not only in China, but also in other regions of Asia and Africa, the focus of development operations must be double." Rural development is vital in the base economy, and rapid urban industrial expansion is and will be a major source of growth for the country's economy.

4.1.4 Strategies that helped China manage urbanization[22]

China's urbanization is rising rapidly, according to Shahiddo Yusuf, senior advisor to the World Bank's Development Research Group and co-editor of the new book "Urbanization in China."

[22] *China's urban transformation strategy | ORF (orfonline.org)*

China has succeeded in either halting or redirecting migration from villages to small and medium-sized cities by urbanizing on an unprecedented scale. It's congested, yet there aren't many slums. The family register to regulate immigration and steer immigration to small and medium-sized cities has been a significant component of China's urbanization plan. [22]

“One of China's greatest achievements in rapid urbanization is that crowded living circumstances may stymie the process to the point where few slums exist. This is a significant accomplishment for poor countries.”

It has, however, loosened the restrictions for hookers in bigger cities, and there is continuing discussion over the system's future function and if it predicts immigrant access to local services. Low levels of poverty and unemployment in the city. The Chinese economy's fast expansion has helped to alleviate urban poverty. It is believed that 4-6 % of the population is affected. The urban jobless rate will fall to 3-4 % as well. The allocation of public services and numerous administrative tasks for the local government is another significant component in China's successful urbanization. In 2005, Chinese residents' satisfaction with local government was greater than 72 %, compared to many other nations, including the United States. Avoid urban horizontal spots. China also preserved land area for urban development cities, which presently account for roughly 4.4 % of the total land area.

"On the negative, the income gap between villages and cities is extremely significant," Tony Sevi pointed out. “Air and water pollution in cities are a significant concern, and services for migrants, as well as safety nets for the poor and the elderly, must be addressed adequately.”

4.1.5 Demand and strains of large cities

China has been more adept than many other nations in responding to urbanization pressures, but it must respond promptly to numerous challenges. Infrastructure and work Between now and 2025, between 200 and 250 million individuals are expected to relocate to China's cities, boosting the present mobile population to about 155 million. Providing jobs and infrastructure for this expected

flood of people will be a major issue. Rapid economic growth continues to be crucial in developing the finance markets required to support the financing of urbanization. [23]

A significant lesson for quickly urbanizing countries may be derived from Germany, Japan, and South Korea, where the automotive industry is booming but cities stay relatively small if oil is cheap, which is not the case in the urbanized United States.

1. **Energy:** Urban residents consume 3.6 times the amount of energy as rural dwellers. It implies that energy consumption has not peaked. Furthermore, energy intensity (energy consumption per GDP unit) is 7 times that of Japan and 3.5 times that of the US.
2. **Motorization:** While the government has designated vehicles as a critical sub-sector, governments must balance the benefits and drawbacks of new motorization. As a result, cities expand, energy consumption rises, and pollution rises.
3. **Water:** Water scarcity in China exceeds 2,100 cubic meters per capita, accounting for one-third of the global average. The issue is even more severe in the northern areas, where climate change might worsen dry conditions.
4. **Agriculture land:** Given the high commodity prices and rising demand, it is critical to have adequate arable land for Chinese agriculture, which also helps to limit the city's unwise development.
5. **Climate change:** The climate change has an impact on densely populated lowlands. To safeguard these places from sea level rise and flooding, significant setup may be required.

4.1.6 The fundamental model of modern urbanism

The conventional urbanization problem is based on the temporal and Chinese features of future urbanization, and this article provides a fundamental model of new urbanization. China's urban building is being developed in a sustainable manner. The main topic is population urbanization. It propels computerization, agricultural industrialization, and new industry. Economic growth through productivity is a way of development. Government policies and markets serve as

[23] China's Rapid Urbanization: Benefits, Challenges & Strategies (worldbank.org)

safeguards. The ultimate objective of new urbanization is to create a metropolis in China that combines urban and rural regions. Given the same chance, infrastructure integration spans China's urban and rural areas, public services are equal to everyone, farmers and urban people may develop knowledge, skills, personal quality, and income. The following are some specifics: [25]

1. **New economy:** The industrial system in the framework of modern industrialisation is composed of high-tech content, delivering excellent economic advantages, low resource consumption, low environmental pollution, and is not labour demanding. Domestic demand and consumer support comprise the demand structure system. Human capital and innovation elements are crucial in the structural system. The corporate structure system is made up of large organizations as well as many small and medium-sized businesses.
2. **New environment:** It should achieve attractive natural scenery, good ecological environmental resource protection, effective environmental protection, and good people-environment interactions.
3. **New society:** Communication techniques controlled by new communities, new social organizations, new societies, social and social links are worldwide, lifestyles are modern, and resident composition is diverse and flexible. The social class system is shaped like an olive and is a mix.
4. **New governance:** It offers a social environment with good institutions and the rule of law for urban and rural growth and urban life, as well as an open and convenient market environment, a free and open cultural environment, and a democratic and free political environment.

4.1.7 New industrialization and modern agriculture

With global information, substantial innovation, and the Digital Revolution, China's new urbanization has three new doujinshi. Which are as follows: [25]

1. **New Pulling strength:** Information technology is built on a new industrialisation that provides strong economic advantages, low resource consumption, minimal pollution, and labour-intensive high-tech content. The Intelligent Digital Revolution and Information Technology will constitute a new driving force for modern urbanization.

2. **Fresh impetus:** China should fully utilize the most recent information technology, agricultural production data, and administration of the most recent service base. Agricultural mechanization, agricultural research, agricultural industrialisation, and increased labour quality provide a fresh drive for new urbanization.
3. **New source of energy:** Information technology is a contemporary scientific and technology representation that impacts the supply and demand for urbanization indirectly and directly controls the volume, pace, and quality of urbanization. Information technology, new industries, and contemporary agriculture provide a more powerful source of power than ever before, guaranteeing that urbanization is people-first innovation-driven and sustainable.

4.1.8 The fundamental method of Chinese new urbanism

The success of new content urbanization is dependent on fresh motivation and techniques for executing object urbanization. It is critical to keep the broad approaches of sustainable development and modern urbanism in place. Sustainable urbanization is a balanced development in the short and long term, as well as a coordinated development of the economy, society, and environment, allowing future generations to achieve sustainable development, live and work in peace, and be happy. [24]

- People relocating from provinces to cities were the first to embark on the path to urbanization.
- We travel the smooth route of urbanization, emphasizing the need of equality and efficiency.
- Explore the urbanization route, where industry and cities combine to promote long-term development.
- Walk the green development route of urbanization to preserve the ecosystem's natural beauty.
- Inclusive growth, which follows the trend of urbanization, ensures justice and definition.
- Choosing the route of pushing urbanization innovation ensuring that cities take the lead in the future.
- Develop the market's fundamental role in the route of government-led urbanization.
- Walk the open urbanization road to capture the city's uniqueness.

[24] *China's new urbanization plan: Progress and structural constraints - ScienceDirect*

4.1.9 China's policy approach to encourage new urbanization

The fundamental concept of modern urbanization is to insist on comprehensive, coordinated, and long-term growth of urban building in China, with scientific development as a guideline. The main topic is population urbanization. It propels computerization, agricultural industrialization, and new industry. Economic growth through productivity is a way of development. Government policies and markets serve as safeguards. This article outlines eight concrete strategies for integrating rural and urban China. Based on the functional principle of completely compensating for market failure, the government implements four basic measures proactively and consistently: strategy and planning, infrastructure, provision of public services, improvement of institutions and policies, and strengthening of supervision. It is also possible to advance the management. [24]

1. **Leading the Development of Sustainable Strategies and Plans, as well as New Urbanization.**

- The objective of development is to create urban China by combining urban and rural areas.
- Total urban population and density.
- Site of construction and level of urbanization.
- The ideal urbanization objective attained in two phases.
- system of city scales.
- Urban space layout
- A functioning urban system

2. **Infrastructure and public services that enable the healthy growth of new urbanization.**

- Construction of a nationwide integrated infrastructure network.
- Improving regional infrastructure network integration.
- Develop equitable public services gradually in cities, rural areas, and countries.

3. **Improve supervision and administration, as well as support the orderly development of new urbanization.**

- Create a management structure suited for China's metropolitan regions.
- Developing long-term intergovernmental property rights and financial power linkages.
- Creating a regional intergovernmental cross-government cooperation structure.
- Creating a system of integrated urban and rural management.
- Increasing responsibility and performance.
- Redefining the conditions for the creation of cities and other relevant tasks.

4. **Institutional and policy reforms are required for the sustainable development of new urbanism.**

➢ **Creating long-term institutions and strategies to ensure urbanization.**

- Extensive fiscal and tax reform.
- Advancing the land reform process.
- The family record system is being reformed in more depth.
- Deepening the reform of the labour system.
- Enhancement of the social insurance system.
- Increase the depth of financial system reform.

➢ **Creating a long-term strategy to assure urbanization's ongoing growth.**

- Mechanism for price adjustment.
- Ecological incentive scheme.
- Mechanism of the site.
- Mechanisms of Funding.
- Financial assistance mechanism.
- Mechanism for Tax Adjustment.

4.1.10 China's major strategy for urban Innovation[25]

1. **Granting urban residency.**

   The measure would allow rural migrants to settle in cities with their families and enjoy the same public services and entitlements as other city residents, which was previously unthinkable. Despite regulatory changes, it appears that their difficulties are not ended, as many rural immigrants continue to struggle to get urban residency (family register) and welfare benefits, particularly in major cities. Local governments have enacted stringent rules, and applications are scrutinized based on factors such as education level, tax payments, and job experience. Those with poor scores are ineligible for city residency. It turns out that the government is striving to improve its people's quality of life and to lower the requirements for encouraging urbanization.

2. **The growth of urban clusters and the freeing of urban possibilities.**

   11 of the 19 city clusters that have been finalized for development have strategy and investment plans available. The Beijing Tianjin Hebei cluster is dedicated only to science, and it is home to numerous enterprises (science, technology, medical, and finance), who have created over 6,100 subsidiaries in the region. Many businesses have benefitted from combining the region's creative, industrial, and financial resources, improving their total competitiveness and establishing outstanding urban clusters. As in the United States and Japan, urban clusters will provide new prospects in the area. Analysts highlight that for the urban cluster concept to succeed, member governments must have "financial control over planning, investment, income, and budget." We are also working to uncover and promote the potential of the region's small towns and cities. Wuxi (near Shanghai), for example, is a protected and conserved region for old monuments, buildings, and crafts. Many local and international tourists visit due to the abundance of heritage.

[25] *The goal, path, and policy responses of China's new urbanization | China Finance and Economic Review | Full Text (springeropen.com)*

3. **Constructing a new city style.**

   In China, more than 200 smart city pilot projects are ongoing to improve city life and management. To guide the city's future growth, a four-tier design is being developed, and technological investments such as the Internet of Things (IoT) and cloud computing are being made. Objects are recognized and actual information is gathered using sensing equipment in the first step (sensing layer). The massive volume of data gathered is transferred (through the transport layer) to a processing centre (via the processing layer) for examination. Smart solutions are implemented in sectors such as the environment, home, medical, education, water, security, transportation, food safety, agriculture, and power at the final step (application layer). For example, Xinjian's cloud computing and IoT-based water system can monitor river flow and water quality to swiftly handle flood and water pollution concerns. Scholars at Wuhan University see the advantages of smart technology and intelligent planning. We propose the following. “National policy standards and optimal design can prevent massive losses in the early phases of a project.” We establish national IoT and information management standards to integrate as the number of smart cities rises. "There is a need to improve information security."

4. **Enhancement of the city's housing supply system.**

   By designating additional land for house development and establishing a state-owned leasing firm, the Chinese municipal administration is taking efforts to boost the supply of residential housing. We are also working to expand the long-term rental industry. Rental and co-owned houses will account for 30% of total new land supply. To keep house prices constant, effective home price control measures have been created. Speculative demand will be curtailed by "home buying restrictions and an increase in the minimum down payment necessary for mortgages."

5. **Setting future city population targets**

Shanghai, Beijing, and Guangzhou have established demographic objectives for the future. The three city governments are attempting to limit future population growth by implementing steps such as transferring services from various government departments to newly formed cities. This decision was taken in order to preserve optimal living conditions (or to manage "major city illnesses") while also reducing demand on urban resources. The government recognizes that these initiatives will aid in the development of these cities becoming internationally significant cities. The decision to create positive targets has been highly criticized and deemed unrealistic. "Shanghai requires young and highly qualified individuals to be competitive and inventive," Gwangchukton added. "When such measures are implemented, migrant workers and the city's underprivileged will bear the brunt of the consequences."

These analyses demonstrate large-scale urban changes for various components of China's urbanization policy and progress in execution. To summarize, attempts are being undertaken to tackle the challenges that exist in current cities. Many cities are already making advantage of strong infrastructure, services, and technology. There are other measures in the works to alleviate traffic congestion in heavily populated cities. At the regional level, new urban and urban cluster development work is undertaken to accommodate the expansion of future cities and to address regional development imbalances. When making such efforts, it is critical to follow good governance standards. As China strives towards the development of world-class metropolitan centres that provide a high standard of living, greater efforts must be made to address the country's disregard of social, cultural, and environmental concerns.

4.1.11 A dynamic scenario simulation:

Will the urbanization process influence the peak of carbon emissions in the building sector?

Accelerating urbanization has put China's pledges to cut and neutralize carbon emissions to the test. However, it is uncertain how urbanization will impact the maximum carbon footprint of buildings in the future. First, this paper presents a three-dimensional framework for urbanization.

After that, an innovative dynamic scenario simulation model is created by combining Kay's extended identity and a Monte Carlo modeling approach to investigate the future dynamic evolutionary trajectory, possible peaks, and peak times of building carbon emissions in China from 2000 to 2050, while accounting for uncertainty factors. Finally, a dynamic sensitivity analysis is performed to investigate the impact of various elements of urbanization. According to the findings, in a business-as-usual scenario, the rural construction industry would be the first to hit the energy peak in 2027. According to dynamic scenario models, the construction industry would peak at 3.09 (0.36) Bt CO2 in 2037 (4). In example, the urban housing sector will peak at 1.27 (0.18) BtCO2 in 2040 (4), the rural housing sector will top at 0.51 (0.03) BtCO2 t CO2 in 2021 (4), and commercial construction will peak at 1.41 (0.30) Bt CO2 in 2038 (4). Through the co-effects of urbanization, i.e. economic and spatial urbanization, dynamic sensitivity analysis reveals that rural-to-urban migration will have a stimulating influence on peak and peak periods for carbon dioxide emissions in buildings. Overall, this study can assist the government develop efficient carbon mitigation plans to meet the carbon footprint and offset carbon emissions by providing a better understanding of the influence of urbanization on peak carbon emissions. [26]

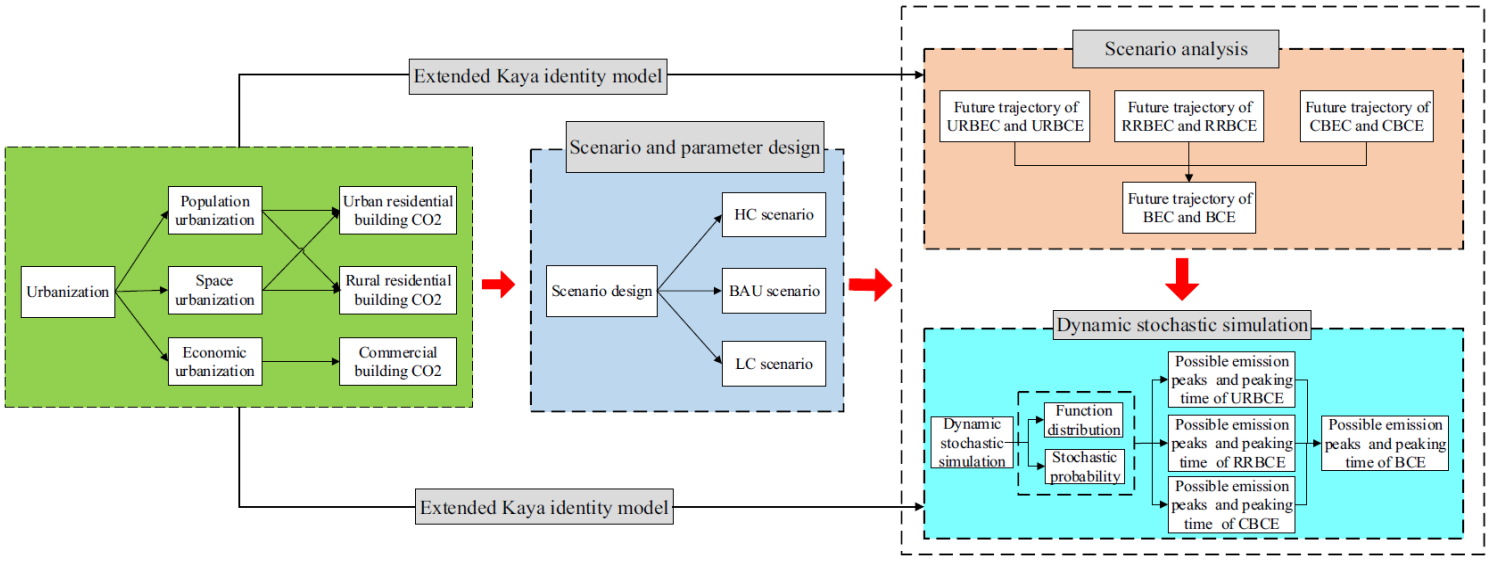


Figure 5: The research framework *Source: Tengfei Huo, W.G. Cai, Mu Lingling - Energy and Building – October 2020*

[26] *"Tengfei Huo, W.G. Cai, Mu Lingling - Energy and Building – October 2020"*

Chapter 05: Urbanization and Carbon Emission Case-Study of European Regions

5.1 Amsterdam, Capital of the Netherlands.

3.1.1 Why Amsterdam?

Aside from bikes and meat-free meals, there are several more aspects that contribute to Amsterdam's status as a green city. Amsterdam, the Dutch city, intends to reduce CO2 emissions by 55% by 2030 and 95% by 2050. It also intends to offer renewable energy to 80% of the households in the area by 2030. [30]

5.1.2 Introduction

Amsterdam, a city in the western portion of the Netherlands, has a port at Ijsselmeer that connects to the North Sea. It is the Dutch capital's primary business and financial hub. Although Amsterdam is the formal capital of the Netherlands, the administration is based in The Hague. In Amsterdam, for example, the royal family merely resides outside the Royal Palace on a square called Dam. The city lacks the magnificent architecture that may be seen in other major cities. There is no triumphal arch or towering monuments, and the squares are too narrow for huge parades. The small, busy streets of Amsterdam's Old Town, where the majority of the population still does business, reflect the city's intimate nature. Gable homes, magnificent brick exteriors coated in sandstone, ornately painted cornice, towers, churches, carillons, and barrel organ music-like structures that remind the splendour of the past, yet modern cities the reality of life is frequently hidden in this beautiful dream.[27]

The municipality includes over 1,300 bridges and overpasses and is divided into approximately 90 "islands" by a network of downtown waterways. Amsterdam is the economic heart of the Netherlands, and history coexists with innovation. Despite the city's sophisticated subway system, around one-fifth of the workforce still travels by bicycle. The city is well-known for its numerous

[27] *Amsterdam | History, Population, Climate, & Facts | Britannica*

Chinese and Indonesian eateries, as well as the hundreds of houseboats that line the canals. Since the mid-1960s, Amsterdam has been recognized for its liberal attitude, drawing many people seeking a better way of life. Local city area of 64 square miles (165 square kilometres); metropolitan area of 245 square miles (635 square kilometres). The city has a population of 1,028,603 people. [27]

5.1.3 Biocarbon in Netherlands

Biochar includes all of the carbon in the biosphere, that is, all of the carbon found in living biomass (plants and animals) and soil organic matter (SEEA EEA, 2014) 1. The SNA ideas, on the other hand, grow the biological resources that are farmed as part of the economy. As a result, the biomass of crops, grasses in meadows, and animals is classified as "coal in the economy," rather than biochar. This only applies to agricultural and animal biomass; soil carbon under arable land and grassland, as well as the remnants of dead plants left in the field, are all part of the biochar. Despite the fact that the Netherlands' woods are mostly maintained, it has been agreed that carbon in forests is ascribed to biochar and not to economy. [28]

For practical reasons, only the top 30 cm of soil were studied for biochar. This results in a significant underestimate of the overall quantity of biochar in the soil, particularly in the case of peat and peat soils. This flaw in existing models may also have an impact on C-fluxes for groundwater table fluctuations beyond this depth. [28]

The carbon account keeps track of overall biochar inventories as well as changes in those stocks. In theory, all important changes in biochar resources, such as net primary production, biomass degradation, soil respiration, biomass harvesting, and so on, may be included. The numerous mechanisms linked to carbon production and storage in the biocarbon cycle are especially relevant in this context. Because carbon storage is typically rather short-lived, the biocarbon cycle is known as the short carbon cycle; if trees or wood catch fire, the carbon is released back into the atmosphere. Surface carbon in soil can also be released, for example, by plowing or erosion, while carbon stored in peatlands can be released as water levels fluctuate, both naturally and artificially.

[28] *"Statistics Netherlands and Wageningen University - The SEEA EEA carbon account for the Netherlands – June 2017"*

As a result, the long-term geological storage period of carbon in the form of biochar is relatively unstable. Biochar stocks, on the other hand, can be substantial and essential because to their sensitivity to land use and hence policy. [28]

Total carbon sequestration (the net amount of carbon stored in plant and soil each year) was spatially uniquely predicted in this study. Carbon sequestration will be viewed as a resource addition due to natural growth. Furthermore, certain biochar stockpiles are a net source of emissions. Biochar is oxidized in peatlands in the Netherlands as a result of lowering the water table, resulting in net CO2 (and CH4) emissions into the atmosphere. These emissions will be accounted for in inventory as controlled shrinkage reductions. [28]

Finally, the production of cattle is now seen as a waste reduction, but is increasingly recognized as a resource in the circular economy. As such, coil is a component of the economy. It is assumed that the entire carbon returned to the environment in the near term as CH4 or CO22. Manure emissions (CH4, CO2) are recognized as direct economic streams in the atmosphere. This is in compliance with the IPCC standards and the AIR problem caused by sea air. [28]

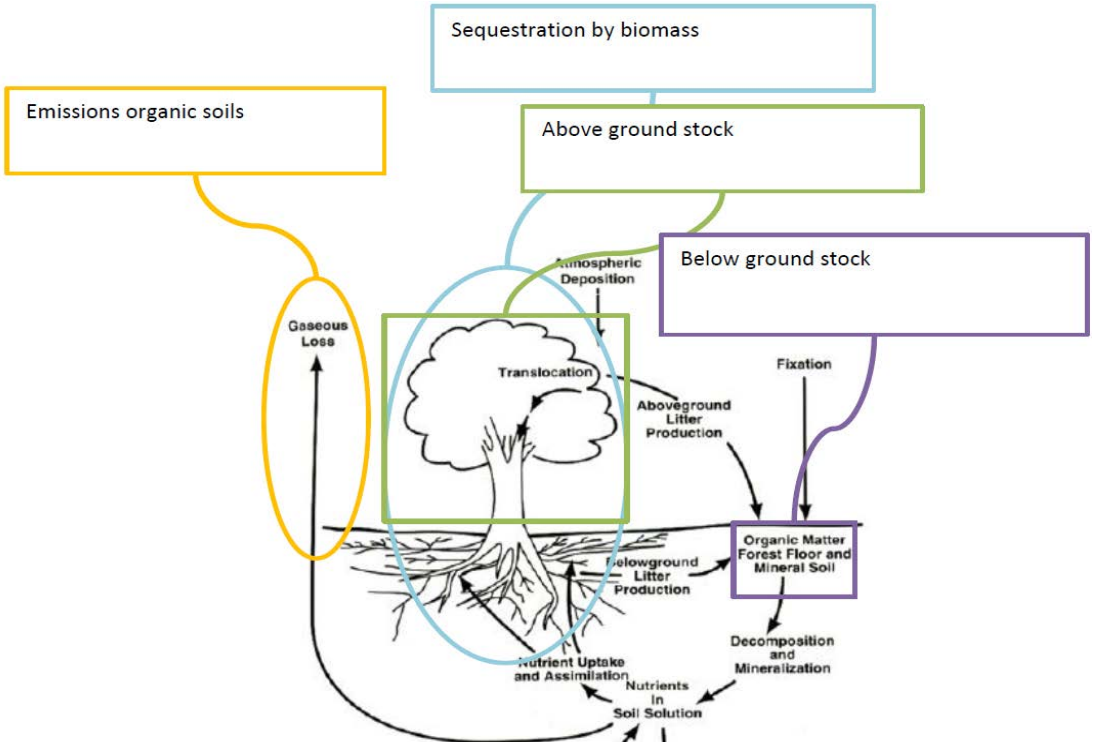


Figure 6: Processes in the biocarbon cycle.
Source: Statistics Netherlands and Wageningen University - The SEEA EEA carbon account for the Netherlands – June 2017.

5.1.4 Why is it eco-friendly [29]

1. **Zero CO2 Emission:** According to a resolution voted by the European Parliament in November 2019, the European Union is in a "climate emergency" as a result of the urgent need to halt global warming.

   Amsterdam, already one of the most ecologically friendly cities and the most committed to tackling the problem, wants to be Europe's first zero-emission city by 2050. Above all, we want to achieve this goal through a policy aimed at reducing CO2 emissions from automobiles while emphasizing sustainable transportation. There are two modes of transportation: public and private. The city intends to replace all diesel buses with zero-emission vehicles and to boost the number of electric taxis. Simultaneously, a financing package is offered to assist the general population in replacing old cars with electric vehicles. The most polluting vehicles are also barred from entering specific sections of the city. When you achieve your objectives, Amsterdam will be one of the most ecologically friendly cities in the world.

2. **A Green Airport:** Operating airports may create significant quantities of carbon dioxide emissions unless minimum sustainability measures are implemented. Fortunately, as the century progresses and more people become aware of the issue, more airports and airlines are working hard to reduce their emissions. Amsterdam Airport, administered by the Dutch company Schiphol, is a pioneer in this field. Responsible energy use entails making effective use of available energy and using as clean energy as feasible. The firm, which has offices in Amsterdam, Eindhoven, Rotterdam, and Lelystad, has contracts with power providers, and the airport runs entirely on renewable energy generated in the Netherlands. Their most ambitious objective, however, is to cut CO2 emissions per passenger to 1.35kg by 2020. And because we were able to reduce it to 1.52kg CO2 in 2017, it appears that we are on the right track. Arriving at such an airport to find a city as exciting as Amsterdam is

[29] *6 fascinating facts about eco-friendly Amsterdam (vueling.com)*

thus a double benefit.

3. **Cycling and walking:** For the sake of convenience, the majority of Amsterdam residents choose to go by bicycle. If they don't have a bike, they can rent one in the city to encourage them. It's no accident that Amsterdam's most popular "hotspots" are all within walking distance of one another. The canal directs people on shortcuts, and it's not terrible for Amsterdam's medieval district to inspire awe. Another reason to go for a stroll or ride a bike. Pedal boats are another way Amsterdam encourages environmentally friendly transportation. It is also one of the most practicable, with over 100 kilometres of canals and over 1,500 bridges. If you don't mind being a little adventurous, you can take the metro rail downtown. It produces less CO2 than a cab or automobile.

4. **Amsterdam for non-touristy tourists:** Because mass tourism poses difficulties in terms of urban sustainability, more individuals are turning to alternative tourism. The Untouristed Guide to Amsterdam (private Querido and online) suggests various choices for exploring the city in a variety of ways. This entertaining guide may take you to street markets, gardens, flea markets, stores, and unusual locations that are not on the free tour's traditional tourist routes. Other options include urban vegetable gardening, culinary lessons, trash fishing in canals, and a fun "wedding" with the locals.

5. **Food:** Food waste is a worldwide issue. In the EU alone, it is estimated that around 100 million tonnes of food are wasted. Aside from the ethical concerns, this has major economic and environmental consequences, as food production has a significant environmental impact. So, as the Helsinki Waste to Taste group has stated since 2016, reducing food waste is an excellent approach to combat climate change. In Amsterdam, you may dine at one of the in-stock chain's foreign restaurants.

   It is nearly unheard of to discover a restaurant menu that does not include local veggies and fresh products. There is probably no place for you if you are searching for a large fast food business. The residents of Amsterdam value locally grown food because they feel it

symbolizes food culture and ethics. Throughout the state, there are several businesses providing biological goods to assist ecological farmers.

6. **Sustainable fashion:** When it comes to the leading sources of pollution, fashion is frequently the offender. You may feel as though you are pointing with your finger depending on how you look at it. Indeed, the usage of pesticides, vast volumes of wastewater, and poisonous dyes that eventually end up in rivers all contribute considerably to global CO2 emissions. The cotton sector alone consumes 3% of global wastewater. It's fantastic! A T-shirt requires around 2.495 litres of water to manufacture.

   This is why Amsterdam is committed to producing eco-friendly clothing. They collaborate with a variety of organizations and businesses to develop sustainable fashion initiatives. Amsterdam is a forerunner in terms of initiative, teamwork, and sustainability. The Dutch Fashion Action Plan, for example, is a collaboration between the Dutch government and the fashion sector that gives advice to fashion businesses. This entails maintaining greater openness if the fashion house rejects the coalition's agenda. In the Netherlands, there is also a Sustainable Fashion Week. This state connects customers to a number of Dutch cities that have ethical fashion stores.

5.1.5 Commitment towards sustainability [30]

Aside from cycling and meat-free meals, there are several more aspects that contribute to Amsterdam's eco-friendliness. The Dutch capital intends to cut CO2 emissions by 55% by 2030 and 95% by 2050. Within the following decade, the city will stop utilizing natural gas before 2040 and will solely transfer emissions via roads and water. It also intends to supply renewable energy to 80% of local residents by 2030. Amsterdam Airport Schiphol also use electric buses to transport passengers, and KLM, the Netherlands' national airline, has pledged to buy 75,000 tonnes of sustainable fuel yearly in order to cut emissions. [30]

[30] *Amsterdam ranked as one of the world's most eco-friendly cities for workers | I amsterdam*

Amsterdam is sometimes referred to as the "Gateway to Europe" because of its strategic location amid Europe's major economies. It provides complete access to the European market because Amsterdam Airport Schiphol is strategically positioned and services over 300 cities. You may easily work in Amsterdam while going to Brussels, Paris, London, and Berlin thanks to the high-speed train service. The Port of Amsterdam has been named one of Europe's greatest ports. [30]

5.1.6 Urban development policy [31]

1. **How is it growing?**

   It's a pleasure to live, work, study, and visit Amsterdam. However, the city is quickly expanding, with around 11,000 new people and 5,000 new dwellings added each year. Jobs are being created, and the number of tourists visiting Amsterdam is increasing quickly. This accomplishment has a number of disadvantages. Houses are becoming more affordable for a rising number of Amsterdam residents, particularly around the A10 ring road and the IJ River. This has an impact on the quality of life in Amsterdam: congested streets, parks, and bike lanes.

2. **In 2040, how will the city and its surrounds look?**

   Amsterdam wants to be an inexpensive, mixed, undivided city where everyone has access to life regardless of money, family composition, age, or job. This covers those with low and middle incomes. Instead than merely spreading to the surrounding green belt in all directions, Amsterdam provides capacity for expansion by imaginatively boosting housing density and changing existing building sites.

   70,000 houses with essential (social) facilities are anticipated to be developed by 2040. On existing business parks and office areas, new projects and houses will be developed. These are converted into appealing residential and working complexes with ample space for prospective knowledge-based economic activities.

[31] *Policy: Urban development - City of Amsterdam*

3. **The Ring Zone and the banks of the IJ River.**

The Ring Zone's primary development will be in Zuidas, including workplaces, thousands of residences, and a variety of services. Station Zuid, located in the centre of Zuidas, is developing into one of the most significant public transportation hubs in the Netherlands. The Noord / Zuidlijn (north / south metro line) links directly to Central Station in Amsterdam.

Where Hamerstraatkwartier, Zeeburgereiland, IJburg (and other areas) are being developed.

- In the direction of Zaanstad.
- The terrains of Houthavens, Buiksloterham, and NDSM are being developed and changed.
- HavenStad (nearly a port area on the ring road) will house 40,000 to 70,000 people and provide thousands of jobs.
- Janstadt and Amsterdam collaborate on the reconstruction of the Achtersluispolder, Hembrugterrein, and Janbank.

4. **Public transportation in the region**

Public transportation that is well-connected is critical for the expansion of cities and the development of major cities. As a result, public transportation networks like as trains, buses, trams, and subways are extended outside the city limits. The Rescue Vision is considering "closing" the West Tangent (Priority Bus Vehicles [HOV] between West Poult and Schiphol), the East West Metro, and the remaining section of the Metro Ring (between Insulator Weblog and Central Station). A smooth transition from vehicle to public transportation is feasible in much more places than are now accessible, and IJ's whole network of ferry links is expanding and rising in frequency.

5. **Metropolitan zone**

The city has entered the country. We are putting plans in place to carry out actions that will help us achieve our growth goals. This entails administrative ownership, which entails keeping a constant pulse on progress and coordinating operations as needed.

Amsterdam is the central city of the metropolitan region of Amsterdam; however, it is not the only city. All parties in the region may rely on and support one another. Every city contributes to Amsterdam's delightful way of life, work, and entertainment. From this vantage point, the city of Amsterdam is always on the lookout for solutions both inside and beyond the city, while keeping the surrounding context in mind. This is the only option for Amsterdam to become a globally competitive and sustainable metropolis.

6. **Sustainable energy**

The city of Amsterdam wishes to expedite the improvement of its capital's sustainability. Cleaner air, land, and water are required. Cities must also become greener, quieter, and more energy efficient. By 2020, the energy utilized per inhabitant should provide 20 percent less sustainable energy. The majority of this will be generated by solar energy on the roof, a closed heating network heated by waste heat, and more wind turbines in the Amsterdam harbour. Amsterdam is also investing in the region's sustainable energy generation, notably the North Sea wind farm.

7. **Investments**

- **Streets:**

Transportation on the City's Streets A type of public space that mixes several socioeconomic purposes in order to attract different individuals for different reasons throughout the day. Long connections across cities are required to connect different sorts of neighbours as well as new city neighbours to historic cities. As a result, these public spaces attract a diverse range of individuals and serve important economic and social roles in the region as well as throughout the city. Because of the restricted area on the streets, there is constant conflict between activities, amenities, and transportation. This makes them an intriguing and lively environment, but it also creates a delicate balance between individuals who use the distance for transit and pleasure, and the colourful or unappealing cityscape.

- **Investing in natural areas and water:**

  Amsterdam is a pleasant place to live, which is essential for safeguarding one's future. Green space improves the city's beauty and liveability. It is becoming more essential in the welfare of people and the attraction of companies, making vegetation and water more appealing. This may be accomplished, for example, by altering and updating some parks, such as Rembrandt park, to accommodate evolving user demands. The city is also spending in order to be able to survive the city's environment. The building of a green roof for enhanced rainwater collection in this case entails the creation of a new climatic protection area along the IJ River's banks.

- **Refurbishment of the square, park, and quayside:**

  The increased density of dwellings in downtown places additional demands on public space. As a result, particular consideration should be given to the design and usage of streets, squares, parks, and piers. It also adds space and concerns for pedestrian and bicycle safety throughout the majority of the ring, including continuous bike paths along the IJ River's banks.

5.2 Copenhagen, Capital of Denmark.

5.2.1 Why Copenhagen?

Environmental incentives are at the top of Copenhagen's priority list. Copenhagen has risen to the top of the list of the world's greenest cities as a result of continued investment in green alternatives. The city has lofty ambitions for providing a high quality of life for its inhabitants while also being ecologically sustainable. [33]

By 2025, the capital will be the first CO2-neutral metropolis. Only 29% of families own a car, bicycling is more popular than driving, and the city has more bike routes. Cycling has grown even more popular as most of the city's hotels now provide bikes! We feel that Copenhagen has now eclipsed Amsterdam as the world's most bike-friendly city. Organic diets are also becoming popular in the city. Organic goods account for 24% of all food sold in the city. Not only that, but 88 % of the food served at public institutions is organic. Copenhagen is continuously presenting innovative methods to live an environmentally responsible lifestyle. [33]

5.2.2 Introduction

Copenhagen is Denmark's capital and biggest city. It is situated near the southern edge of Sound on the islands of Zealand and Amager. One of Europe's oldest capitals, and its monarchy with a regal aura is one of the world's oldest. Beautiful vegetation, amazing adventures beyond, elegant hideaways, cool waterfront activities, and lots of wealth in business environment. The city is a globally renowned knowledge centre in major industrial fields, consistently receiving the highest marks in global rankings for habitability, business, and sustainable technologies. It may be the UN World Happiness City Index, and it is a very popular location to live, work, and visit, ranking first. The city emerges from the depths of history, wise, youthful, lively, and inventive, with a richness of cultural, entertainment, recipe, retail, and sports experience. People look forward to the region's environment of authenticity and independence, equality and variety in the Copenhagen style.[32]

5.2.3 Facts about Copenhagen.

- Copenhagen, a Viking fishing hamlet founded in the 10th century on what is now known as the Gammel Strand, became the capital of Denmark at the beginning of the 15th century.
- Copenhagen has a population of 1,330,993 people (5,822,763 in Denmark as a whole).
- Copenhagen is also the second biggest city in Scandinavia, with an area of more than 90 km2.
- It is the largest metropolis in Northern Europe and the heart of the border Oresund area.
- Every day, we prioritize climate, mobile, and smart city business to guarantee that Copenhagen is clean, ecologically friendly, and the greatest location to live, work, and visit. By 2025, the city hopes to be the world's first CO2-neutral metropolis.
- Its sophisticated public transportation system, which includes a network of subways, extensive bus lines, and easy-to-navigate trains, is well admired. With the purchase of a Copenhagen Card, visitors may have free access to public transportation and city/surrounding attractions.

[32] *Introduction to Copenhagen | Wonderful Copenhagen*

- Copenhagen, which is easily accessible, has been awarded the world's finest cycling city. Every day, residents' cycle 1.4 million kilometres of bike lanes on the city's 384 kilometres of bike lanes, as well as the superhighway.
- The capital is also ranked in the top ten of the Global Liveability Index (excellent living conditions), making it a favourite city break and gathering location for both residents and international visitors.
- The city is one of the major financial capitals in Scandinavia, as well as Denmark's cultural, economic, and government core, and it is home to significant worldwide firms in the ITC, pharmaceutical, and clean technology sectors.
- Currently, the Social Democrats hold the mayor's office in Copenhagen, where Lars Weiss served as mayor.
- Copenhagen's airport, which connects to the city's metro system, is also a significant aviation centre in Scandinavia and has been ranked as one of the world's most punctual airports.
- Copenhagen is a lucky city; it is presently recognized as the 5th happiest city in the world (2019/20), and Denmark is ranked as the 3rd happiest country in the world.
- Finally, in 2020, the Guide Michelin Cities of Nordic awarded 17 restaurants in Copenhagen a total of 23 stars. This eatery is part of a vibrant local gastro scene that includes restaurants, food markets, and coffee shops.

5.2.4 Copenhagen: spotlight of sustainable city [33]

Copenhagen is one of the world's most ecological and energy-efficient cities. It aspires to be the first carbon-neutral capital by 2025, according to the Carbon Neutral by 2025 strategy. Several efforts contribute to this aim, including Copenhagen's ecologically friendly means of transportation, which are responsive to climate change, sustainable urban redevelopment, and efficient energy use strategies. That planning process is more essential than just altering people's values in attempts to promote healthy and sustainable lives in individuals. A 2006 poll found that

[33] *Sustainability - Copenhagen, Denmark (weebly.com)*

54 % of bicycles in Copenhagen ride for convenience, whereas only 1% ride for environmental concerns. As a result, sustainable and energy-efficient communities are not formed entirely from residents' desire to be green. Rather, now is the moment to make sustainable options available. The success of Copenhagen will be determined by how effortlessly accessible the planned projects are to ordinary residents. [33]

1. **Transportation that is environmentally friendly**

   Copenhagen is well-known for its environmentally friendly cycling infrastructure. Instead of relying on a large number of vehicles to go around town, well-managed bike lanes offer sensible mobility in the city. Copenhagen has removed more than one-third of all fossil fuel consumption for basically all transportation, resulting in an annual reduction of 90,000 tonnes of greenhouse gas emissions. It improves air quality in cities by lowering carbon dioxide emissions. The target for this year is 20,000 tons, or "4% of overall CO2 reduction." People in Copenhagen utilize weekends and long-distance vehicles, but bicycles are the primary means of mobility. Copenhagen also intends to invest in vehicles powered by electro-hydrogen. This year alone, 85 percent of city automobiles will be electric or hydrogen-powered. This is highly recommended for both commercial and environmental reasons.

2. **Climate change risk**

   To fund climate change mitigation, Copenhagen employs an interdisciplinary strategy. According to the 2011 Climate Adaptation Plan, it is critical that well-funded projects with integrated technical expertise be developed to endure anticipated floods in water and sewage systems. Among those involved in this process are the government, Copenhagen Energy, CPH city and port development and Copenhagen subway**.** When saltwater rises as a result of storms and floods, communities invest in embankments, increased sewage capacity, disaster preparedness, and the construction of structures above sea level.

   The initial move in 2011 was to disseminate climate evidence to the general public and companies. The goal of this effort was to enlighten the public on current environmental circumstances and to offer individuals with alternatives for how to act in the event of a natural disaster. Another project, expected to cost about 50 million Danish kroner, will see the opening

of a number of pipes. The design makes the most of Copenhagen's current canal system while also ensuring that enough rainfall is released to avert floods. Buildings in high-risk locations should register and track the effects of climate change.

Copenhagen is delighted to present St. Kjeld as the first region to be rebuilt to adapt to climate change this year. The plan is to use current roads to elevate India and then leave the roads in temporary multiples or canal systems in case of a flood. The water from the roadway is drained into the harbour. The asphalt that was formerly used for Rotary, on the other hand, has been turned into conspicuous covering with grass fields on the sides. Changes to this sort of infrastructure are significant, financially onerous, and demonstrate knowledge of climate change.

3. District Heating and Cooling

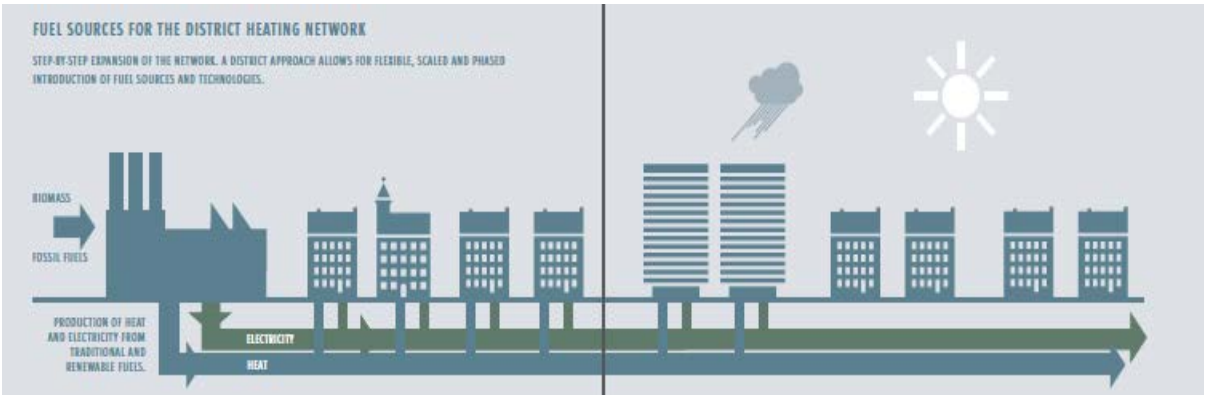


Figure 7: Fuel sources for the district heating network *Source: Sustainability - Copenhagen, Denmark (weebly.com)*

In addition, the city is investing in efficient energy by utilizing district heating and cooling. The technology creates hot and cold water centrally and then distributes it throughout the region. Copenhagen has ushered in a new era of heat-related combined heat and power (CHP). It recovers and re-uses the heat energy lost during electricity generation. Cooling will continue to be used. Copenhagen is converting chilled water that has been partly cooled into cold water. This network allocates resources in such a way that energy is distributed and shared effectively across the city. Carbon dioxide emissions are minimized by combining the plant's fuel source with sustainable biomass fuels. The city of Copenhagen's short-term objective is to convert all

remaining coal-fired CHP units to biomass. The benefits of the CHP system include employment development, reduced CO2 emissions, district heating costs around 45 percent less than oil by individual house boilers, low-cost energy generation that is environmentally friendly, and no influence on air quality.

4. **Eco-friendly buildings**

Copenhagen is looking for methods to improve its present urban structures in order to consume less energy. When historic structures are upgraded with the mind without sacrificing architectural beauty, this is referred to as "additional equipment." Copenhagen employs this approach and intends to save 10% of its power use and 20% of its heat demand by 2025. Renovations involve the replacement of outdated windows as well as the construction of insulated walls, doors, and roofs. The green garden and solar cells have also been added. Advanced technology is also used, and a building with an intuitive flow and entire energy screen may be installed throughout the structure. The sophisticated heat-sensitive technology can determine how much heat is wasted from the structure.

Denmark now boasts the greatest rate of renewable energy generation from wind turbines in the world, accounting for 22 percent of total energy consumption. These wind turbines are located in farms that are owned by both the government and the community. Local talents are utilized to maintain employment creation and aid urban growth in sustainability by making this chance available to the public.

5. **Green Space Preservation**

Copenhagen not only constructs infrastructure but also safeguards green places. This is regarded as an efficient method of lowering city surface temperatures and contributes to minimizing the urban heat island effect, in which solar energy accumulates as heat within city structures during the day and is released late at night. However, because there is insufficient vegetation and water to support this process, heat is trapped within the city. This makes maintaining an optimal body temperature challenging for humans and animals. As a result, the city's structures are interwoven with leisure areas and beautiful parks. Copenhagen received the European Green Capital Award in 2014. This is an amazing achievement in terms of long-term sustainable city Copenhagen's green is a valuable asset to cities worldwide as they

compete to outperform one another, and it serves as a model for managing this business in urban and municipal greenery projects.

6. **The Government behind Ecology**

Copenhagen's objectives include a focus on sustainability. The Green Copenhagen park strategy was introduced in 2004, with the goal of conserving green spaces while new buildings are being built. This strategy is still in effect today, with 25% of Copenhagen covered with green from all new construction. The City of Copenhagen developed an action plan titled "Pocket Parks, Trees, and Other Green Spaces" in 2009, which focused on the integration of public buildings and urban landscape design. As a result, land use patterns have been reshaped.

Copenhagen is not simply erecting buildings; it is also concentrating on rehabilitation and integrating green measures inside and around infrastructure. For all new projects, open spaces and towns can request a Sustainable Urban Drainage System (SUDS). This criterion reflects a better water infrastructure while keeping the neighbourhood's general aesthetics in mind. In order to show moisture resilience papers, additional building permissions are necessary.

Nevertheless, Copenhagen is planning new and significant projects. Planners have been planning the new Masterplan urban neighbourhood of Orestad since the 1990s, understanding that more beautiful locations are needed to preserve the city of Copenhagen. With subway accessibility and water usage technology, this is one of the most advanced locations in the realm of aesthetics and public transportation-oriented development. Orestad pioneered a drainage system that collects and retains rainwater that runs off the road, which residents can then treat and utilize. Many people may find this concept absurd and unclean, but it is their infrastructural work in Copenhagen's Orestad that they are most proud of.

7. **Public Service**

In contrast to systems focused on consumer demand for energy and supply, Copenhagen focuses on supply-side efficiency through energy consultancy services. This institution is a resource that teaches individuals how to utilize natural gas and reduce their energy use. In 1987, he

strongly endorsed the Brundtland Commission report on sustainability. Instead of selling more energy, this service educated Copenhagen residents how to buy as little energy as possible in order to aid in conservation efforts. Young primary school kids are also engaged in such initiatives, and they are exposed to a conscious manner of thinking about energy from a young age. Businesses might seek assistance from energy consultancy services. This will save money as well as energy for later.

Copenhagen is based on a foundation of social services rather than a framework of consumer-driven demand. The majority of these sustainability projects are the result of research presented to the government. According to the poll results, the government combines the private and public sectors.

8. Initiatives across the globe

The United Nations Environmental Program and the Technical University of Denmark established the Copenhagen Energy Efficiency Centre in September 2013, with the efforts of the government, business sector, and public sector at the forefront. This is a governance management strategy made possible by the UN Secretary-Sustainable General's Energy for All (SE4ALL) program. With this worldwide effort, Copenhagen has emerged as a sustainability pioneer.

5.2.5 How environment is at the centre of environmental policy.

Copenhagen became the world's first capital with a carbon-neutral objective in 2009. It wasn't the objective of attempting to solve it in 30 years in 50, 40, but it was accomplished for the first time in 16 years. That 2025 target was one of the most far-reaching on the world at the time. Bringing the city to carbon-neutral levels in Copenhagen was a significant task, but the objective was to drastically minimize Denmark's contribution in the case of a climate emergency. It should also be noted that this objective was established largely independently of many nations and immediately after the 2008 financial crisis, which kicked off a decade of austerity in the United Kingdom. [34]

[34] Copenhagen: A Beacon of Urban Sustainability – Think Sustainability (thinksustainabilityblog.com)

To reach its aim of being carbon-neutral, Copenhagen created a climate program in 2009 that contained many main targets that were to be met within four areas. [34]

1. **Production of Energy**

   After depending largely on oil and natural gas for the most of the twentieth century, Copenhagen began investing in wind energy in the 1990s and progressively transitioned away from fossil fuels. Currently, wind, biomass, or nuclear power generate 76 % of the electricity consumed in Copenhagen.

   Copenhagen is investing in novel energy production methods to get closer to its carbon-neutral objective. The Amager Bakke Waste Energy Facility, which was completed in 2019, is a key contributor to the city's energy generation. The plant will handle 400,000 tonnes of trash from Copenhagen residents and companies, generate enough energy to power 62,500 households at a rate of 99.00 percent, and treat 100 million tonnes of water. Is gathered, and 100,000 tons of flooring are recycled and utilized for the following purposes: Material for roads.

2. **Utilization of Energy**

   It is critical to ensure that the electricity used to power Copenhagen comes from a more environmentally friendly source, but it is also critical to use energy effectively in order to minimize total consumption. In addition to conventional efficiency measures such as triple glazing and LED lighting, Copenhagen has made several noteworthy initiatives to minimize urban emissions.

   Waste heat created by biomass and lung energy facilities in Copenhagen is recycled to heat hundreds of thousands of homes around the city. This is referred to as "district heating." It's not a new idea, but it's a highly successful one that is now used in 99 % of Copenhagen houses. "District heating" has totally reduced emissions caused by house warming via more conventional ways, simply by utilizing wasteful production lines.

   Copenhagen is also investing on infrastructure that will enable "regional cooling" by the use of cold saltwater stimulated between buildings. Using a system akin to "district heating" to heat buildings across Copenhagen can minimize the demand for air conditioning and other energy-intensive technologies while also considerably reducing urban carbon dioxide emissions.

3. Green Mobility

Another issue that Copenhagen must overcome is encouraging people to utilize alternate forms of transportation instead of driving their automobiles. In the year 2000, more than 300,000 vehicles travelled to Copenhagen and served as the primary means of transportation for residents. Major issues were traffic congestion and air pollution caused by the large number of automobiles entering the city. As a result, in order to lower this figure, the city has made significant investments in public transportation in order to increase people's ability to ride bicycles.

Encouragement of bicycles is simply one way they accomplish this. The city's bike lanes and "super cycle roads" have cost more than 1 billion Danish kroner (about. Moving to enhances the safety of bikers and other road users and is a considerably more appealing option than moving to. As a result of this investment, 45 % of city residents are presently riding to work or school.

Copenhagen's utilization of public transportation mirrors that of other European cities. According to a 2014 poll, public transportation was used by 27 % of all commuters working in Copenhagen. However, just 17% of individuals residing in cities fell into this category. This is mostly due to an increase in the number of persons who cycle (the use of cars among city people was lower). Private transportation is encouraged to utilize more ecologically friendly means of transportation. Denmark has suggested a proposal to prohibit the sale of new gasoline and diesel automobiles by 2030 in order to encourage people to utilize other forms of transportation or purchase electric vehicles. This is an initiative to assist improve air quality in Copenhagen.

4. Initiatives of the City-Administration

The city government and its buildings may account for a tiny fraction of overall Copenhagen emissions, but the city government must lead the road to carbon neutrality. Improving the efficiency of government-owned buildings and lighting is a simple solution. The Copenhagen administration intends to cut building consumption by 40% and streetlight usage by 50%.

There are also plans to power all public transportation vehicles with electricity, hydrogen, or

biofuel. This reduces carbon emissions as well as particulate matter emitted in exhaust gases, as well as the quantity of air pollution in the city. Renewable energy is also essential in providing the energy required to power government buildings, with plans to place solar panels on the rooftops of all existing and new government buildings.

5.2.6 Sustainable lifestyle in Copenhagen

Below mentioned are few of the daily lifestyle decisions made by the citizens in Copenhagen.[35]

1. **Dinning out: Where organic is logical & chap, not luxury.**

   The globe map of Copenhagen food now includes New Nordic cuisine. It also changed the emphasis on seasonal, local, organic ingredients. Today, this emphasis is greater than ever in Copenhagen's restaurants, with lots of climate-friendly organic eating options at every price bracket, from the capital's Norma Geranium to the Refen Street Food Market. Purchasing organic vegetables is not regarded a luxury in Copenhagen; it is simply reasonable. Organic food makes for 24 percent of overall food sales in Copenhagen, while organic food accounts for 88 percent of the city's food consumption.

- **Organic Restaurants -** Many Copenhagen eateries choose for organic or almost organic cuisine. You can get organic hot dogs if you prefer Italian, Scandinavian, or Danish hot dogs.

- **Restaurants boosting sustainability -** Organic products alone will not suffice to reduce a restaurant's carbon footprint. Growing your own veggies, reusing resources, and rethinking energy use in every step are just a few of the green measures that set these ultra-sustainable (and delicious) eateries apart.

- **Reffen's street food -** All booths must adhere to the ecological philosophy of "Reduce and Recycle." Use compostable hood services where feasible, limit food waste, and use organic,

[35] *A sustainability guide to Copenhagen | Visit Copenhagen*

free-range, local products. Furthermore, trash must be separated in order to be reused as much as feasible.

Reffen launches approximately 50 projects throughout the world in the form of booths, bars, and creative workshops. Reffen has a total space of 6000 m2, with access to an additional 4000 m2 perfect for enjoying meals and beverages while looking out over Copenhagen Harbor. Don't be concerned if you're visiting during the winter. All year long, you may enjoy beverages, delectable cuisine, and leisure.

The goal is to establish a hotspot for food markets, creative workshops and start-ups, cultural events, and innovative initiatives that will appeal to and inspire both locals and tourists.

2. **Eco-friendly behaviour/ transport/accommodation**

   - **Act sustainable**

     - **Explore via bike -** The world's first cycling city, with over 375 kilometres of bike routes, offers the greatest two-wheeled experience.
     - **Use public transport -** Join the locals in enjoying unlimited travel on buses, trains, and subways with the ease of a shared ticket.
     - **Return and earn -** Get refund of deposit money, which was invested in an empty can or bottle, when returning the element back to the local store.
     - **Refill again and again -** Denmark's tap water is of world-class purity, so get a free refill by swinging it from a faucet or public water fountain.
     - **No plastic -** Bags, straws, and single-use plastics Now is the time to reduce, reuse, and think about alternatives to a plastic-free future.
     - **Bin it -** Let us utilize public garbage cans to maintain our streets clean and, if feasible, separate rubbish to ensure appropriate recycling procedures.

- **Eco-friendly shopping -** Shopping is pleasurable, but purchasing a long-lasting, ecologically responsible, high-quality product that is also wonderfully constructed is pleasurable.
- **Local bites -** Demanding locally grown and produced foods, ironmaking, and environmentally friendly dining. Denmark is delicate and lovely in every way.
- **Always good splash -** When swimming in the harbor, make sure you're a good mermaid to get a splash of clean water all the time.
- **Explore -** Get off the main path and explore Copenhagen's liveability near the city centre for a memorable stay.

➢ **Eco certified stay**

It is really easier to locate a sustainable place to stay in Copenhagen than it is to find an unsustainable place. This is due to the fact that the majority of the city's hotel rooms have received certified Eco Certification.

3. Sustainable Neighbourhood: Nordhavn

Nordhavn is a hub for modern architectural and design studios. Inside the building, open mouthed architectural and design studios may be found in new wonders like The Silo and Portland Towers, as well as a somewhat smaller portion of UN City.[36]

[36] *Why the new Nordhavn area is a hub for design and architecture | Visit Copenhagen*

- **Konditaget Lüders -** It is a recreation area located in a multi-story parking garage in Copenhagen's Nordhaven neighbourhood. This crowded neighbourhood includes 2,400 m2 of rooftop alternative urban space and playgrounds available to everyone. The building was built by JAJA Architects and stands 24 meters above the ground, offering stunning views of the sound and harbor from the rooftop.

  Make use of the roof space for morning instruction on bringing youngsters on active trips. CrossFit, TRX training box jumps, panna football, 60-meter running courses, trampolines, swings, climbing

Figure 8: Konditaget Lüders
Source: Why the new Nordhavn area is a hub for design and architecture | VisitCopenhagen

- **Portland Towers -** Portland Towers was the first structure to be built in Nordhavn's new neighbour, rhusgadekvarteret. With a height of 52 meters, this tower is one of Nordhavn's highest structures, but what makes it unique is its form.

  Portland Towers were old industrial silos used to store cement that were erected in 1979. Today, the ultra-modern design of this structure is unrecognizable. The ancient silo was completely renovated in 2013-14 and now functions as an ecologically certified workplace with spectacular 360-degree views of Copenhagen and the Sound. The new office structure under construction has been attached to the exterior of a typical cement

silo and is currently 24 meters above ground. The original interior contains a reception area, stairs, and an elevator that climbs up, and from the building stand, you can enjoy a panoramic view of the city. Because it is an office building, the Portland Tower is not available to the public, but if you're on an architectural excursion in Copenhagen's new city, you may see it from the outside.

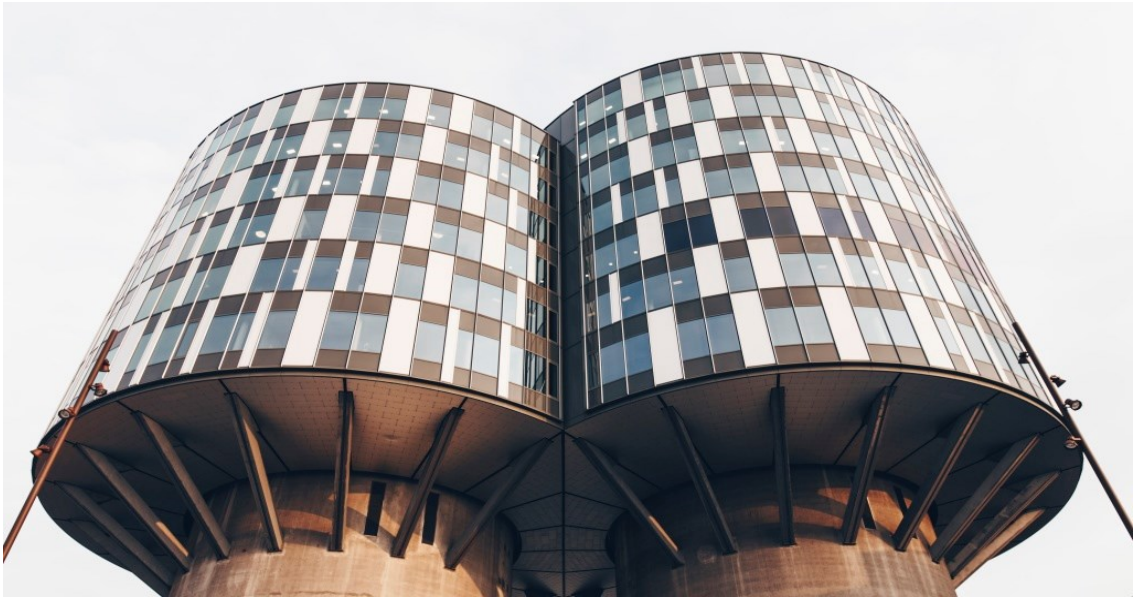


Figure 9: Portland Towers
Source: Why the new Nordhavn area is a hub for design and architecture | VisitCopenhagen

- **The Silo -** The ancient industrial port region of Nordhavn or North Harbor is forming new neighbours. The silo is one of the new places for modern construction on old industrial property. The Silo is located on Nordhavn's shore, directly in front of the grain storage. discarded concrete container Converted into a 17-story luxury condominium built by the Danish COBE architect, as well as a high-end house with public space. Aside from The Silo, COBE is responsible for numerous architectural marvels in Copenhagen, including Nordvest's THE LIBRARY and downtown Israel's Square.

  The silo is an avant-garde look from the outside, and its steel-clad exterior is ideal for Gotham City. Inside, the original concrete structure is kept as alive and undamaged as possible and stored, leaving the room for 38 distinct flats as a result of the original silos'

spatial change. Floor heights of up to 7 meters are common in multi-story residences ranging in size from 106 m2 to 401 m2. On the 17th level, open restaurant silos with floor-to-ceiling windows provide 360-degree views. The first level is also accessible to the general public, and it has exhibitions on current trends in Nordhaven.

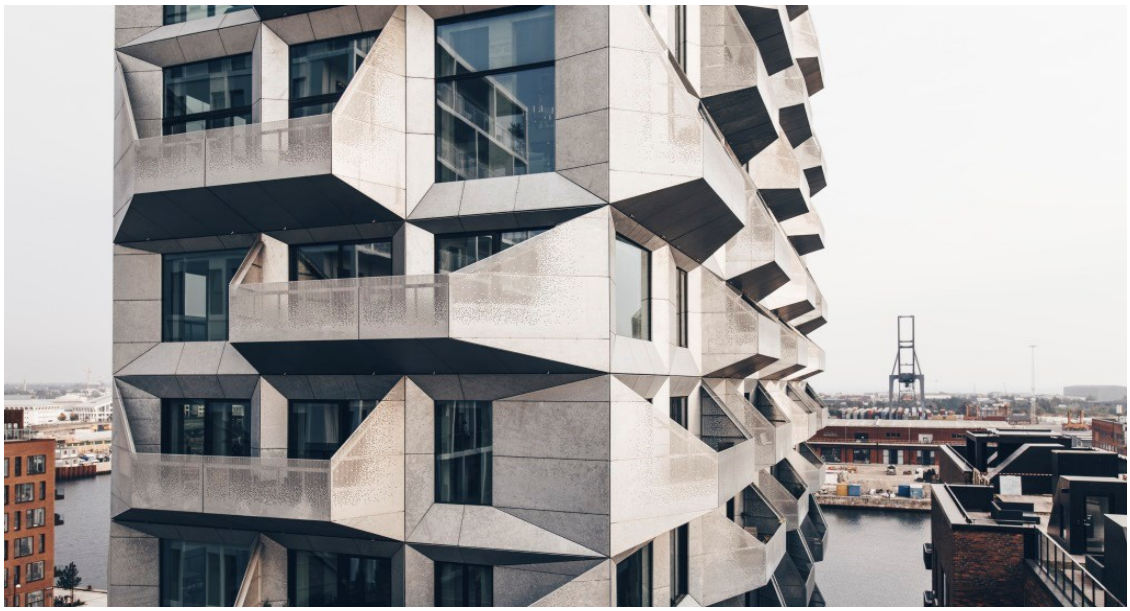


Figure 10 The Silo
Source: Why the new Nordhavn area is a hub for design and architecture | VisitCopenhagen

- **UN City -** The first Marumorumoren UN City Campus opened in July 2013.
  The building now houses 11 UN entities and 1,500 workers from 100 nations. UN City Campus 1 is one of the most environmentally friendly buildings constructed by the Danish firm 3xNielsen. That sort of stuff happens in Scandinavia. The structure is formed like an eight-finger star, with a heart-shaped open area in the centre. This design was selected to represent inter-ministerial dialogue and collaboration. The open area of the structure is adorned with specifically designed steps that represent the interaction of several UN organizations.

Figure 11: UN City
Source: Why the new Nordhavn area is a hub for design and architecture | VisitCopenhagen

- **Paustian Nordhavn -** It appears to be the red thread of Nordhaun's Kalk Brendeli Rob Skadi's Paustian furniture and design company, created by world-renowned Danish architect Jern Utsson. Paustian provides the best in Danish and worldwide design in a wide selection of furniture, carpets, lighting, and accessories. Designs by the Bururekku brothers, Charles and Ray Eames, and Werner Panton may be found here. Paustian also offers a one-of-a-kind collection of furniture made by Danish architects and designers.

Figure 12: Paustian Nordhavn
Source: Why the new Nordhavn area is a hub for design and architecture | VisitCopenhagen

- **Menu Space - Menu** Space was established by Norm Architects as a creative endeavour aimed at bringing creative thinkers closer to the business and encouraging them to contribute their ideas and stories. The hall is lined with Danish Design Brand Menu's elegant classic furnishings. The showroom is in Nordhavn, a new industrial district in Copenhagen, and it has its own café where visitors may take a breather and get some inspiration. One of numerous design attractions in Copenhagen to fit the schedules of design aficionados.
- **GYBI Showroom -** 2,000 square meters of world-class Danish furniture designs may be found at Frihavnen's enormous GUBI showroom. GUBI is one of the biggest Danish design triumphs of our time, and its furniture may be found in museums such as New York's Museum of Modern Art (MoMA). Danhostel Copenhagen, a designer hostel in Copenhagen, also sells GUBI furniture. GUBI is known for its flexible but basic design.

5.2.7 Nordhaven: The key for integrated urban development

The development strategy is based on the area's present structure, which is separated among autonomous islands. The development plan's characteristics contribute to the particular identity of the rhusgade region, while certain old buildings and local surroundings are preserved. Existing structures must also provide a clear connection to the port's historical and cultural history and underline the region's distinctiveness.[37]

1. Variety of urban spaces.
2. Compact development.
3. A vibrant neighbourhood facing the sea.
4. Combination of different sizes and types of buildings.
5. A high-quality public transport route through the western part.
6. Efficient and environmental transport solutions.
7. The planned road network in Nordhavn is located along the existing routes.
8. Connections to mobilize by bicycle.

[37] *Integrated urban development: Copenhagen and its Nordhavn case (iadb.org)*

5.2.8 Learnings from Copenhagen: Nordhaven case

Copenhagen is regarded as one of the world's most liveable cities. It is a city where progress and wealth are inextricably linked, yet there are also difficulties. As the population grows, more individuals will need to make room for greater employment and mobility. By 2025, the population is expected to increase by 18%, resulting in 100,000 new inhabitants. Efficient mobility is one of the most essential criteria for a city's attractiveness, and it is vital in the interests of both inhabitants and companies. However, the region's increased pace of mobility is putting strain on the transportation infrastructure. [37]

Nordhavn's new Earth is supposed to give some solutions to these problems. The building of Nordhavn will assist to counterbalance the region's tendency of rising disaster-affected migration by constructing new residences and employment hubs. This enables individuals to commute to a centrally placed workshop by bicycle or rail. CPH City & Port Development owns the site and has a goal to carry out and expand the project in collaboration with the city of Copenhagen. The city of Copenhagen's duty as a planning authority is to establish the groundwork for the necessary planning to allow the project's development. In this sense, CPH City & Port Development is a state-established urban development corporation that is jointly owned by the City of Copenhagen (95 %) and the State of Denmark (5 %).

Creating a new region is a time-consuming and labour-intensive process of planning and development. The new earth will serve as a basis for many people's lives and future occupations. All of this occurs as the city changes all the time. As a result, the objective of CPH city and port development is to build a long-term sustainable urban region at the cutting edge of social development trends. This entails constructing a contemporary urban area that corresponds to current objectives as well as CPH City & Port Development's commercial strategy.

Nordhavn, when finished, will house as many employees as 40,000 residents. The city's new earth will be developed in Copenhagen's historic district. The former industrial district has been turned into a compact metropolis with densely inhabited residences and offices surrounded by canals, water branches, and the Panorama Sea, which is placed on piers and piers. The first step is close

to Århusgade There are 165,000 m2 of residential space and 140,000 m2 of business space in the region. In 2014, the first residents and staff moved into the neighbourhood.

The sales procedure is quick, but you still have the option to use it. New regional designs in other parts of Nordhavn include residential and commercial construction possibilities. CPH City & Port Growth is extending 100 hectares of Nordhavn over the next 10 to 20 years to make more room for Copenhagen development. Above all, this project is being built to make room for a 1100-meter-long dock.

5.2.9 How sustainability is going beyond the environment in Copenhagen.

Sustainability is also required for society and the economy for all of these key aspects in ecologically sustainable urban development for Copenhagen to call itself a sustainable city. [34]

What about the city's social aspects after this? Denmark has continuously been in the top three of the annual United Nations Happiness Report since 2016, and it was voted the happiest country in the world in 2016 and 2017. Copenhagen itself conducts yearly assessments of more than 200 cities across the world. People in Copenhagen have a lower cost of living than people in other major European cities with greater average earnings. Furthermore, with 300 m2 of green space per capita, Copenhagen delivers numerous health and well-being advantages to a far bigger population than many other European cities.

Copenhagen symbolizes a socially sustainable model, but what about the economy? For several years, environmental preservation and economic growth were considered to be unrelated, and the concept of "green growth" was simply a pipe dream for environmentalists, despite the rising urgency to solve the climate disaster.

In reality, it's the polar opposite. Despite experiencing one of the most severe financial downturns in modern history between 2005 and 2015, Copenhagen's economy grew by 24 percent. Prior to the current shutdown due to the coronavirus, the jobless rate has dropped by only 3.7 percent each year since the 2008 collapse. According to a London School of Economics research, Copenhagen has long been one of Europe's most economically productive towns, helping Denmark rank 10th in the world in terms of GDP per capita.

5.2.10 Motivation from Copenhagen

According to all accounts, Copenhagen is currently prospering and on track to become the world's first carbon-neutral city by 2025. [34]

In Copenhagen, announcing a target of carbon neutrality by 2025 was a pretty big statement. The 2008 financial crisis affected virtually every major economy on the globe, with most just now getting some traction in their recovery from the economic shock and focusing practically everyone's attention on their climate change response. Few have viewed it as a chance to reintroduce sustainability into policy on a national or global basis.

However, Copenhagen did. It viewed the financial crisis as a chance to create an economy that prioritized the environment - and there's no turning back now. It has been proven that 'green growth' is quite real, and that it is very feasible to enhance the environment in which we live while expanding the city's economy and continuing to provide a higher quality of life for all.

We are already at the same place as when Copenhagen was found in 2009. The coronavirus has had a significant influence on the economy and many aspects of our life, and we must restart and rebuild it. When Copenhagen chose to prioritize 'green growth' and sustainability in 2009, science was sufficient to demonstrate the urgency of addressing climate change. For more than a decade, the same evidence has only reinforced the need of reducing emissions and building sustainable cities.

5.2.11 Copenhagen: Solutions for sustainable cities by STATE OF GREEN. [38]

1. **Introduction -** A sustainable city is the starting point for a sustainable planet. Keeping this in mind, Copenhagen seeks to combine sustainable solutions with a focus on growth and quality of life in order to make Copenhagen a more liveable city.

   With more than half of the world's population residing in cities, Copenhagen, like other cities across the world, is developing and encountering issues such as carbon emissions, traffic congestion, and garbage accumulation. With adaptation and mitigation measures,

[38] *CLEAN - Forside (cleancluster.dk)*

Copenhagen has overcome the problem, recognizing additional advantages such as decreased air pollution, enhanced health, and optimized recycling.

Being a sustainable city includes reducing carbon emissions. It may also help our economy flourish and, as a result, enhance the quality of life for our citizens. A habitable city is one in which people can live, breathe, work, and play. Green mobility, enabled by a mix of world-class bicycle infrastructure and efficient and integrated public transportation, lays the path for green growth and quality of life.

Investing in sustainability offers economic rewards as well. Cleaning our ports' waterways has benefited the marine environment while also benefiting business, tourism, and real estate prices. An integrated public transportation system powered by alternative ecologically friendly fuels not only lowers traffic congestion but also saves billions of euros while keeping cities efficient and competitive.

2. **Mobility -** Riding has long been a Danish heritage, but Copenhagen took it a step further by incorporating cycling into urban planning and architecture. The majority of Copenhageners choose the low-cost option, but a quick and simple method to avoid it is to ride a bike. Indeed, we intend to raise the number of commuters with Copenhagen alternating job and school from 35% in 2011 to 50% by 2015.

   Every time more Copenhagen residents work or go to school, an essential part of their bike plan is to ensure that there are no missing links. The objective is to build a network of bike paths across Copenhagen. This saves trip time and increases bike safety. Safety, convenience, comfort, time savings, and habitability are all important considerations. Cycling is the key to building a typical city.

   Wider bike lanes, better design, and action campaigns are all ways to make cities safer for bikers. Copenhagen wants to improve the proportion of its people who feel comfortable riding a bicycle as a result of these measures (from 67 % in 2010 to 80 % in 2015 and even

90 % in 2025).Improved comfort and convenience are accomplished not only via greater safety, but also through bicycle lane maintenance, improved eye control, and, of course, quicker travel times and smoother train and subway journeys.
Shorter trip times can be achieved through a variety of means, including more organised bike networks and green waves for cyclists at traffic signals.

In addition, in the fall of 2013, a new intelligent bike sharing system will be introduced. For example, the system allows train passengers to reserve a bike at the arrival station and use it to get to work or other locations in the city. The bike-sharing system's objective is to expand public transit, and the new bikes will allow customers to go between stations as well as from station to station.

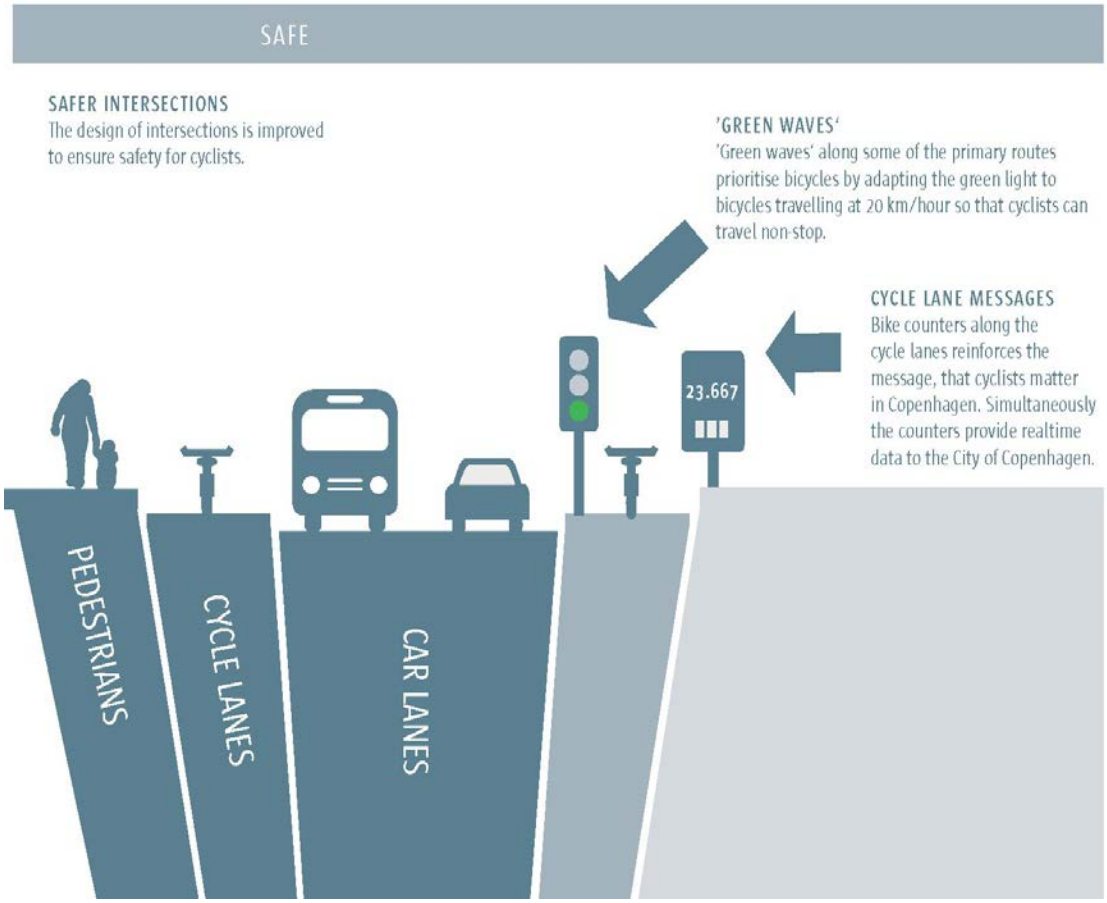
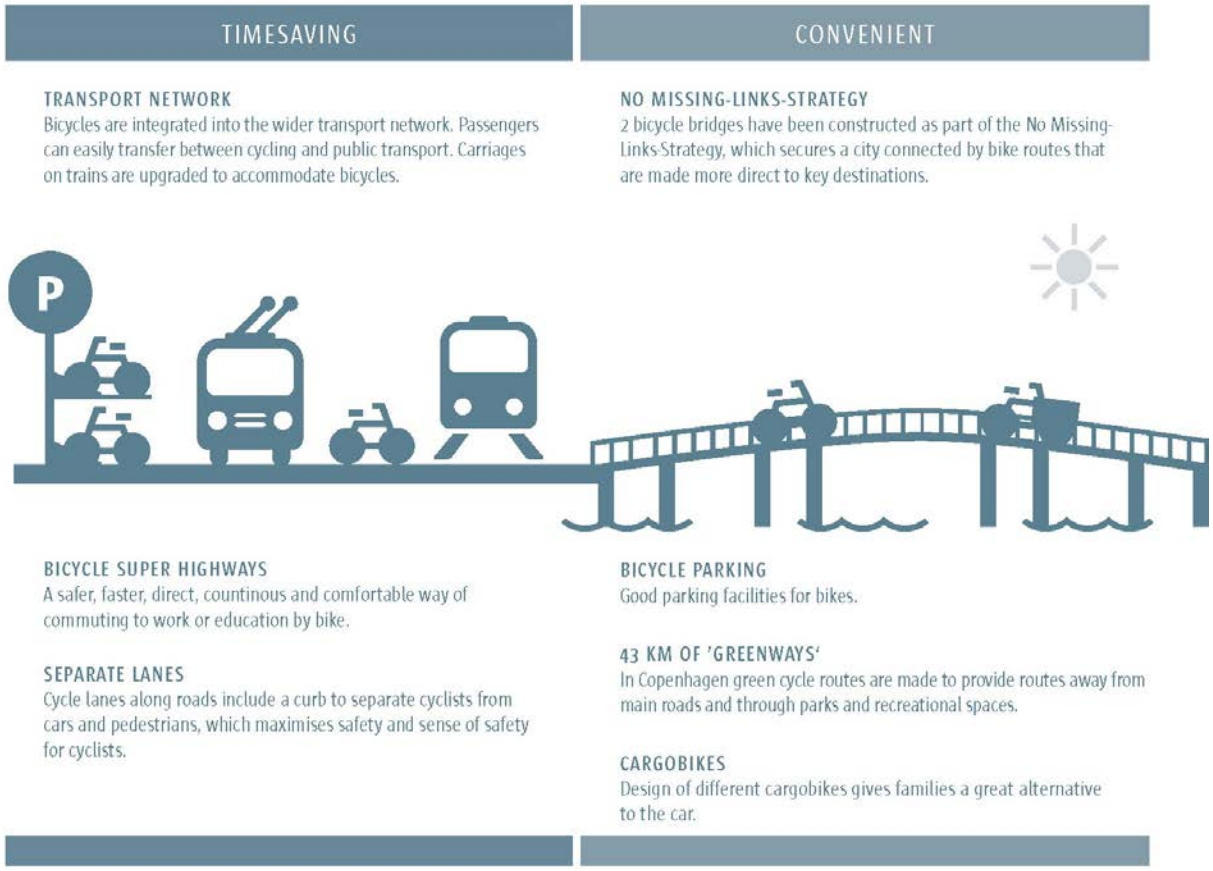


Figure 13: Safety
Source: CLEAN - Forside (cleancluster.dk)

- **DESIGNING A CITY FOR CYCLIST.**



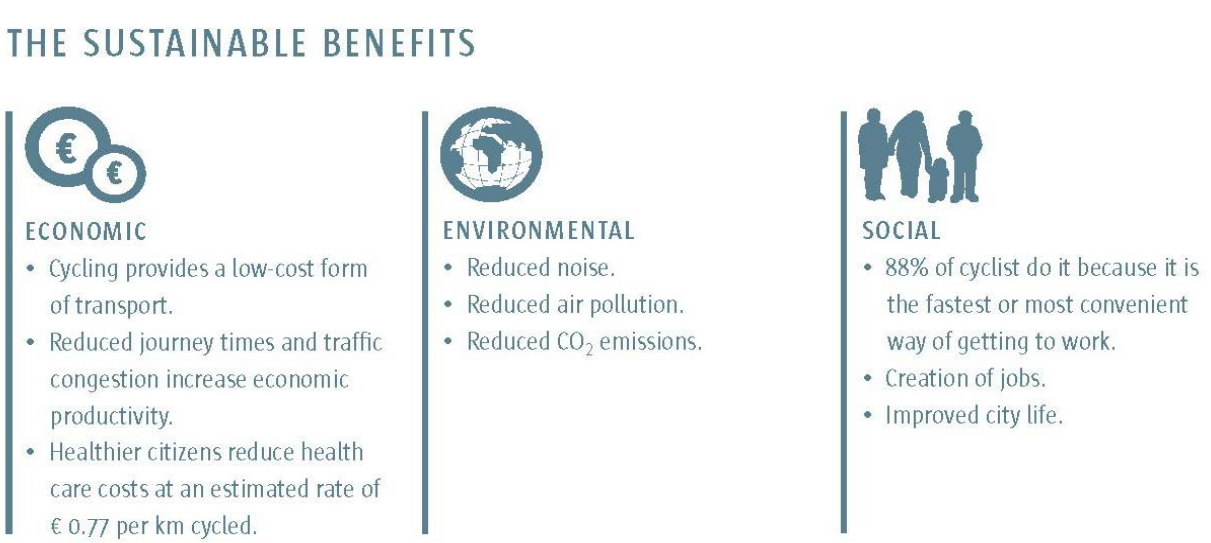


Figure 14: Designing a city for cyclist *Source: CLEAN - Forside (cleancluster.dk)*

- **PUBLIC TRANSPORT USAGE.**

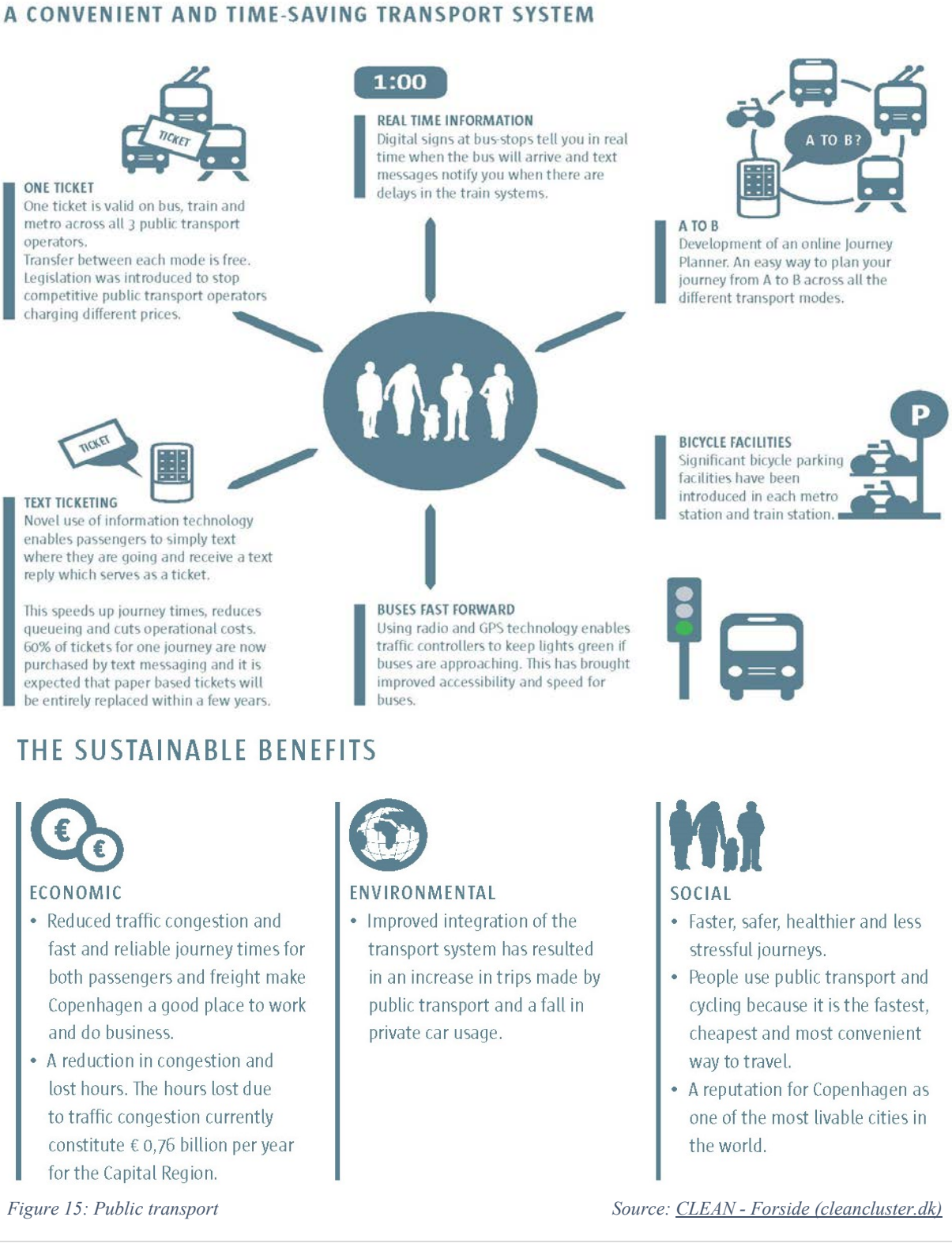


Figure 15: Public transport *Source: CLEAN - Forside (cleancluster.dk)*

3. **Water Management -** Copenhagen is one of the few cities in the world where you can drink high-quality water straight from the tap. As the city of Copenhagen expands, there is a serious threat of water demand exceeding groundwater supplies.

   The major difficulty is to sustain a groundwater-based drinking water supply. Water must be delivered via long-distance pipe due to a lack of water sources in Copenhagen and local pollution of water sources around the city.

   Innovative technology and regulations have enabled the protection of groundwater resources, the reduction of losses in drinking water delivery systems, and the reduction of drinking water use.

   - MAKE YOUR WATER DRINKABLE.

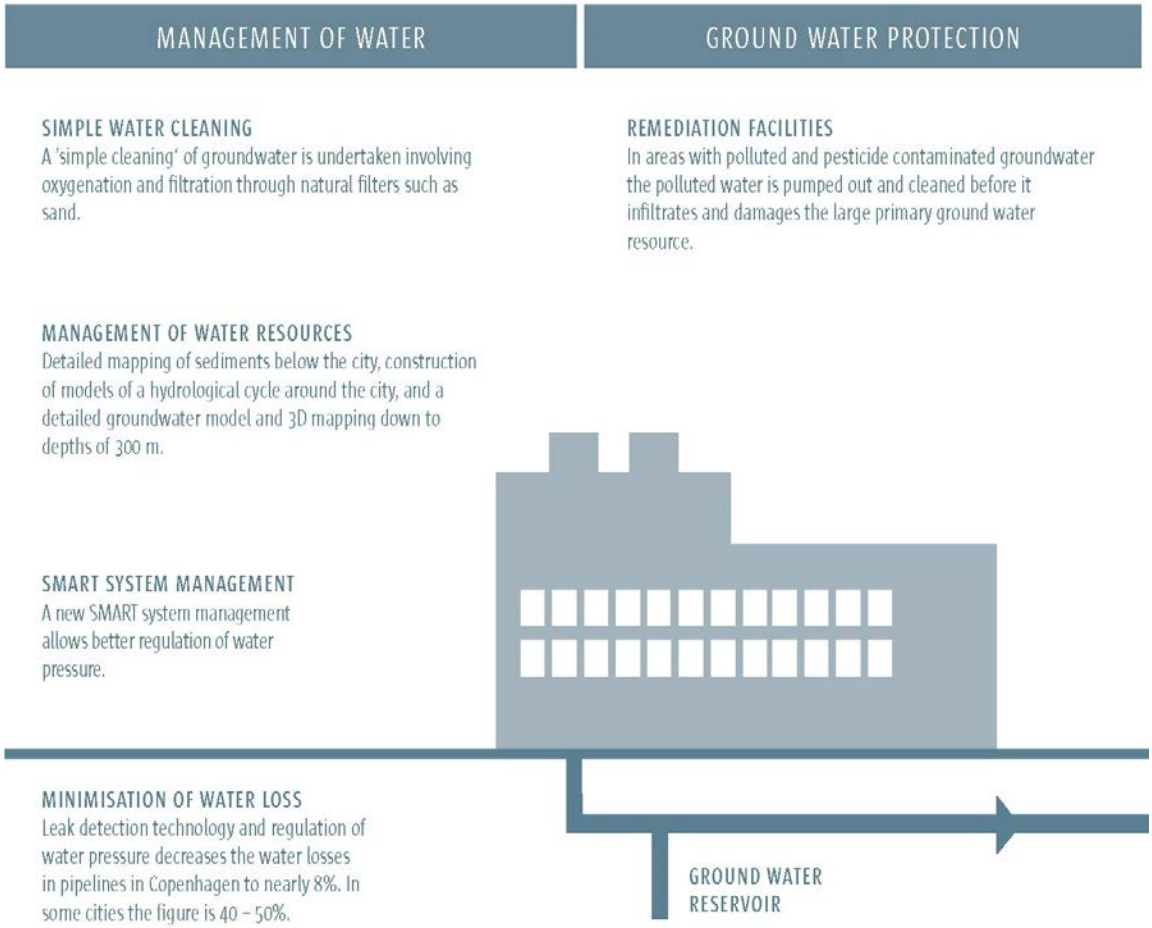
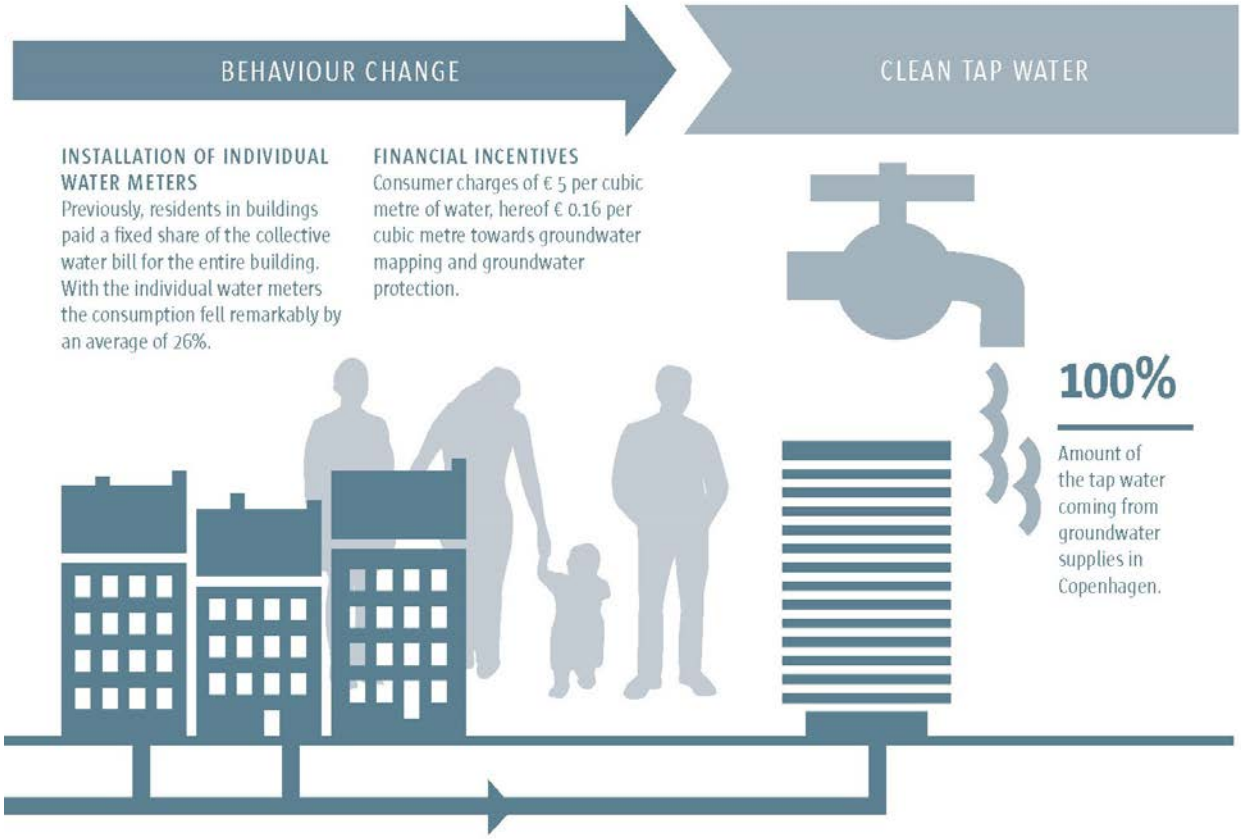


Figure 16: Better management of water resources
Source: CLEAN - Forside (cleancluster.dk)



THE SUSTAINABLE BENEFITS

ECONOMIC

Reduced long term costs through:

- Lower energy use.
- Less frequent need to fully replace existing pipe network.
- Better monitoring and repair.
- Local businesses achieve reduced production costs through greater water efficiency.

ENVIRONMENTAL

- Energy consumption from water services reduced.
- Energy intensive solutions like desalination avoided.
- No chemical treatment of drinking water.
- Low demand for bottled water.

SOCIAL

- The cooperation between municipalities and supply companies encourages mutual interest in groundwater protection.

Figure 17: Behaviour change towards water
Source: CLEAN - Forside (cleancluster.dk)

4. Recycling waste in your city –

SOLUTION IN DETAIL

COPENHAGEN HAS A PLAN

The vision and overall objectives reflected in the Resource and Waste Management Plan are ambitious and call for focused, persistent, and long-term efforts.

The efforts of the city for a more resource efficient waste management system fall under four topics each with a specific target and a number of areas of effort and concrete initiatives. Each topic furthermore contains a flagship project. This is a special focused area of effort that is characterised, among others, by setting the agenda and having a significant environmental effect.

We will utilise waste better so that as many resources as possible are recycled and as little as possible is incinerated.

20%

Reduction of incinerated waste in 2018.

90,000

TONNES FROM ALL INITIATIVES

45,000

TONNES FROM FLAGSHIPS

Amount of waste away from incineration into recycling and reuse.

THE SUSTAINABLE BENEFITS

ECONOMIC

- Increased economic productivity without damaging the environment
- New green treatment solutions provide growth
- Establishment of an economically and environmentally sustainable market
- Due to the future scarcity of resources, raw material prices will increase – both when it comes to virgin and recycled materials
- Improved corporate reporting and green credentials for business.

ENVIRONMENTAL

- Reduced pressures on finite resources, such as virgin aggregates
- Reduced greenhouse gas emissions from incineration
- Reduced energy consumption from the manufacturing process
- Reduced greenhouse gas emissions and pollution from mining of virgin resources
- Establishment of closed loop of resources.

SOCIAL

- Empowering and involving citizens in change
- Prevention of the harmful emission of pollutants to people and water as well
- Community building
- Increased environmental awareness
- Nudging as a means to change behavior
- Waste sorting as a social norm.

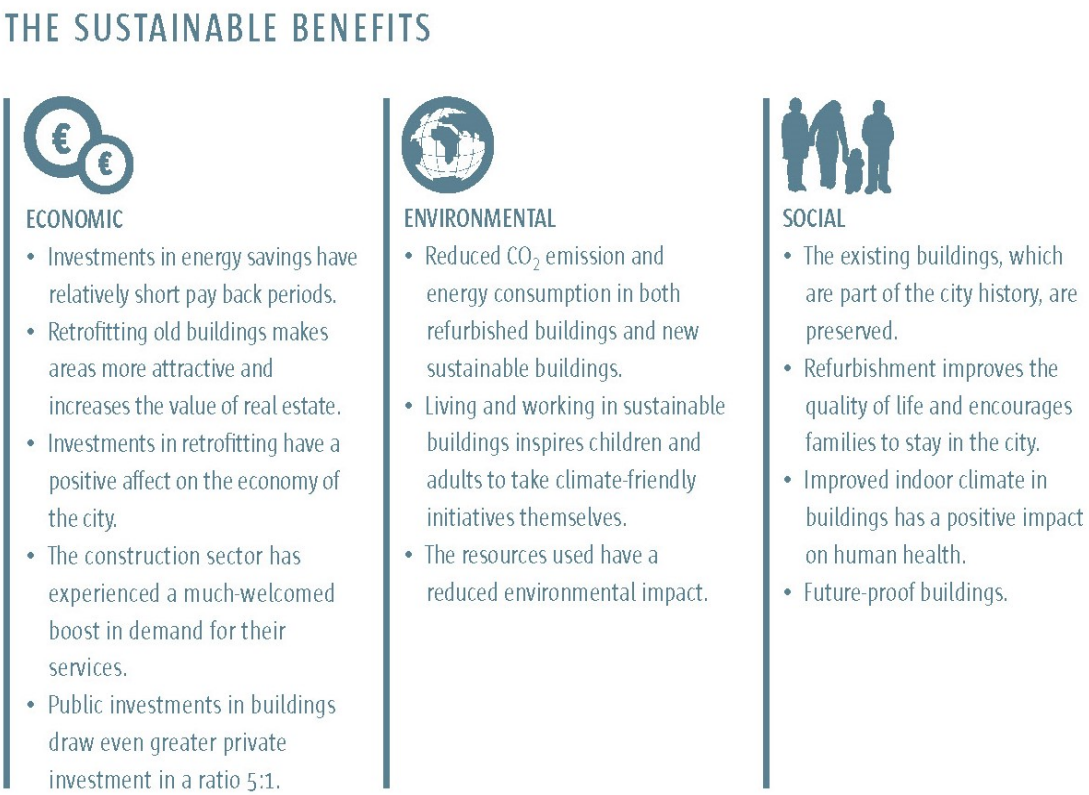
Figure 18: Recycling waste in the city *Source: CLEAN - Forside (cleancluster.dk)*

TOPICS	MEASURES	FLAGSHIPS	TARGETS 2018
LESS WASTE	• More reuse. • Less food waste. • Resource-aware procurement.	• Sydhavn Recycling Centre. • The city will establish a centre for innovation, knowledge, and green growth in the resource and waste field.	• The City of Copenhagen has reduced the waste generation with 6,000 tonnes through more direct reuse, less waste, and by supporting the development of cleaner products through partnerships.
BETTER WASTE SORTING	• Better waste sorting options in blocks of residential flats. • More options for sorting in single-family homes. • Integration of innovative waste solutions in the urban space. • More sorting by the business community. • Cleaner construction and demolition waste.	• Copenhageners for waste sorting. • Waste sorting must be a natural part of everyday life for everybody.	• All citizens in the City of Copenhagen must have access to source sorting of the most typical types of waste near their homes, and all municipal institutions will be sorting their waste.
MORE EFFICIENT AND ENVIRONMENTALLY FRIENDLY WASTE COLLECTION	• Noise-free and zero carbon waste collection. • Waste collection to improve recycling.	• Biowaste and heavy transport fuelled with biogas • The city will utilise resources contained in biowaste better and ensure that nutrients remain in circulation.	• 25,000 tonnes of biowaste is separated for anaerobic digestion. • At least 60% of the collection vehicles of the City of Copenhagen will be fuelled with alternative fuels.
BETTER WASTE TREATMENT AND RECYCLING	• New waste treatment centre in Amager. • More control of WEEE. • More waste outlets and development of new treatment options.	• Recycling and prevention of plastics. • The city wants to divert plastic waste away from incineration to separate collection and reprocessing into a quality allowing for the manufacture of new plastics. This benefits environment and climate alike.	• A high-tech waste treatment centre and a sorting plant that can post-separate recyclable materials to ensure higher quality and recycling has been established.

Figure 19: Waste management *Source: CLEAN - Forside (cleancluster.dk)*

5. **Build and retrofit the sustainable way -** Consideration of energy usage while building and renovating is a beneficial investment for our well-being, the environment, and the economy. The increased quality of life that results from sustainable buildings is just as significant as the energy savings.

   Collaboration among academic institutions, architects, engineers, and business and governmental partners has resulted in innovative solutions. Through creative restoration projects and new world-class architecture, solutions that improve the quality of life of the people who live and work in the building as well as the overall impression of the city are provided. There are numerous and well-proven technological solutions for sustainable building and innovation. Significant savings may be realized by improving the energy use of the building, and the return on investment is quite rapid.



COPENHAGEN BUILDS AND RETROFITS THE SUSTAINABLE WAY

THE TECHNICAL SOLUTIONS ARE USED IN BOTH NEW SUSTAINABLE BUILDINGS AND RETROFITTING.

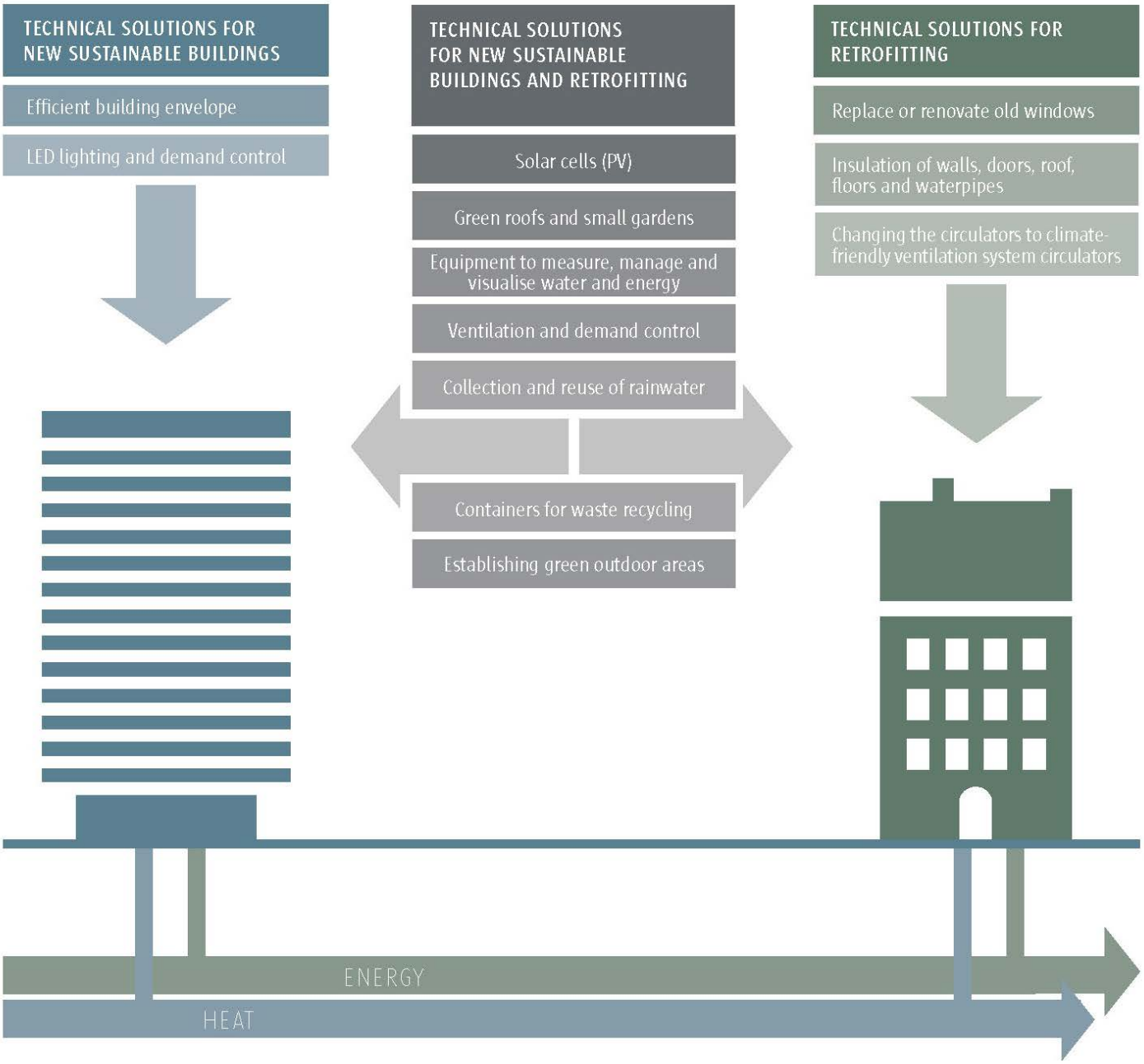


Figure 20: Copenhagen builds and retrofits the sustainable way
Source: CLEAN - Forside (cleancluster.dk)

6. **Urban planning -** Copenhagen is well-known for its eco-friendly desires and bicycles. The social and economic benefits of an urban approach to urban planning are little understood about green cities.

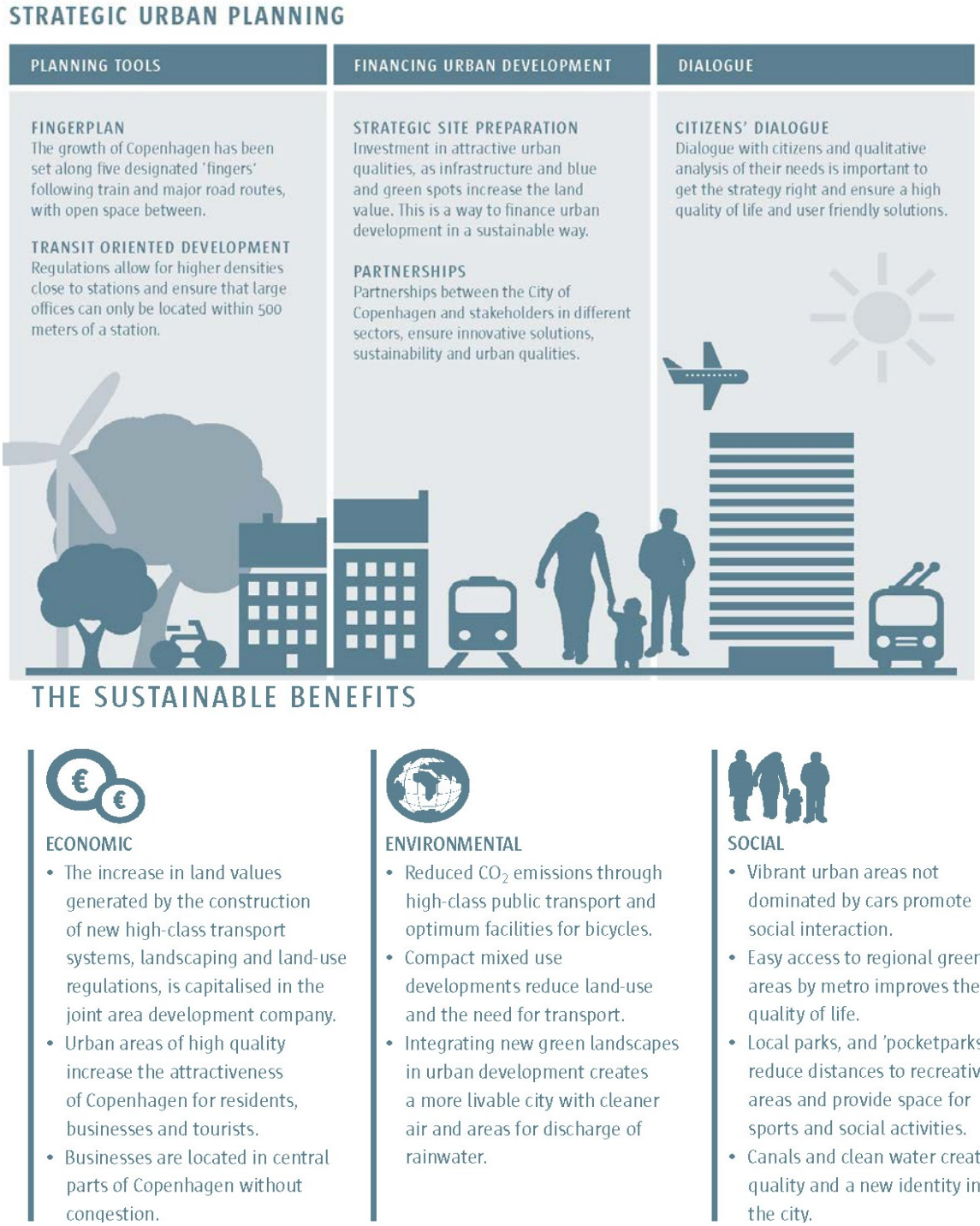


Figure 21: Strategic Urban planning
Source: CLEAN - Forside (cleancluster.dk)

7. **Get your city carbon neutral -** Copenhagen is responsible for CPH 2025 Climate Planning as well as climate change. We aim to demonstrate that growth, progress, and increased quality of life can coexist with lower CO2 emissions. It is critical to discover solutions that are smarter, more ecologically friendly, healthier, and lucrative. And, by 2025, we will be the world's first carbon-neutral nation.

Figure 22: Adapting to the future climate
Source: CLEAN - Forside (cleancluster.dk)

8. **District heating -** District heating is one of the most effective and adaptable methods of producing and supplying energy locally, and it has the potential to dramatically minimize waste associated with intense power generation. Additional emission reductions have been accomplished by adding renewable energy sources such as excess wind energy, geothermal energy, and biomass to replace fossil fuels in the system.

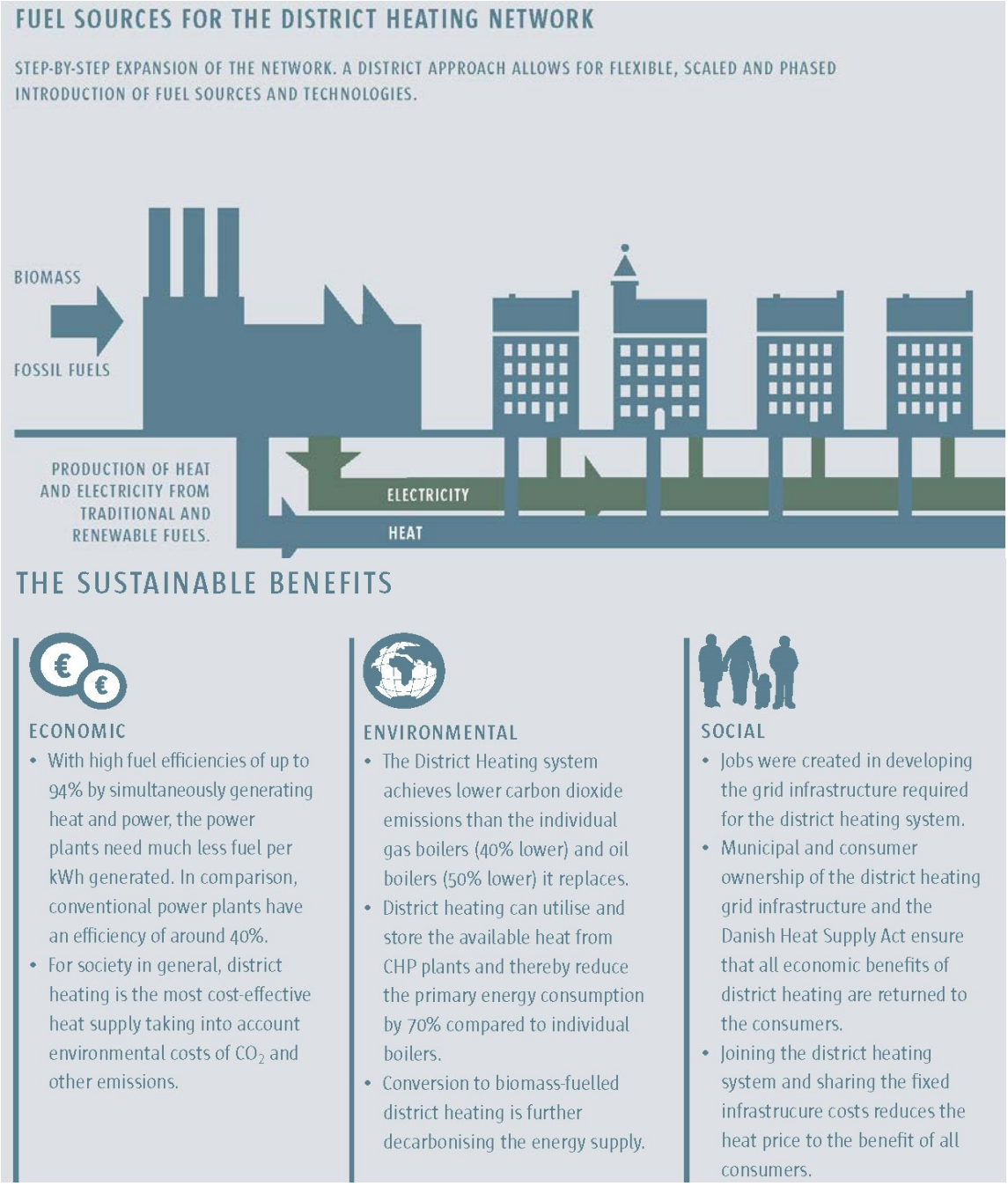


Figure 23: Fuel sources for the district heating network
Source: CLEAN - Forside (cleancluster.dk)

Chapter 06: Conclusion of Case Studies

In conclusion to the case studies of a country China and two European cities Amsterdam and Copenhagen, the numerous approaches implemented by these areas to address urbanization and carbon emission issues are impressive. The ideas to begin living an eco-friendly lifestyle play an important role, where the settled people living in locality have an attachment to their region and so as its new advancement. That's what boosts the ideas to implement locally.

China has achieved remarkable results in its control of urbanization and carbon emissions in recent years, and the country's goals to control urbanization and reduce carbon emissions are expected to be met as a result of its smart strategies, despite the country's large population and production capacity. One of the most essential goals was the approach utilized to analyse large cities and population requirements and strive to meet them. The new laws and regulations for new industries and modern agriculture had a positive influence on the industrial sector in terms of carbon emission management, as well as the urbanization of the surrounding areas. On the other hand, the methods utilized for new urban housing sectors, where the government establishes the new parameters to follow and a new type of housing sectors played an essential part in achieving the aims.

Whereas Amsterdam and Copenhagen have a highly eco-friendly approach to city planning. The objective was to come up with fresh amusing and enjoyable concepts to enhance the lives of residents, which had a positive influence on the long-term goals that were intended to be met shortly. The concept of a green airport in Amsterdam, as well as a carbon-free city, adds to the city's uniqueness. One of Amsterdam's renowned methods is that the city is filled of cycling and walking routes, which encourages both inhabitants and visitors to move more frequently and in a healthy manner. Whereas Copenhagen is not lagging behind in such tactics and sustainable ideas, ideas for sustainable housing, transportation, district heating and cooling, and the preservation of open green spaces in the city help the city to make a special move that catches everyone's attention, as Copenhagen also has the goal of becoming a zero carbon emission city soon.

Chapter 07: India's Overview on Urbanization and Carbon Issues

7.1 India’s Urbanization

7.1.1 History of urbanization

Urbanization in India has expedited the development of the private sector, which has been aided by the country's transition to a mixed economy following independence. India's urbanization is accelerating. According to the 1901 census, 11.4 % of India's population lived in urban areas. According to the 2001 census, this figure climbed to 28.53 %, which was more than 30 % and 31.16 % according to the 2011 census. According to the United Nations World Population Report 2007, 40.76 % of the country's population is expected to reside in cities by 2030. According to the World Bank, India will lead the worldwide urban population rise by 2050, followed by China, Indonesia, Nigeria, and the United States. [39]

7.1.2 Causes of urbanization

The following are the primary causes of urbanization in India: [39]

1. As a result of World War II, the government's services were expanded.
2. People migrated from Pakistan following India's partition.
3. The Industrial Revolution.
4. 11th Five-Year Urbanization Plan for Indian Economic Development.
5. People migrate to cities for a variety of reasons, one of which is to find work.
6. Urban infrastructure amenities.
7. Since 1990, there has been an increase in private sector growth.

7.1.3 The problems and issues of urbanization in India

Due to unrestricted migration, urbanization in our nation was not planned. Unplanned urbanization in India has resulted in a slew of issues, including unemployment, power outages, pollution, social

[39] *August_2015_1439550658__96.pdf (worldwidejournals.com)*

unrest, and poor sanitation. The fast growth of India's urban population has resulted in a slew of issues, including a rise in slums and a drop in living standards. Urban areas also have a negative impact on the environment. Emphasized the following issue: [40]

1. **Urban Lounge** - The underlying causes of urban issues include ill-advised city development, both in terms of population and geographic area, as well as actual city expansion. Most cities' economic bases are incapable of dealing with difficulties generated by over scaling. Big-scale immigration occurred fairly consistently in large cities, rural areas, and villages. As a result, the city's size is increased.
2. **Overcrowding** – It occurs when there are too many people living in too small an area. Overcrowding is a natural by-product of urban overpopulation. It's no surprise that chilly, densely populated cities in restricted quarters face the challenge of overpopulation. This is widespread in nearly every major Indian city.
3. **Housing** - The prior major issue for the government would be to provide homes for the expanding urban population. Because housing costs are growing in relation to urban middle-class income, the great majority of low-income earners live in overcrowded conditions, many of which lack appropriate ventilation, lighting, water supply, and sewage treatment facilities. Current projections in Delhi, for example, predict a shortfall of 500,000 tenements over the next several decades. The term "housing poverty" was coined by the United Nations Centre for Human Settlements (UNCHS). Individuals and households without "safe, secure, and hygienic shelters, basic infrastructure such as tap water, and appropriate facilities for sanitation, drainage, and removal" are included. "Household Waste" is included.
4. **Sanitation** - Another sad characteristic of metropolitan environments is poor cleanliness, particularly in slums and unauthorized colonies. Many disorganized colonial and slum drainage systems do not exist, or if they do exist, they are in poor condition, poorly shaped, and drainage is obstructed. These filthy circumstances are less likely to cause hygiene-

[40] *11 Major Problems of Urbanisation in India (yourarticlelibrary.com)*

related diseases like diarrhea and malaria. Unsafe garbage disposal is a major issue in cities, and waste management has long been a concern.

5. **Squatter Settlement** - The slam is relatively temporary, especially when compared to the large number of squatter colonies scattered throughout the city; however, the slam is relatively stable, and in practice, it clearly distinguishes between the slam and squatter settlements, with the exception of those located in the city's old interiors. The outskirts of the city where it meets the rural hinterland. Squatters' settlements, in general, feature temporary dwellings erected without legal licenses (i.e., on disallowed land).
6. **Environmental concern** - Vulnerability to rising hazards from both man-made and natural calamities. According to the UNDP, 70% of India's population is at danger of floods, while 60% is vulnerable to earthquakes. In metropolitan locations, density and overcrowding enhance the danger. Heat islands form in metropolitan areas, groundwater is not recharged, and the water issue persists. It is desirable to require water harvesting in this situation.
7. **Poverty** - Today, over one-third of the city's population lives in poverty. There is a gap in metropolitan places between those who have and those who have not. The difficulty provided by poverty is arguably the most challenging of the city's difficulties. The issue of decreasing exploitation, alleviating misery, and improving living conditions for the urban poor. According to the 2010 UN Habitat Report, urban inequality has grown. Between 1995 and 2005, urban inequality in India grew from 34 to 38%, depending on consumption.
8. **Transport** - Because the wealthy are purchasing more automobiles and taking less public transportation. This large number of automobiles in the city is increasing traffic congestion and making public transportation less efficient. Furthermore, public transportation is scarce, necessitating the usage of a private vehicle. Public transportation is accessible to those with disabilities. In addition, there is a shortage of infrastructure and inadequate upkeep of existing public transportation systems.
9. **Unemployment -** The unemployment situation is not as bad as the previous one. In India, urban unemployment is estimated to be 15-25 % of the workforce. Among educated persons, this rate is quite high.

10. **Water -** It is one of nature's most vital components for maintaining life, and from the dawn of urban civilization, the site of the settlement has always been determined by the availability of water. However, as cities grew in size and population, water supplies began to fall short of demand.
11. **Trash disposal -** As the number and size of Indian cities increase, so does the problem of trash disposal. Our city's massive volume of waste creates significant health issues. Most cities lack sufficient garbage disposal mechanisms and have an abundance of old landfills. This dump is a breeding ground for disease, with several toxins seeping into the environment.
12. **Urban Crimes -** The contemporary metropolis serves as a gathering place for people from disparate disciplines who have little affection for one another. The problem of crime, as well as other concerns, worsens as cities become more densely populated. Indeed, the growing trend of urban crime disrupts the calm and peace of cities, making them safer, particularly for women.

7.1.4 Governments priority towards new urbanization

Government policy for urban development. The Department of Urban Development (MoUD) and the Department of Residential Urban Poverty Mitigation are two relevant ministries and agencies for national (GoI) level cities (MoHUPA). The most significant urban development aim of the Government of India is to establish an economically productive, efficient, comprehensive, and responsive ULB with an emphasis on strategic targets. [41]

- Universal access to basic services
- Create a time-dimensional planning and governance structure.
- Modern, transparent budgeting, accounting, and facilities management.
- Financial sustainability of ULBs and service suppliers.
- Governance utilization.
- Transparency and accountability in the delivery and administration of urban services.
- The city which is Slum-free.

[41] *Urbanization in India (worldbank.org)*

In December 2005, the Government of India (GoI) announced a representative urban development initiative known as JnNURM (Jawaharlal Nehru National Urban Renewal Mission) to attain these aims. Over a million ULBs and more than 30 ULBs of religious, historical, or tourist value). JnNURM offers changes and incentives in exchange for a pledge to implement a seven-year obligation reform, which will allow ULB to access money for investment and capacity building. A mission's investment component consists of two submissions.

1. The Ministry of Urban Development is in charge of carrying it out (MoUD) Investment in Urban Infrastructure and Governance (UIG)
    - Water, sewage, wastewater, and so on.
    - Solid Waste Management (SWM);
    - Urban traffic.
    - Street lighting.
    - Environmental protection.
2. Basic Services for the Urban Poor (BSUP) delivered by the Ministry of Urban Poverty Alleviation (MoHUPA) with housing investments supporting the Slam's integrated development The Government of India has established the Rajiv Awas Yojana (RAY) Slam Free City Program as a means of accelerating progress toward the objective of Slam Free India.

Furthermore, most province governments have their own urban development plans and programs at the state and local levels, concentrating on the majority of the concerns listed above.

7.1.5 12 Indian cities: Future of sustainable urban development

The Innovation, Integration, and Maintenance (CITIIS) program for urban investment was established in 2018 by the Government of India, AFD, and the European Union. Smart metropolis of the future. The following are 12 award-winning projects.[42]

[42] *These 12 Indian Cities Are the Future of Sustainable Urban Development | AFD - Agence Française de Développement*

1. **Agartala with a new river-front**: Agartala, the capital of the north-eastern Indian state of Tripura, is located on the banks of the Howrah River. Agartala Smart City Limited (ASCL) is an initiative that intends to revitalize the city's riverfront and identity. It intends to fortify the embankment and establish a responsible waste management system, as well as to preserve the biodiversity fostered by the river and to establish an organic garden. These gardens can provide greater job opportunities for local inhabitants, particularly women, while also conserving the surrounding natural environment.
2. **Amritsar towards smarter travel:** The Golden Temple, a prominent Sikh temple in northern Punjab, is located in the holy city of Amritsar. The Amritsar Smart City Limited (ASCL) project is focusing on the renovation of the public transportation infrastructure. Their primary objectives are to increase the number of e-vehicles and "smart cards," build a feeder network for last-mile connection, and digitize public transportation networks. This not only saves money and makes public transportation easy for locals and visitors alike, but it also improves Amritsar's ecology in the long run.
3. **Bhubaneshwar reinvents public places:** Bhubaneshwar is the capital of Eastern Odisha and the region's cultural centre. The B-active project, designed by Bhubaneshwar Smart City Limited (BSCL), intends to restore open areas in cities and provide answers to a variety of other urban issues. The BSCL program is focused on the development of the city's primary assets, which are streets, parks, playgrounds, waterways, and ancient sites. These initiatives focus not only public health, but also active recreation and organized sports, in addition to enabling individuals to govern open areas.
4. **Hubli - Dharwad launch goes green:** Hubli and Dharwad, twin towns in Karnataka, are warning twin cities in southern India. Hubli-Dharwad Smart City Limited (HDSCL) has proposed constructing a green walkway along Unkal Nala, which is 8.5 kilometres long. In addition to improving conditions and managing the flow of rivers, the project will feature the building of cycling and pedestrian paths linking to Hubli Dharwad's main roadways. This is to address the region's drainage issues and encourage ecologically friendly transportation choices.

5. **Ujjain with more breathable rooms:** Ujjain, a historic city in Madhya Pradesh, India's central state, is a famous pilgrimage site. Ujjain Smart City Limited's (USCL) planned project seeks to optimize and develop some of the city's most frequented locations, in order to support and improve the chances of involvement and support from both Ujjain visitors and locals. The project focuses on improving roads and public passageways, as well as redeveloping open areas around Mahakl Temple, the Maharaj Wada Complex, and Chota Rudra Saga Lake.
6. **Dehradun gets more commuter and eco-friendly:** Dehradun, the mountainous capital of Uttarakhand's northernmost state, has evolved into a metropolis with time and a bustling population. Dehradun Smart Cities Limited (DSCL) has created more commuting-centric, sustainable, ICT-enabled mobile services to address crowded roads, cost-effective transportation, and air pollution. Reorganizing public transportation lines, enhancing traffic management, and developing web/mobile apps for commuters are all part of this. More significantly, this plan contains components to protect your child's safety while traveling.
7. **Surat from waste land to bio-diversity land:** Surat, India's ancient port city, is located in West Gujarat. Surat Smart City Development Limited (SSCDL) has suggested a successful proposal to transform urban wastelands into beautiful biodiversity parks in order to improve the availability of green space and open space in Surat. This is done not just to clean up open spaces and turn them into habitats for flora and animals, but also to provide room for public parks. The project will also assist in the creation and connection of ponds, as well as the regulation and maintenance of rainfall.
8. **Amaravati re-establish the basics:** Amaravati is the state's new development capital in southern Andhra Pradesh (after being divided in 2014 to form Telangana). Many individuals in the particular region are impoverished. Amaravati Smart and Sustainable Corporation Limited (ASSCL) serves as a community leader in the process of creating fundamental physical and social infrastructure, electricity supply, safe drinking water, health care and education, waste management, and sewage systems.
9. **Kochi with digital healthcare revolution:** Kochi City (also known as Cochin) is a historic commercial city and renowned tourist destination in Kerala's southwest. Cochin Smart

Mission Limited (CSML) is dedicated to the development of a more focused ICT-assisted medical sector. This eHealth service comprises features such as managing a digital database of medical information as well as the supply chain required by doctors and patients. This technology not only makes medical services more accessible and affordable, but it also leverages the acquired data to give key insights on the metropolitan population.

10. **Chennai's schools equipped with smarter classrooms:** Chennai is the capital of Tamil Nadu, a coastal state in India. Many children from low-income urban households attend subpar public schools. Chennai Smart City Limited (CSCL) proposes installing smart classrooms in these institutions to promote a more inclusive and fulfilling education. The project not only integrates digital learning and building science laboratories, but it also invests in physical infrastructure and promotes extracurricular activities, emphasizes gender equality in classrooms and playgrounds, and encourages teachers and other stakeholders to develop their skills.
11. **Pondicherry empowers the community:** The territorial capital of the Indian Union of Puducherry is the French colony prior to Pondicherry (also known as Pondicherry). PSCCL (Puducherry Smart City Corporation Limited) has created a scheme that encourages the retention of low-income earners, with the tagline "Our neighbours are also your neighbours.". Their vision is to establish a "slum-free" Pondicherry in which the community's opinion can readily reach the government. People's forums, social housing and public infrastructure improvements, and ICT support services are all important components of the PSCCL project.
12. **Vishakhapatnam with modernization drive for schools:** Visakhapatnam is the capital and biggest city of Andhra Pradesh. GVSCCL (Greater Visakhapatnam Smart City Corporation Limited), like CSCL, seeks to enhance municipal schools. They join the present pool of 149 schools in order to convert underused property into usable spaces, develop infrastructure, improve accessibility, invest in IT, establish "smart" campuses, and expand existing schools. Will be improved. The goal is to rename the Greater Visakhapatnam Municipal Corporation (GVMC) school by encouraging pupils to work outside and to improve their digital literacy.

7.2 All about India's Greenhouse gas/Carbon Emission

7.2.1 overview

After China and the United States, India is the world's third greatest emitter of greenhouse gases (GHG). The primary sources are coal power stations, non-cattle, and cattle, and per capita emissions are still considerably below the global average, although they are increasing rapidly. India is also extremely sensitive to climate change, owing to the melting of glaciers in the Himalayas and shifting monsoons. The nation has pledged to reduce the economy's "source unit" by 33-35 percent by 2030, compared to 2005 levels. [43]

Delhi may have the greatest yearly CO2 emissions in the United States. In fact, Delhi's yearly CO2 emissions of 69.4 million tons exceed the CO2 emissions of Bangalore, Hyderabad, and Chennai combined. In terms of CO emissions per capita, Chandigarh and Vadodara are well ahead of the others, with 3.9 tonnes and 3.5 tonnes, respectively. According to a research released in November 2017 titled "CO2 Emissions from Fuel Combustion (Highlights) 2017," the level of CO2 from fuel combustion in India in 1971 was 181 million tons (MT). From 2015 to 2,066 million tons, a 1,041 % rise. There has been an increase.

The relationship between carbon emissions and global warming has been well known for a long time. The higher the concentration of CO2 in the atmosphere in cities that release more CO2, the stronger the absorption of the sun and the faster the temperature increases. The city has no other option than decreasing carbon dioxide emissions. Extreme weather phenomena have begun to strike Indian cities with frightening regularity. If global warming continues, a record 360 million people in 142 Indian cities would be exposed to extreme heat by 2050. Temperatures in three Indian cities (Chennai, Mumbai, and New Delhi) have consistently risen over the previous 50 years. Temperatures in Chennai have risen by 0.9 degrees Celsius between 1960-1970.

Based on this year's strategy of "development in the light of the sun" for the transition to clean energy, the Renewable Energy Department approved 60 cities, including 13 pilot cities and 5 model cities, until the 12th 5-year plan period. It has been approved. These methods will aid in the reduction of emissions at a period of significant rise in urban energy consumption owing to urbanization and economic development.

[43] *The Carbon Brief Profile: India*

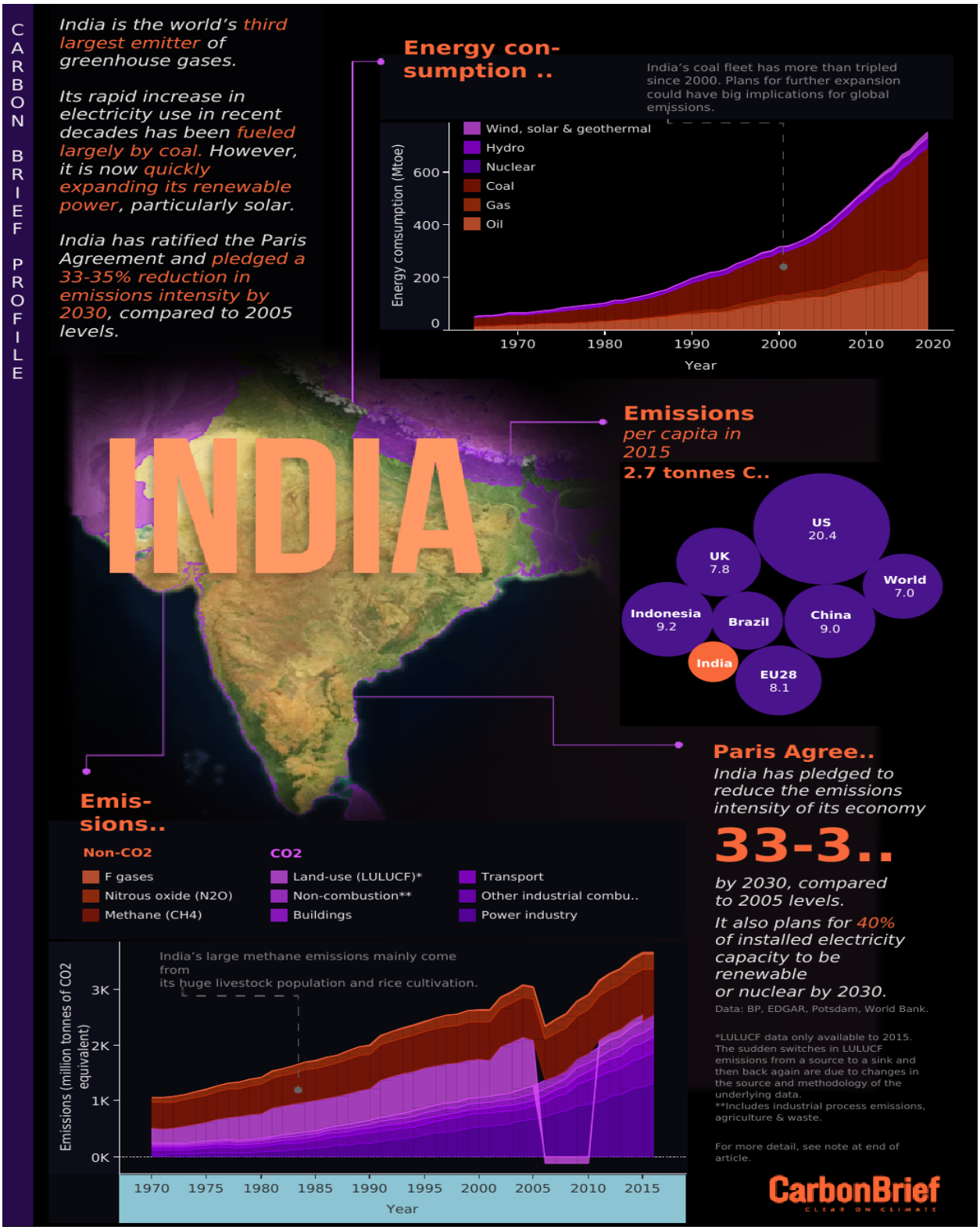


Figure 24: Carbon brief profile *Source: The Carbon Brief Profile: India*

7.2.2 India's emission competing China

Urbanization in India is hastening greenhouse gas emissions in automobiles quicker than in China. According to studies, Indians release an average of 20 kilograms of CO2 per capita when travelling, with the Gurugram region (Haryana) emitting the most (140 kg CO2) and the Shrawasti region emitting the least (1.8 kg CO2) (Uttar Pradesh). We investigated the link between population density and transportation emissions in India.[44]

Most developed nations' experience has proven that urbanization reduces emissions. The distance between work and home got shorter as urbanization advanced, providing importance to public transportation. However, the authors suggest that approach did not work effectively for emerging countries.

A 1% rise in urbanization increases CO2 emissions by 0.12% in China, whereas it increases emissions by 0.24 % in India. In 2017, India's CO2 emissions grew by around 4.6 %, with per capita emissions of approximately 1.8 tonnes. Despite being the world's fourth-largest emitter, India's per capita emissions are significantly lower than the global average of 4.2 tonnes. However, according to Global Carbon Project statistics, these emissions have consistently grown over the previous decade, with an average growth rate of 6%.

Rising gasoline prices are not always a good way to reduce pollution. Commuter emissions decreased 11 percent in certain places due to a pound increase in fuel costs, but only approximately 3 percent in low-income ones. "Given the region's low commuting emissions and low socioeconomic status, our analysis shows that limited support for gasoline price hikes as a method to reduce commuting emissions is favourable," Said by University of Glasgow and Mercator Research.

Delhi has the greatest per capita commuting emissions, which are also a result of high pollution levels, and the region has 2.5 times the commuting emissions of Mumbai, Kolkata, Chennai,

[44] *Emission levels rising faster in Indian cities than in China - The Hindu*

Bangalore, and Hyderabad. "Delhi's high socioeconomic class and reliance on personal mobility resulted in higher commute emissions than other big cities," according to the research.

There were certain locations with comparable population densities but varying per capita emissions, indicating that “simple densification” is a poor policy for reducing commuter GHG emissions, and India advocates concentrating on electric automobiles and effective public transportation networks. However, this should be tailored to the area's geographical condition.

7.2.3 Paris Pledge

India is one of four negotiating blocs at the International Climate Conference. BASIC is a partnership of four rising economies that includes Brazil, South Africa, and China. G77+China; Rainforest Countries Union; Like-Minded Developing Countries (LMDC). GHG emissions in 2015 were 3571 million tonnes of CO2 equivalent, according to statistics gathered by the Potsdam Institute for Climate Impact (PIK). Since 1970, emissions have more than tripled. In 2015, India's per capita emissions were around one-seventh those of the US, at 2.7 tCO2e, less than half the global average of 7.0 tCO2e. [45]

On October 2, 2016, India ratified the Paris Agreement, nearly precisely a year after submitting the climate commitment of the Paris Climate Talks and the "Contributing to National Decisions" document (NDC). The aim is to cut emissions connected with each unit of economic output (“emission agglomeration”) by 33-35 percent by 2030 as compared to 2005 levels. Even if the commitment is reached, emissions in India could grow by 90 times between 2014 and 2030, according to a Carbon Brief estimate at the time. By 2030, India intends to have 40% of its installed power capacity renewable or nuclear.

It also details the strategy to expand tree cover in order to produce an extra cumulative carbon sink of 2,500-3,000 MtCO2e by 2030, which is about comparable to total emissions in one year. According to the commitment, India's aims are "the most ambitious in the context of contemporary development," condemning rich nations' "dark and inadequate" solutions to global warming. "India

[45] *The Carbon Brief Profile: India*

was not a contributor to the problem, but an engaged and productive player in the quest for answers," he added. India has made it clear that the pledge's execution is heavily reliant on climate financing, technology transfer, and assistance for capacity building in wealthy nations. It is projected that at least $2.5 trillion in domestic and foreign finances would be required by 2030.

According to the Climate Action Tracker (CAT), an impartial review of climate commitments made by three research institutes, the Indian NDC is in accordance with the Paris Agreement's 2C targets but lacks the 1.5C limit. However, the CAT claims that the highest limit of policy scope in India is compatible with 1.5C. Following the adoption of the final National Electricity Plan (NEP) in 2018, the CAT stated that India is now well on its path to meeting the Paris objectives. The CAT said that if the government employs hydro and nuclear power, it will be able to meet its 40% non-fossil power capacity objective in less than a decade. India's emission base in 2030 is almost 50% lower than in 2005, and CAT projects are well above the objective of 33-35 %.

Not everything is rosy. The assessment is a collaboration between researchers and non-governmental organizations aimed at encouraging aggressive climate action. Transparency in climate policy stems from here. The NDC of India states that it is in agreement with limiting temperature rise to 2 degrees Celsius or less, however the current (2018) policy falls short of this. The Indian government is revising its long-term economic strategy for 2030-2045.

According to the CAT, this is "separating" carbon emissions from economic development. In 2020, India has the opportunity to increase its commitment to climate change. However, it does not yet incorporate the Paris Agreement's aims into local legislation. In 2008, India issued the National Action Plan on Climate Change (NAPCC), which was divided into eight missions addressing various elements of climate mitigation and adaptation strategy. The eight missions are discussed in detail in the sections that follow. The Indian state is also obligated to develop a national climate action strategy. Some of these include attempts to reduce emissions, portability rules, and the allocation of solar and wind power.

7.2.4 India's per capita amount of CO2 emitted by average person

Annual emission data are frequently used to compare countries' contributions to climate change. This metric, however, frequently reflects variations in world population numbers. This graphic depicts per capita emissions in different nations to help people understand their "footprint." [46]

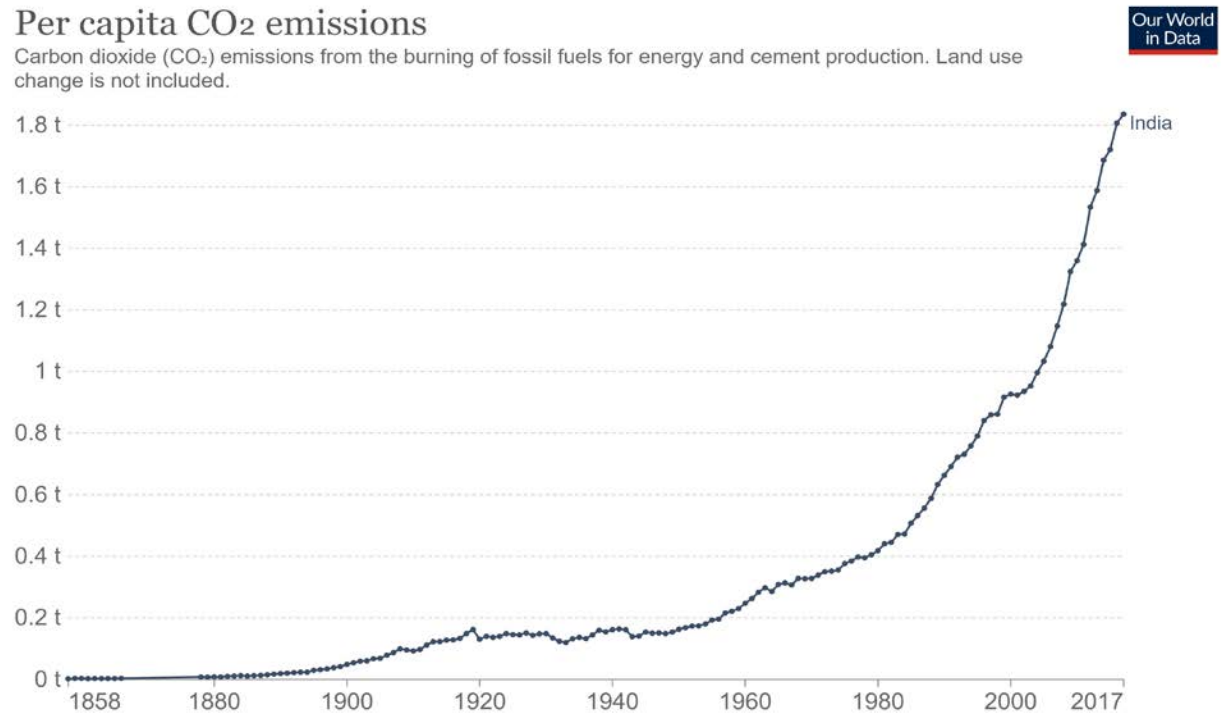


chart 5 : Per-capita CO2 emissions
Source: India: CO2 Country Profile - Our World in Data

7.2.5 Yearly amount of CO2 emission in India

This interactive chart shows the yearly growth in annual CO2 emissions. [46]

- A positive number implies that emissions were greater in a particular year than the previous year.
- Negative value indicates that emissions were lower than the prior year.

Emissions might fluctuate greatly from year to year, resulting in a very 'noisy' time series.

[46] India: CO2 Country Profile - Our World in Data

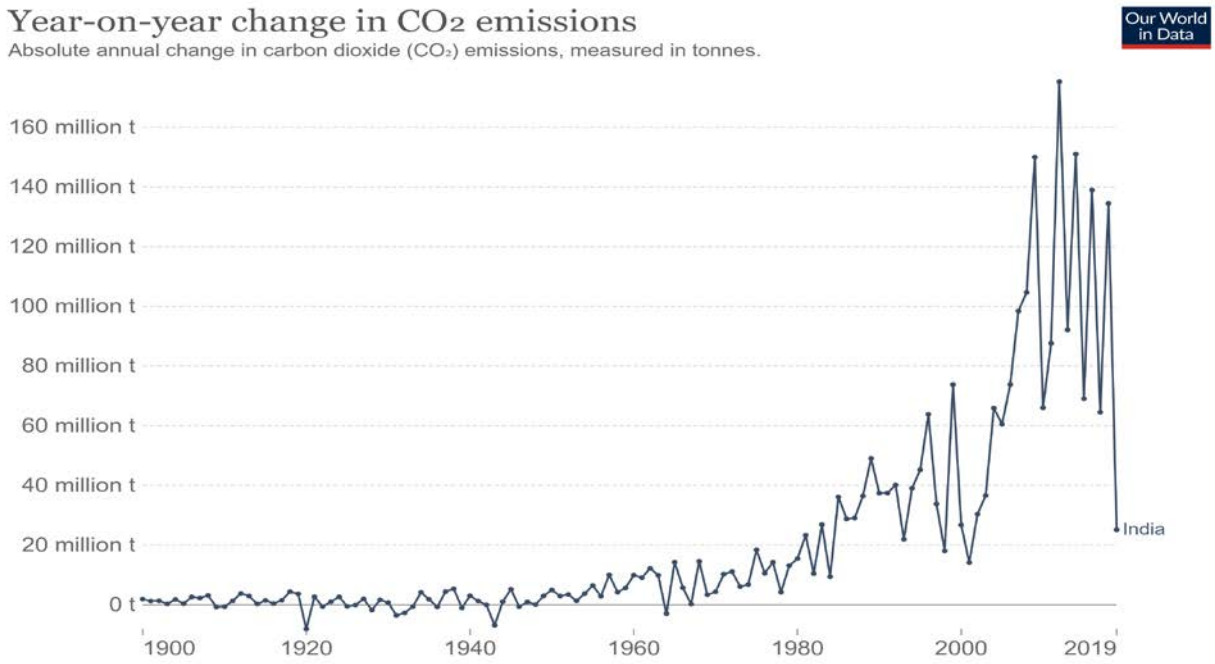
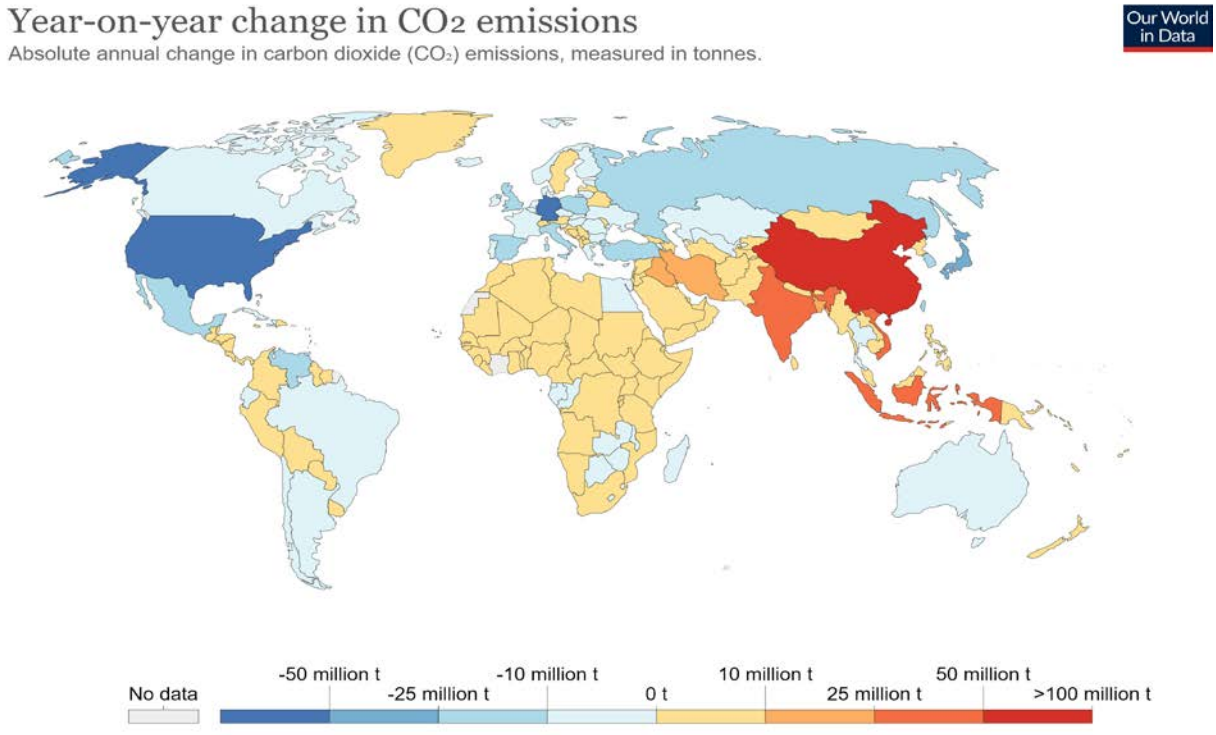


chart 6 : Yearly change in CO2 Emissions in India
Source: India: CO2 Country Profile - Our World in Data



Map 6: Yearly change in CO2 emission
Source: India: CO2 Country Profile - Our World in Data

7.2.6 Major initiatives helping India reduce its CO2 footprints

Yes, we live in a worldwide society that is propelled by the force of industry. Horsepower is no longer only a measure of power; it is also a gauge of other countries' progress. Is the artwork, however, as pink as it appears? The massive destruction of the environment was one of the worst representations in the name of development. In this circumstance, there is no method to see an alteration. We're going to make some adjustments by exercising the controls we have. India, like all other countries, has planned special efforts to preserve its crucial wilderness and reduce carbon emissions. After all, if the responsibility is with us, it will not go. [47]

These are five efforts that have been shown to greatly improve the country's climate and ecology.

1. **NRDC's India Initiative on Climate Change and Clean Energy:**

   The work of the Natural Resources Defence Council to establish a low-carbon, sustainable economy began in 2009. The National Resources Defence Council will collaborate with its Indian partners on four main projects:

   - Increasing building efficiency.
   - Enhancing US-India co-operation on Climate change.
   - Preparing for Public Health impacts on Climate Change.
   - Strengthening environmental governance.

This company is based on some pretty fascinating end goals. One of them is the improvement of environmental governance, which has suffered a significant setback in recent years. Commissions such as the National Green Court and the Ministry of Environment must act impartially and on substantial reasons.

2. **PepsiCo India's Waste to Wealth initiative:**

   PepsiCo India has collaborated with Exnora to assist an environmental NGO in working on this revenue-generating venture, which will benefit over 500,000 people in India. The initiative

[47] *How 5 Initiatives Are Helping India Reduce Its Carbon Footprint | Youth Ki Awaaz*

recycles 80 % of household garbage into organic fertilizer by converting it into recovered biodegradable waste. In addition, we undertake community awareness initiatives.

This initiative is totally dependent on community involvement. The program has recycled approximately 35,000 tonnes of waste that would otherwise have gone to landfills. However, Pepsi and Coca-Cola are subjected to all of the ecologically harmful columns. Plastic bottles and plants, they argue, are not yet green, and this has been widely publicized.

3. **Save Himalaya Campaign:**

It is an effort of the Indian Environmental Association to conserve the Himalayas and to gain community support for this goal. The Himalayas are unquestionably India's guardian mountain. The initiative focuses on studying the Himalayan environment and formulating strategy to protect it. The mission attempts to address several critical challenges connected to:

- Himalayan glaciers and the associated hydrological consequences.
- Biodiversity conservation and protection.
- Wildlife conservation and protection.
- Traditional knowledge societies and their livelihood
- Planning for sustaining of the Himalayan Ecosystem.

4. **National Action Plan on Climate Change:**

The strategy was initially implemented in 2008. This was followed by a discussion of a big environmental concern and how to resolve it. Recognizing the importance of the country's economic growth, the plan commits to regulate India's greenhouse gas emissions while achieving its development objectives. The strategy lists eight key "national missions."

- National Solar Mission.
- National Mission for Enhanced Energy Efficiency.
- National Mission on Sustainable Habitat.
- National Water Mission
- National Mission for sustaining the Himalayan Eco system
- National Mission for a Green India.

- National Mission for Sustainable agriculture.
- National Mission on Strategic Knowledge for Climate Change.

5. National Wetland Conservation Program:

Wetlands are defined as " marshes, marshes, peatlands, or bodies of water natural or artificial permanent or temporary fixed or floating fresh, brackish, or salt water not exceeding 6 meters in depth at low tide."

In 1985, the Government of India launched the National Wetland Conservation Program, selecting 115 wetlands in need of immediate care and establishing a management action plan for the following 4-5 years. The primary / federal territory submits a long-term comprehensive management action plan (MAP) for 3-5 years, ideally 5 years, after certifying the wetlands based on the plan. which coincides with the planning period.

Many environmental firms operate on a national and worldwide scale, but in fact, environmental concerns are the first to cross national boundaries. The “right to development” cannot be used to excuse developing countries when approaching toward environment. And “responsibility rests with developing countries” is not a justification that developed countries frequently employ. We may share portions, but we must remember that we all share the same environment; therefore, the duty falls on all of us.

Chapter 08: National Urban Policy Framework by Ministry of Housing and Urban affairs (Govt. of India)

8.1 Abbreviations

Table 2: Abbreviations of National Urban Policy Framework

BID	Business Improvement Districts
CCU	City Comprehensive Urban Plan
CEC	City Economic Councils
DBT	Direct Benefit Transfer
FAME	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles
FAR	Floor Area Ratio
GIS	Geographic Information System
HPEC	High Powered Empowered Committee
ICCC	Integrated Command and Control Centre
LAP	Local Area Plan
LEDP	Local Economic Development Plan
MAAS	Mobility as a Service
MoHUA	Ministry of Housing and Urban Affairs
NITI	National Institution for Transforming India
NMAM	National Municipal Accounting Manual
NMT	Non-Motorized Transport
NUP	National Urban Plan
NUPF	National Urban Policy Framework
OSR	Own Source Revenue
SDG	Sustainable Development Goals
SIUP	State Integrated Urban Plan

SLB	Service Level Benchmark
SPV	Special Purpose Vehicle
TDR	Transferable Development Rights
TPS	Town Planning Scheme
UMTA	Urban Mass Transport Authority
URDPFI Formulation	Urban and Regional Development Plan and Implementation
VCF	Value Capture Financing

Source: NUPF_Final_Oct 2020.pdf (iica.nic.in)

8.2 General Summary

8.2.1 Challenge and Opportunity

In the 2000s, India had a "population bonus," with a rise in its working-age population share. A large number of young people and working populations in India's cities may be an asset in the nation-building process provided appropriate education, skill training, and employment opportunities are made available to everybody. Furthermore, as life expectancy rises, so does the share of the old population, necessitating a more robust health-care system. The necessity of health infrastructure in particular has been emphasized in order to create better resilience to severe natural catastrophes in the future throughout the pandemic.[48]

Cities in India are plagued by inefficiencies in service delivery and are under significant strain on their infrastructure. According to the 2011 census, tap water is only utilized as the primary source of drinking water by 70% of urban households. Only 33% of individuals surveyed had access to a piped sewer system, while 38% relied on septic tanks. By 2030, India's water demand is expected to more than double the current supply, eliminating the risk of catastrophic water shortages and a 6% loss in GDP (NITI 2018). Informal settlements house 20% of urban households. While 260,000

[48] *NUPF_Final_Oct 2020.pdf (iica.nic.in)*

buses are required for public transportation, barely one-sixth (46,000) are available. According to estimates, $1.2 trillion needs be invested in India's urban infrastructure by 2030.

According to the text of the law, the modification to Article 74 resulted in decentralization, but not spiritual decentralization. As ULB's budgetary and fiscal autonomy dwindles, its reliance on subsidies grows (ULB's revenue share increased from 44% in 2007-08 to 51% in 2017-18). Service delivery is being hampered by deficiencies in the institutional and budgetary capabilities of ULB and other territory governments. Only around 1% of Urban Local Bodies (ULBs) have an A or better investment grade credit rating (MoHUA 2017). This is worsened further by a lack of competence to handle the complicated planning, finance, and execution duties connected with municipal management. Inefficiency and dependence traps feed off each other, creating a vicious loop. The absence of traditional urban planning methods and frameworks for regional economic growth has resulted in ill-advised city growth and disputes between urban and rural populations.

To secure the country's long-term and fair growth, a transition from general business to a long-term, integrated strategy to economic growth and sustainable urbanization is required. Already the world's third-largest economy in terms of purchasing power parity, India was anticipated to develop at a CAGR of more than 7%, with an 8% CAGR objective for the following few years prior to the epidemic. The GoI advocates a cooperative, competitive, and strong federalism marked by a considerable delegation of income and duties to the country, while encouraging friendly rivalry and collaboration among states to drive greater performance and the general development of the country. The Goods and Services Tax (GST) implementation and India's reform initiatives are two instances of how India's federal model works.

8.2.2 Justification

It is required to ensure the country's long-term and fair growth. MoHUA understands that India's growth narrative is happening in that city and should help the city's Prime Minister Hon’ble's quadruple post-COVID-19 vision come true.[48]

- Atmanirbhar Bharat (Self Reliant India)
- Vocal for local
- USD5 trillion economy by 2025

These are two goals that are closely connected and compliment one other. Atmanirbhar Bharat educates citizen-led movements on the benefits of using locally produced goods and demands that these goods be made locally in order to minimize reliance on imports. The $ 5 trillion economic tourism services industry will provide $ 3 trillion, while manufacturing and agriculture will contribute $ 1 trillion each. Atmanirbhar Supporters Bharat and the region will all be a part of the USD5 trillion economy's ambition. These changes will be driven by urban regions that have grown into manufacturing hubs, regional growth centres, transportation hubs or ports, tourist attractions, capitals, special economic zones, financial, education, and information technology hubs, among other things. Improvements in our capacities, creativity, and technology are also part of Atmanirbhar Bharat. As a result, the emphasis must shift from "Make in India" to "Make for the World" in the export of raw materials and value-added goods, which will be the economics of manufacturing. Progress toward Atmanirbhar Bharat may already be observed in the global "Ease of Doing Business" rating of banks. India advanced to 63rd place (2019) from 142nd place (2014). A number of changes, including contract execution, company start-up, property registration, and tax payments, are connected to urban improvements, helping India to enhance its global rankings.

8.2.3 Vision Statement

NUPF upholds the national goals and vital role of cities in India, envisioning “an urban region with a defined identity that gives possibilities for liveability, high responsive governance, a sustainable environment, quick economic progress, and life for its citizens.” [48]

8.2.4 Strategic Intent

Moving to Atmanirbhar Bharat necessitates a paradigm shift in the manner in which the city program is supported. This indicates that public expenditure may be focused on citizens' accomplishments, as a fundamental shift in a results-based system that assesses the outcome of present project-based finance is required. You may enjoy the advantages rather than merely completing the assignment. Results-based funding allows for greater flexibility in implementation and makes attaining people' objectives the sole focus of all efforts. Men living in slums, women in need of secure public transportation, youngsters eager to engage in tomorrow's information economy, and a slew of other benefits are the genuine winners. It is for them that we must abandon

the road we have been on for so long. This will allow for the formation of vocal citizens on a local level. [48]

As municipalities begin to focus on performance accomplishment, a performance-oriented attitude produces a virtuous cycle of continual progress in their capacity to profoundly permeate these organizational cultures. Probably the only method to enhance the municipality's skills in a systematic manner.

8.2.5 Core Principals

States and ULBs can do this by implementing the "basic principles of Outcome-based Funding."[48]

- Integrated: One city – One program – One funding source
- Citizens First-Project Next is a people-centred approach.
- Collaborative: Encourages collaboration among the federal, state, and local governments.
- All states and cities are welcome.
- Demand Driven: States and cities determine the outcomes they wish to accomplish.
- Based on the end result, it favours 'Function' over 'Form.'
- Equitable: Determines funding using objective formulae.
- Encourages Commercial Financing: Raise More, Profit More.
- Promotes Independent Performance Evaluation as a Goal
- Data-driven decision-making is aided by data.
- Transparency: Public Disclosure and Citizen Participation
- Encourages innovation by allowing you to do more with less.
- Increases Capacity: Encourages Learning by Doing
- Reorients the role of the GoI: from driver to facilitator

8.2.6 Implementation of ‘Strategic Intent’ by States and Cities

To promote the GoI's cooperative competitive federalism, strategic intent must be realized through a combination of "top-down" and "bottom-up" techniques. Strategic purpose has resulted in the identification of 10 functional areas. Each city creates a City Comprehensive City Planning

(CCUP), which is stated in the City's ten functional sectors and contains essential tasks. At the basic level, this is aggregated. The state also includes significant regions that are included in the "Main" category. For these two nations, create an integrated city plan (SIUP). These are submitted to MoHUA for funding. [48]

For the first time, urban planning and funding must be integrated such that “results” for people are the primary criterion supporting the Lord and the city. To offer high-quality outcomes and achievements on NUPF grounds, strategic intent must connect capabilities, money, and governance.

Cities: Urban Comprehensive City Planning (CCUP) is based on the overall "economically lively and productive" city-targeted promotion area and strategic treatment of regional goals "results." CCUP proposes a Regional Economic Development (LED) plan with the goal of strengthening the economic basis and enhancing quality of life for the economy's future. The economic focus will directly contribute to NUPF's reasoning for establishing an employment foundation, improved Atmanirbhar Bharat, and a $5 trillion Indian economy.

State: The next stage is to combine CCUP and create a Main Integrated City Planning (SIUP) document that will allow for program and financing integration. The primary objective of the country is to integrate CCUPs and "based on outcomes" by identifying the key interventions required by state governments to review the framework and assist CCUPs. Coordination and development of a national-level “results base” in the form of frameworks (e.g., policies, laws, regulation, finances, institutions, safety devices), SIUPs to boost economic potential to carry out.

GoI: MoHUA assists nations and ULBs with 'performance-based' financing bodies by organizing and integrating resources into SIUP-compliant national urban planning (NUP). The GoI will alter course and limit its function to planners. Countries and cities are the primary drivers. The GoI promotes administrative capacity development, particularly in smaller ULB states and cities, by establishing suitable learning methods.

8.2.7 Functional Area

Because NUPF understands the numerous problems that Indian cities face, the framework employs a "loose and light touch" approach based on about ten (principles) that apply to several functional domains. The framework is organized into ten parts, each of which covers a separate functional area, as shown below:[48]

1. Urban Planning
2. Urban Economy
3. Physical Infrastructure
4. Social Infrastructure
5. Housing and Affordability
6. Transportation and Mobility
7. Urban Finance
8. Urban Governance
9. Urbanization and Information System
10. Environmental Sustainability

Each part begins with an assessment of the region's major issues, followed by a list of policy reasons, policy measures, and outcomes for stakeholders such as Indian cities, states, and governments. In nature, behaviour is exemplary. All states and localities are allowed to prioritize operations and add or remove them as long as they are consistent with the overall strategic objective.

8.3 Urban Planning

8.3.1 Abstract

The first master plan was intended to be overly comprehensive, and the area plan could not be finished after several years of planning and preparation. The resultant development of Indian cities, along with unplanned urbanization, congestion, and deterioration of the environment, has caught the plan off guard. In particular, urban planning executed in this manner has not been adopted owing to the plan's rigidity and maladaptation, as well as the connecting elements between the

spatial and functional features that are unrelated to the investment plan. As it is, the issue is that it is not genuinely inclusive. The failure to integrate spatial and economic planning at the regional and national levels has exacerbated the skewed ranks of former colonial settlements, preventing full realization of the advantages of economic and development planning. [48]

8.3.2 Justification

The framework's major aim for urban planning is to enable Indian cities to fulfil the requirements and desires of a rapidly increasing population. Second, all citizens, particularly those who understand the various needs of the poor, disabled, and vulnerable, must contribute to urban planning. Third, the master plan must be adaptable in order to adjust to the city's and its surrounding environment's quickly changing socioeconomic situations. To establish a more balanced urban network, we must also combine spatial and economic planning at the regional level. This will have the most economic ramifications from urbanization. [48]

8.3.3 Summary of Actions

Table 3: Summary of Action - Urban Planning

LEVEL	KEY ACTION
City Level	• Create Master Plans (integrating spatial and economic focus) • Master Plans should be reviewed every five years (based on consultative review) • Set aside developed land for EWS/LIG. • Prepare the LAP and TPS (using smart IT tools) • Extend the limits of planning zones to encompass peri-urban regions. • Master Plan should have a 2-year strategy, action-oriented plan that is budget-linked • Plan preparation should be collaborative, taking into account the perspectives of many stakeholders. • Variable FAR/TDR may be used as density management and resource mobilization strategies.
	• Prepare a State Urban Policy Framework (SUPF) that is linked with the NUPF.

State Level	• SUPF will guide cities using NCU/NUPF recommendations/frameworks. • New guidelines should be issued based on convergence concepts (remove schemes or departmental silos) includes the preparation of LAPs and TPS • Create a framework for public/stakeholder involvement (also ensuring Plan Execution to flow from ward level consultations) • Cities' Master Plans must be approved on time. • Allow ULBs to plan, own, operate, and provide services.
Central Level	• Provide a rough structure/guideline for the master plan. • Provide a framework for differentiating FAR/TDR zones/density management, as well as resource mobilization mechanisms. • Coordination with GoI authorities (for example, SEBI for TDR) to allow legislative framework • Model Form-Based Code Recommendations • Framework for including peri-urban areas/census towns • Changes to the URDPFI (TCPO) should be made as needed.

Source: NUPF_Final_Oct 2020.pdf (iica.nic.in)

8.3.4 Outcomes

Table 4: Outcomes - Urban Planning

	Short-term	**Mid-term**	**Long-term**
ULB Level	Re-examine the Master Plan (prepare 2-year Strategic Plan with economic focus)	Revision of the Master Plan (GIS based integrating spatial and economic strategy)	ULBs who are self-sufficient and empowered
State Level	Create a SUPF and guidelines for LAPs and TAPs.	Implement the convergence agenda in collaboration with LAPs and TPS.	Plans that are dynamic, iterative, adaptable, gender-responsive, and developing
Central Level	Guidelines for the Master Plan's Economic Focus	Tools for resource mobilization framework	Make the switch to long-term, adaptable Master Plans.

Source: NUPF_Final_Oct 2020.pdf (iica.nic.in)

8.4 Urban Economy

8.4.1 Abstract

The Indian village hierarchy is significantly skewed in a few big towns and numerous villages. This is owing to the persistence of colonial settlement patterns in the five-year plan due to a lack of procedures meant to integrate spatial (regional, urban/rural) and sector-by-sector investment planning. Furthermore, rather than being regarded as the result of numerous economic development initiatives influencing urban growth and settlement patterns, planning has been viewed as a distinct program functioning in silos. This limited perspective cannot optimize the economic advantages of urbanization progress.[48]

Clusters of people and companies result in high levels of production and employment creation, allowing agglomeration economies to benefit. However, it is possible to do so even in densely populated agglomeration economies. This occurs when infrastructure and basic services are insufficient to meet the rising demands of the population and companies, preventing agglomeration economies from being fully used. Congestion is now impeding India's ability to realize the full economic potential of its urbanization.

8.4.2 Justification

In all directions, the city enjoys an advantageous link to the hinterland. First, numerous towns and villages are connected in a mutually advantageous manner to build a network, and a well-balanced network is constructed consisting of a big metropolis and other villages and towns of size. The role of spatial planning in this setting is to coordinate and converge multiple plans that operate at different levels. Region, state, and country are all terms that can be used interchangeably. As a result, the state government must pursue policies primarily aimed at integrating spatial and economic development aspects on these multiple scales, which is ultimately a balance between spatial expansion and investment maximisation. It results in a rigid hierarchy. Second, the government must plan for the supply of essential infrastructure and services that allow people to live normal lives. For street merchants, there is a vending machine area. [48]

8.4.3 Summary of Actions

Table 5: Summary of Action - Urban Economy

Level	Key Action
City Level	• Provide social security to non-unionized workers (policy and programme) • Encourage the use of Business Improvement Districts (BIDs) • Create City Economic Councils/CECs (in larger cities) • City dashboards that capture city-level investments, GDP, and a jobs/growth database • Create a Local Economic Development Strategy (LEDP)
State Level	• Locate cities with high economic growth potential. • Integrating the Informal Sector Strategy • Allocating sufficient resources for skill development and local economic growth • facilitating resource convergence (programme and funding)
Central Level	• Framework for a well-balanced settlement network (rural-urban continuum) • Guidelines for choosing cities with high potential for economic growth (BIDs and CECs)

Source: NUPF_Final_Oct 2020.pdf (iica.nic.in)

8.4.4 Outcomes

Table 6: Outcomes - Urban Economy

	Short-term	Mid-term	Long-term
ULB Level	Evaluate economic worth and create an LEDP	City dashboards based on a growth database and LEDP	BIDs and CECs that are inclusive and functional
State Level	Assist cities in carrying out LEDPs.	Skill-upgrading and resource allocation	Making the most of human capital in cities
Central Level	Frameworks and standards for Atmanirbhar Bharat	Assist states and cities in meeting their LEDP targets.	Contributing to the accomplishment of Atmanirbhar Bharat

Source: NUPF_Final_Oct 2020.pdf (iica.nic.in)

8.5 Physical Infrastructure

8.5.1 Abstract

According to HPEC (2011), water utilities can only recoup around 30-35% of their typical operating and maintenance (O&M) expenditures. For the treatment of water services, there are three management models (including sewage service management). (1) State ministries and territories control the system, (2) urban and municipal entities manage the operations, and (3) a dedicated water and sewage committee established in the city manages the sector. With the revenue from water provision, however, the disparity in costs frequently results in deterioration of quality, preventing local govt from making major investments to improve or maintain standards. [48]

When the share of the urban poor who rely on public toilets is large, India's urban regions are served by inadequate sewage systems. SBM enhanced hygiene, and watering the toilet supplied a sewer pipe. However, the following issues have been resolved:

First, because much of the city is not served by sewage treatment facilities or dispersed faecal sludge management, waste typically travels to stormwater drains, natural waterways, and, eventually, major rivers. This issue is worsened for rivers located near large cities.

Second, the sewage conveyed by the subterranean system must be adequately treated before being discharged into natural wastewater. However, in most places, treatment capacity is considerably less than the volume of sewage flow that must be handled. Another area that requires attention is solid waste management. In most Indian cities, households and ULBs do not separate their garbage. Garbage collection is sporadic and, in most cases, untreated, and the municipal solid waste laws adopted in 2000 do not apply. According to a MoHUA (2010) research, SWMs account for 25-50% of ULB spending, whereas cities recoup less than 50% of O&M costs. The majority of the money is spent on collection and transportation, with little attention paid to trash disposal and scientific disposal.

8.5.2 Justification

A set of outcomes and indicators relevant to public needs will be established collaboratively. As a result, the final results list must be locally relevant, fulfil the expectations of a diverse variety of individuals, and be agreed upon by governments at all levels.[48]

Sanitation, water supply, waste management, public transportation, affordable housing, natural ecosystem regeneration, transparency and improved governance, better air quality, and urban inhabitants, for example, will be interested in the list. Other areas that can be covered are possible. Cities are in charge of physical deliverables since most sectors, both major and urban, must play a part in obtaining these outcomes, whereas the country is in charge of legal and regulatory actions.

Following that, a set of measurements for each outcome should be established to guarantee that improvements are objectively measured. These indicators should be basic and easily measurable in order to be monitored and validated. That is, they must have a transitory quantifiable, attainable significance per SMART.

It is a completely different world than in the past, and these metrics must account for both quantity and quality. For example, in addition to counting the number of new connections made to the water supply, the indicator should track the water supply rules and the quality of the water reaching the end user. Mobility indicators in cities should not just focus on the quantity of buses offered, but also on the quality of bus service and the volume of people that utilize these buses. As a result, these metrics effectively evaluate the end outcome rather than intermediate performance and changes such as improved financial management and planning.

When connecting individual faucets, recent epidemics have highlighted the necessity of having access to drains with covers, sewage systems, and separate toilets. These facilities are scarce in slums and low-income neighbourhoods. The city's comprehensive strategy must take necessary countermeasures.

8.5.3 Summary of Actions

Table 7: Summary of Action - Physical Infrastructure

Level	Key Actions
City Level	• Prepare a City Comprehensive Urban Plan (CCUP) that covers all functional sectors. • Plans for 'outcome-based financing' for CCUP • Use GoI and state financing in accordance with the VCF/other creative frameworks. • SPVs with a stronger institutional framework and performance-based contracts • Natural ecosystems should be used as resilience infrastructure systems. • Utilize integrated digital technology to expand on ICCC resources.
State Level	• Prepare SIUP: Physical Infrastructure Improvement Strategic Plan • Provide viability gap financing for CCUP and SIUP initiatives. • Consultatively adopt SLBs (at least those that fulfil GoI standards).
Central Level	• Provide recommendations for preparing the CCUP, SIUP, and NUP. • A professional institute will advise ULBs on how to manage vital services. • Define SLBs and 'outcome-based financing' assistance. • Provide a financing structure based on the evaluation of SIUP outcomes.

Source: NUPF_Final_Oct 2020.pdf (iica.nic.in)

8.5.4 Outcomes

Table 8: Outcomes - Physical Infrastructure

	Short-term	Mid-term	Long-term
ULB Level	Prepare the CCUP (pipeline of projects)	Projects that are fructifying (development and management)	Universal coverage
State Level	SIUP should be prepared (assess and approved project pipeline)	In favour of outcome-based funding	
Central Level	Prepare a NUP and fund outcome-based CCUP and SIUP.	Project monitoring (independent agency)	

Source: NUPF_Final_Oct 2020.pdf (iica.nic.in)

8.6 Social Infrastructure

8.6.1 Abstract

After COVID-19, solutions to some of the problems and challenges stated above must be incorporated with the WHO's idea of Healthy Cities (HC). “A healthy city is one that continues to build and enhance these physical and social settings, as well as extends its community resources, so that people may assist one another in completing their complete life functions and achieving their maximum potential” (Goldstein and Kick Busch 1996). Realizing a healthy city entails designing it around the particular resources of each city, as well as the talents and management capacities of its people and official and informal organizations.[48]

The slum population was projected to reach 75 million in 2001, according to the Slum Statistics / Census Commission study (Senate in 2008). According to the 2011 census, there was a small reduction of 65.49 million people. One of the most often stated aspects in all definitions of slums is a lack of essential amenities. The most essential element is better sanitation and water sources, which are occasionally supplemented by trash collection systems, energy supply, roads and walkways, street lights, and stormwater drainage components. As a result, the problem of urban poverty is linked to the following two issues. Infrastructure, both physical and social.

Investment in human capital, as discussed in the chapter on economic development, is also an essential module in the economic growth of all countries. Investing in human capital can help to alleviate poverty and enable individuals to live healthy and productive lives. There is a significant discrepancy between various areas of the city, mainly in terms of educational achievement and level in elementary and secondary school. Access to high-quality school education is not equally available to all segments of urban society, particularly the migrant population, distance children, and urban poor. Gender disparity in education is also a big issue in cities and India.

Female students outperform boys in terms of learning outcomes, yet dropout rates are greater among girls. Many educational institutions work hard to give education. However, municipal and public schools have been pushed into private organizations in recent years.

Health has arisen as a major issue, particularly during the epidemic and at all levels of government. The Sustainable Development Goals have unfinished objectives in terms of health and well-being. This also provides for a significant return on investment in the country at the moment of success. Investing in people' health and well-being not only enhances individual potential, but also adds to the country's overall growth. As a result, good coordination with many stakeholders, such as ministries, federal, state, and local governments, and other quasi-governments, as well as convergence of multiple government programs (missions), will solve new health issues. We must increase ULB's capacity to ensure that all people, particularly the urban poor and immigrant workers, have access to social and health services, while also increasing financial allocation.

8.6.2 Justification

First and foremost, we hire everyone who lives nearby. Second, education focuses on learning outcomes and lifelong technological development, third, diverse health programs and the convergence of urban and regional institutions, and fourth, digital techniques aimed at the poor and underserved. As a consequence of their education, settlers, women, children, widows, the elderly, and the crippled have had their municipal and public-school facilities upgraded. Fifth, it preserves monuments, historic structures, and cultural arti-facts, creates public and cultural places, promotes Indian food and soft power (e.g., Lahaina foot), and promotes "Indian." It also encourages citizens to congregate in public spaces rather than retail malls in order to foster social contact. This should be done in conjunction with guaranteeing the availability of other amenities and social services, such as medical care and education, that are not just available to all people, even the poor, but are also conveniently accessible.[48]

8.6.3 Summary of Actions

Table 9: Summary of Actions - Social Infrastructure

Level	Key Actions
City Level	• Direct Benefit Transfer must be fully implemented (DBT) • Investigate collaborations (between civic society and the corporate sector for improved 'outcomes') • Address social infrastructure with a strong emphasis on health (nutrition) and education as part of CCUP's integrated urban development. • Promote 'Indianness,' cultural, and historical legacy. • The outcome of 'moving out of poverty' should be prioritized.
State Level	• DBT should be fully implemented. • Convergence of programs and benefits with an emphasis on 'outcomes' • SIUP's social infrastructure as integrated urban development
Central Level	• Framework for scheme and benefit convergence based on 'outcome emphasis' • State and ULBs should be digitally empowered (facilitate full implementation of DBT) • In NUP, social infrastructure includes health and education as part of integrated urban development.

Source: NUPF_Final_Oct 2020.pdf (iica.nic.in)

8.6.4 Outcomes

Table 10: Outcome -Social Infrastructure

	Short-term	Mid-term	Long-term
ULB Level	Inclusionary city focused on outcomes and citizens	Complete DBT implementation	Getting out of Poverty and Vulnerability
State Level	Scheme convergence should be facilitated.	Every stakeholder's digital empowerment	
Central Level	Provide convergence guidelines (for all social sector services)	All recipients have equal access to social services.	

Source: NUPF_Final_Oct 2020.pdf (iica.nic.in)

8.7 Housing and Affordability

8.7.1 Abstract

In 2015, the Ministry of Homes and Urban Poverty Alleviation introduced Pradhan Mantri Awas Yojana (City) PMAY (U) in accordance with the government's objective of promoting housing for all by 2022. PMAY (U) solves urban housing shortages by securing Pucca. Homes with the appropriate urban furnishings by 2022.[48]

Property rights, or "ownership," are no longer valid, particularly in the case of individual homes. Three factors are used to determine which property rights system is best suited to India's particular setting. (a) Exchange conditions, i.e., the right to purchase and sell; (b) Guarantee term for effective deportation protection; and (c) Effective market protection against disaster-affected migration.

Rental home advertisements were undetected until the pandemic crisis caused millions of migratory workers to return home. Official figures for rental housing vary slightly, however the census showed that about 27.5 % of urban families in 2011 lived in rental property, while the NSS found that 32.9 % of urban households lived in rental housing in 2018. According to the data, a quarter to a third of urban households in India live in rental housing, and the rental housing industry is virtually entirely a private market for small enterprises. Furthermore, research indicates that providing rental housing may be less expensive for the government than establishing ownership. Importantly, renting is more directly connected to employment and educational possibilities than owning a home. Homes can be purchased outside of the city for investment and future usage, but they can only be rented in close proximity to employment and education. However, governmental policy provides little support for private-sector rental housing.

In May 2020, the Affordable Rental Housing Complex (ARHC) for the city's migrants and destitute was launched as a subsystem of the Pradhan Mantri Awas Yojana to fulfil the goal of "AtmaNirbhar Bharat" (Urban). ARHC has the potential to establish a new environment in cities by providing cheap rental housing near workplaces and reducing needless travel, congestion, and pollution.

8.7.2 Justification

Almost 95 % of housing shortages in the EWS and LIG sectors are caused by a lack of furnishings. Given the median family income and the EMI necessary for mortgage services, [48]

1. Foremost, affordable housing, particularly EWS development, necessitates government subsidies and assistance.

2. We require land in order to provide a house for everyone.

3. The location and construction codes must be contextual. The importance of outside space grows with the size of the house. Outdoor space is much more vital in work-based communities since the house is increasingly becoming a workspace.

4. City police must distinguish clearly between private houses and subsequent/speculative housing for specified other purposes (rental, investment, etc.).

5. It is suggested that a rental housing voucher be provided (a kind of cash transfer). The model guidelines for rental homes related to your MoHUA voucher must be completed.

6. Attention should be given to the promotion of do-it-yourself homes. The reason for this is because its architects are already situated on property that has the main variables that influence the economics, livelihood, employment possibilities, and mobility of a residential place. Low-income city people pick their residences largely for their location, rather than for their quality. In general, your own home is built on property where legal title is uncertain. As a result, the existing individual must acquire ownership of the building house.

7. With proper catastrophe mitigation measures, night shelters and lanes in public areas provide accommodation for everybody, including women's hostels, children's shelters, geriatric housing, and temporary housing accelerate in rehabilitation institutions.

8.7.3 Summary of Actions

Table 11: Summary of Actions - Housing and Affordability

Level	Key Actions
City Level	• Specify ‘developed land for EWS' in both the Master Plan and the CCUP. • Implement SIUP-recommended slum-prevention methods. • In-person development in collaboration with partnerships/coalitions for urban transformation • Rental Housing Construction • Implement ‘land title' registration and ‘beneficiary participation.' • Convergence with other missions based on outcomes, such as NULM
State Level	• Create methods to avoid slums under SIUP. • Concentrate on ‘in-situ' and integrated systems. • Provide a suitable framework for ‘land titling' for property rights. • Prepare a State Rental Housing Strategy • Adopt the Government of India's enabling framework for private-sector engagement (VGF, low cost housing technology)
Central Level	• A national housing supply must be built (as PMAY guidelines) • Beneficiaries get universal coverage under the EWS housing program. • Framework for ‘rental housing' (prepared in 2020) • Create an enabling framework for private sector participation.

Source: NUPF_Final_Oct 2020.pdf (iica.nic.in)

8.7.4 Outcomes

Table 12: Outcomes - Housing and Affordability

	Short-term	Mid-term	Long-term
ULB Level	Set aside ‘developed land' for EWS.	Rental Housing Development and HFA	Increasing access to affordable housing for all
State Level	Legislative and regulatory frameworks serve as enablers.	Preparing a State Rental Housing Strategy	
Central Level	Policy framework and housing financing promotion	National Housing Stock Development	

Source: NUPF_Final_Oct 2020.pdf (iica.nic.in)

8.8 Transport and Mobility

8.8.1 Abstract

Congestion, as well as a lack of policy-based changes that benefit private automobiles, such as increasing road capacity at the expense of public cars, were key factors in growing traffic congestion in Indian cities. As a result, by encouraging people to walk, bike, and take public transportation, the emphasis should be on the mobility of people rather than automobiles. In the 2017 National Urban Transport Policy, the Government of India recognized the significance of this idea (NUTP). NUTP and AMRUT, as well as the Smart Municipal goal, all have important consequences for funding city infrastructure (including transportation) and vital services. Fair City Mobility Policy promotes smart mobility in order to decrease congestion.[48]

There are numerous issues that are now exacerbating the problem of over-motorization. These problems provide an opportunity to enhance fair urban transportation in India by providing dependable, inexpensive, and widely accessible integrated public transportation, as well as safe, non-motorized transportation infrastructure that assure last-mile connection.

There are problems, such as different types of public transportation functioning in silos and short circuits rather than as part of a unified network. Inadequate investment in road-based (bus, etc.) public transportation, inadequately low-quality bus fleets, and a reduction in the number of people linked to services. Commuting in the same place as a private automobile slows down and becomes less appealing for commuters who can use alternative modes of transportation because there is no defined public space utilizing the road. Lack of facilities and road infrastructure for non-electric transportation (e.g., walking, bicycling) and brisk excursions that are unpleasant or dangerous for walkers and bikers; Because there is no comprehensive parking ordinance, automobiles parked on the street take up a significant amount of road space. Furthermore, different individuals confront several obstacles when it comes to using public transportation. Furthermore, women confront severe safety risks while using public transportation. It restricts access to jobs, education, and services.

8.8.2 Justification

There are certain factors that are now exacerbating the problem of over-motorization.[48]

1. A continuous link (such as a feeder service) to the last mile of public transportation is required.
2. MoHUA must create rules for pedestrians to encourage distance as a means of movement and access, particularly for street markets to operate in shared public areas.
3. Public transportation must be increased and made more accessible. All aspects of society must be accessible, particularly to the weak, in order to achieve equality among people. Cities in India must consider increasing "accessible and affordable transportation availability for the elderly/women/disabled persons." People in this sector are having a tough time travelling from one site to another inside the city limits owing to traffic and security concerns.
4. The master plan is a more dispersed but functional, tightly linked pattern of regional urban settlement, promoting and changing the old concept of telecommuting relationships into a development-oriented development. Replace and necessitate a single and multi-fixed cluster pattern in the middle of the centre. It is linked to fast-moving corridors, allowing for population distribution and dispersal, and it employs cutting-edge transportation technology for intercity and intercity public transit networks. MoHUA must establish national standards for integrating transportation and mobility plans, as well as master plans based on best practices from industrialized countries.
5. The parking regulation allows for the installation of charging infrastructure for electric cars (EVs). To manage private automobiles, especially in congested locations, it is feasible to implement a differential parking policy that charges higher costs for private cars and lower rates for public services / shared vehicles. I'm sure I can accomplish it.
6. Platform services with many electric cars and autonomous vehicles can have far-reaching effects on transportation and mobility that were previously unimaginable. This is based on a conceptual guideline developed by MoHUA that outlines the direction of growth of the state government and city.
7. App-based public transportation systems must be controlled and streamlined.

8.8.3 Summary of Actions

Table 13: Summary of Actions - Transportation and Mobility

Level	Key Actions
City Level	• Facilitate the ‘mobility as shared services' (MAAS) paradigm. • CCUP will develop a comprehensive mobility strategy and address street furniture. • Implement design guidelines. • Adopt 'outcome-based' principles with 'user convenience' at the forefront. • Establish UMTA • Implement real-time technology that is integrated with ICCC. • Implement a green transportation strategy with the goal of being carbon neutral. • Ensure public transportation's last-mile connection
State Level	• Enable the mobility-as-a-service paradigm. • Integrate ‘mobility as a service' with SIUP and make UMTA easier. • Ensure smooth convergence with other state programs • Incentives for adopting greener technologies in the form of funding
Central Level	• Model of mobility as ‘shared services' framework • Design guidelines for ‘streets' are provided (updated UDRPFI) • UMTA will incorporate a multi-modal strategy and simplify institutions' ‘SPVs.' • Provide recommendations for various stakeholders based on 'outcomes.'

Source: NUPF_Final_Oct 2020.pdf (iica.nic.in)

8.8.4 Outcomes

Table 14: Outcomes - Transportation and Mobility

	Short-term	Mid-term	Long-term
ULB Level	Focus on user convenience/ NMT in CCUP from UMTA	Adopt ‘MAAS,' which provides public access to real-time data.	Transition to green mobility that is both cheap and accessible
State Level	UMTA should be made more accessible, and MAAS standards should be developed.	Facilitate the transition to green transportation by integrating LU and TP.	
Central Level	MAAS guidelines and URDPFI modifications	Institutional setup has been strengthened.	

Source: NUPF_Final_Oct 2020.pdf (iica.nic.in)

8.9 Environmental Sustainability

8.9.1 Abstract

The complete picture of life is a basic idea of sustainable development, in which all things and activities link to each other, affect each other, and then influence each other. The Indian government recognizes environmental sustainability as an important factor in sustainable urbanization and has signed several international agreements, including the Paris Agreement Sendai Framework for Disaster Prevention and the Quito Declaration on Sustainable Cities and Human Habitat for All. The Solar Alliance, in particular, guides India toward a low-carbon, resource-efficient, and sustainable future.[48]

Cities in India are the most afflicted by air pollution, with six of the top ten most polluted cities in the world, including Delhi, which is the most polluted city in the world (World Air Quality Report, 2019). Several causes contribute to urban air pollution, including car exhaust, emissions from industry and power plants, the burning of dust crops on construction sites or roadways, inefficient energy usage in buildings, and the excessive use of biomass for cooking and heating. It is a complicated issue with several causes. Particularly dangerous industrial waste. The situation is most serious in many northern Indian towns, such as the NCR, during the winter, when pollution accumulates close to the ground, necessitating urgent health warnings.

Cities are the most resource-intensive and waste-producing areas. With growing urbanization, urban solid waste profiles, including household trash, building and demolition waste, waste, and so on, are anticipated to increase and deteriorate over the next several decades. There will be more open garbage dumps in cities with insufficient capability to collect solid waste. Flooding in urban areas is a common occurrence in major economic cities like as Mumbai, Chennai, Bangalore and Gurugram. In addition, urbanization exposes a very significant number of people to the risks and vulnerabilities associated with climate change-related events such as natural disasters, global warming, unexpected floods, droughts, and heat waves, which are a poor service area. It is deteriorating as a result of the resultant scarcity of low-cost housing. Increase of informal settlements, particularly in low-lying and hazardous regions.

Building and vehicle energy usage is also a key contributor to urban heat island (UHI) and indoor and outdoor air quality. Cities across the world are voluntarily committing to clean energy (including 100 % renewable electricity) by strengthening resilience, lowering reliance on fossil fuels, and fulfilling carbon emission reduction objectives. To speed the transition to a zero-energy and zero-carbon city, the city is investing in increasing energy efficiency (EE) with a drive for renewable energy (RE) generation.

8.9.2 Justification

1. Long-term and integrated policy frameworks are required for ecological sustainability. Water in India, for example, is heavily polluted by both solid and liquid trash. To discover a direct route to the river and the sea, industrial and household industries must first find a way to the river and the sea. This water pollution not only has an immediate impact on ecological cities, but also on all downstream behaviours, and rivers health must be incorporated into the city as a whole. The expected techniques are on-site drainage systems, including FCAL sludge control. [48]

   Based on existing and ongoing assessments, there is an urgent need to address the hazards of air quality deterioration, water resource and waterway degradation, solid waste-free treatment and disposal, and repeating natural catastrophe threats. By incorporating both short-term and long-term climate hazards into long-term planning processes, the practice of urban resilience and mitigation must be mainstreamed in urban environmental planning.

2. While acknowledging the complexity of cities as well as the vibrancy and size of urbanization, environmental sustainability must be mainstreamed by allowing involvement at all levels of government and all city stakeholders. Environmental sustainability necessitates an integrated strategy throughout the city sector, with preventative actions planned to avoid, mitigate, and limit the negative consequences of natural systems on which community commercial infrastructure systems rely. To that aim, planners and developers must be aware of the changing environmental context and ensure that their actions respond to environmental concerns consciously and ethically. [48]

3. India is split into zones with a high risk of potential death from a variety of disasters, including earthquakes, floods, cyclones, droughts, tsunamis, and landslides. Disaster risk reduction and resilience plans are critical for long-term and sustained social and economic progress due to the high population density in cities. Infrastructure and physical assets are similarly vulnerable to catastrophes due to their inadequate resilience. [48]

4. Vast expanses of impermeable surface are formed, worsening the heat island effect, increasing surface water runoff, and ultimately contributing to urban floods. As cities become inundated and contaminated with human waste and hazardous chemicals, the danger of disease rises. [48]

5. Concerns regarding the impact of urban growth on natural ecosystems must be incorporated into urban development plans, especially masterplans. [48]

8.9.3 Summary of Actions

Table 15: Summary of Actions - Environmental Sustainability

Level	Key Actions
City Level	• Pollution surveillance • Adoption of Rapid Adoption and Production of (Hybrid and) Electric Vehicles (FAME) • A comprehensive sanitation strategy will be included in the CCUP. • Increasing the number of green places • Water management plans (5-10 years in the future) with special reference to current water bodies (sea, river, ponds, lakes, and tanks), integrated with CCUP • The City Disaster Risk Reduction and Resilience Plan (DRRRP) will be included in the CCUP. • Prepare an Energy Efficiency Plan for the City
State Level	• Prepare the state's urban DRRRP. • Assist ULBs with convergence, technical assistance, and a 'outcome-based' approach.
Central Level	• Provide a framework for water management, disaster recovery, and energy management strategies. • Facilitate the allocation of financial resources on a 'outcomes-based' basis.

Source: NUPF_Final_Oct 2020.pdf (iica.nic.in)

8.9.4 Outcomes

Table 16: Outcomes - Environmental Sustainability

	Short-term	Mid-term	Long-term
ULB Level	• Integrate and mainstream water body health (sea, river, pond, tank, etc.) into master plan. • Make plans (water, DRRRP, energy, CCUP)	Implement the 'outcome-based' strategy.	Cities that are environmentally friendly, socially responsible, long-lasting, and robust
State Level	Local plans should be merged with state action plans.	Convergence with various departments should be made easier.	
Central Level	Create the appropriate frameworks.	Convergence with various departments should be made easier.	

Source: NUPF_Final_Oct 2020.pdf (iica.nic.in)

Chapter 09: Effects of COVID-19 on India

9.1 Abstract

Since the beginning of the COVID-19 crisis, scientists have been working diligently to shed light on a range of topics, including the processes that allow the virus to spread, as well as the recovery and adaptation strategies and policies required for environmental and socioeconomic consequences. Cities are frequently hotspots for COVID-19 infection due to the concentration of people and economic activities. As a result, numerous researchers are attempting to understand the impact of COVID-19 on cities by investigating the epidemiology of the pandemic in metropolitan areas. This study aims to offer an overview of city-related COVID-19 research by evaluating the literature released in the eight months following the first confirmed cases in Wuhan, China. Its primary goal is to comprehend the pandemic's influence on cities and to identify key lessons that may be applied to urban planning and design following COVID-19. Early studies on the influence of urban COVID 19 on the emphasis of the subject, according to the findings, were mostly connected with four key themes:[49]

1. Environmental quality.
2. Socio-economic impact.
3. Management and governance.
4. Transportation and urban planning.

Despite the fact that this provides a range of study problems, the first subject, which deals with air quality, meteorological factors, and water quality issues, dominates, while other themes are still under-considered. During the lockdown, improvements in the city's air and water quality will emphasize the substantial environmental consequences of human activities, giving a call to awaken to green growth routes. It also includes further ideas for post-COVID city planning and design in the areas of socioeconomic issues, city administration and governance, transportation, and urban design. Overall, available research indicates that the COVID-19 issue represents a great

[49] *The COVID-19 pandemic: Impacts on cities and major lessons for urban planning, design, and management (nih.gov)*

opportunity for planners and policymakers to take transformational action toward the construction of more egalitarian, resilient, and sustainable cities.

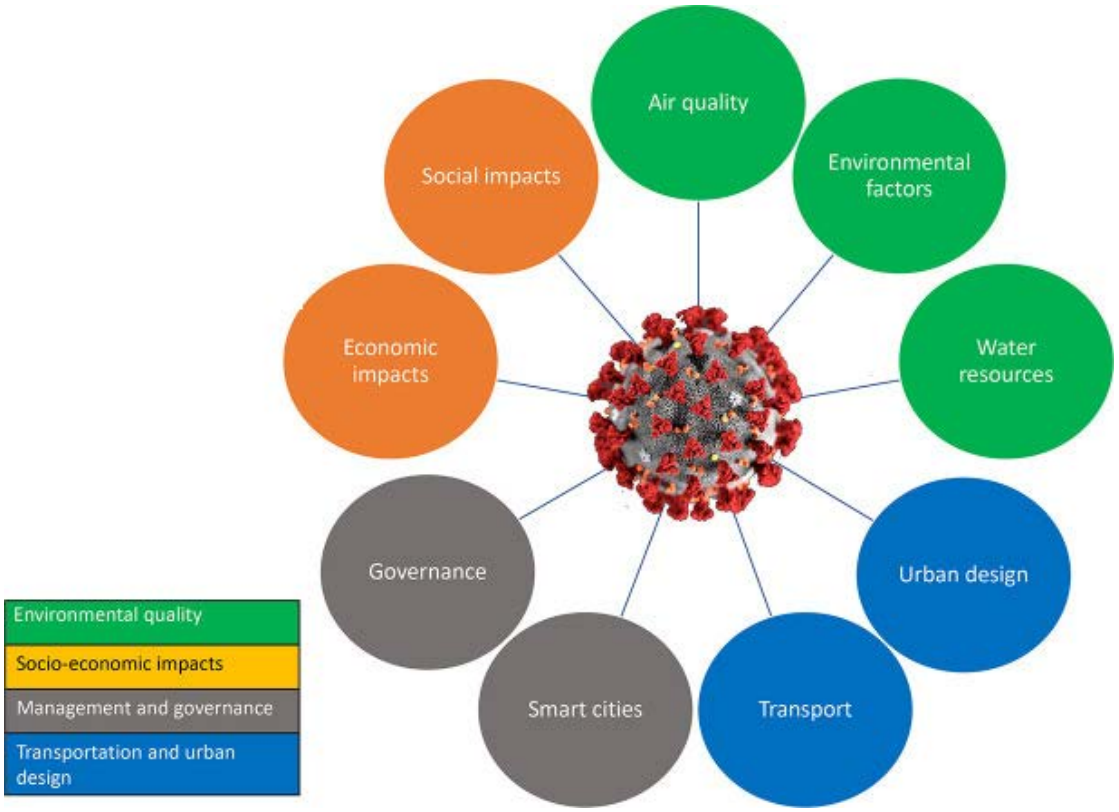


Figure 25: Graphical abstract
Source: The COVID-19 pandemic: Impacts on cities and major lessons for urban planning, design, and management (nih.gov)

9.2 Concerns and recommendation for post COVID-19

Table 17: Concerns and recommendation for post COVID-19

TOPIC	THEME	Major issues revealed by the pandemic	Major recommendations/implications for post-COVID planning
		- In many cities, traffic emissions are important causes of pollution.	- Greening the transportation and industrial sectors can have a significant impact on air quality.

Environmental Quality	Air Quality	- Non-traffic pollution sources are also relevant in some situations. - COVID-19 transmission/mortality rates are significantly linked with high levels of air pollution in various situations. - Long-term exposure to air pollution can make humans more vulnerable to pandemics.	- Reducing traffic-related pollution is insufficient to solve air quality in all settings. - Because methods to reduce certain pollutants may raise secondary pollutants, comprehensive approaches to pollution reduction are required. - Reducing air pollution can help to reduce pandemic transmission/mortality rates.
	Environmental factors	- The evidence for a link between temperature and COVID-19 transmission rate is equivocal. - When the wind speed is low, air pollution is more likely to worsen.	- During pandemics, social distance and other protective measures should be promoted indefinitely, regardless of environmental conditions. - Improving air quality can help to address both acute and long-term concerns linked to covid-19 and other pandemics.
	Urban water cycle	- Unregulated human activities have contaminated water resources in several cities. - Drugs used to treat COVID-19 patients have the potential to damage freshwater resources. - The ineffectiveness of lockdown measures is hampered by a lack of sewage treatment	- Priority should be given to developing rules to reduce negative agricultural, industrial, and transportation impacts on water resources. - Adequate disinfection of water treatment facilities and wastewater treatment plants, as well as measures such as preventing sewage leaks into freshwater resources, are required to limit human exposure to the virus.

		infrastructure in impoverished regions.	
Socio-economic impacts	Social impacts	- COVID-19 has shed new light on existing issues and inequities. - Inequalities make containment difficult and may lead to additional viral spread. - Enforcing social separation and other reaction measures in slums is difficult.	- Priority should be given to more inclusive measures aimed at decreasing disparities and meeting the needs of disadvantaged populations. - Priority should be given to slum improvement. - Social distancing strategies should be supplemented by economic assistance systems. - Improving response and recovery capacity requires a stronger sense of community.
	Economic impacts	- A homogeneous economic system makes a country more vulnerable. - The economic consequences of the epidemic disproportionately affect marginalized populations. - Cities are exposed to disruptive occurrences due to the global supply chain.	- It is critical to diversify the economic structure of cities. - During pandemics, developing relief initiatives to assist vulnerable and disadvantaged people is essential. - To deal with the economic ramifications of the pandemic and comparable future catastrophes, a shift to a more local supply chain that enhances self-sufficiency is required.
	Governance	- Lack of proactive preparation and emergency plans is a key cause for certain	- Long-term visioning and integrated urban governance improve adaptive capability.

Management and governance		governments' inability to respond successfully. - Inadequate urban governance erodes response and adaptation capacity.	- In the event of a pandemic, local governments should give economic and social assistance to vulnerable communities. - In addition to top-down measures, local leadership and community participation are important for timely pandemic response.
	Smart cities	- Smart solutions have helped to build more effective and efficient responses and recovery procedures (e.g., infected personal identification and isolation, reduced human-to-human contact when delivering services, etc.). - While technological techniques have been effective in controlling the infection, they have raised issues about privacy and transparency.	- Making real-time and geo-referenced data available to the public allows for improved reaction and recovery from disasters. - Technological techniques should not be utilized to compromise privacy concerns or to strengthen power dynamics. - Human-centred methods are more suited for citizen empowerment. - The combined technique is appropriate for managing pandemic containment privacy issues, promoting information exchange, and limiting disinformation dissemination.
	Transportation	- Improved transportation connection is a risk factor that might contribute to the spread of infectious illnesses. - During pandemics, public transportation may	- Smart mobility limitations based on the transmission risk of various means of transportation are critical for controlling the virus's spread. - More emphasis should be placed on avoiding possible public health

Transportation and urban design		enhance the risk of transmission. - The epidemic may lead to a shift in negative views about public transportation.	concerns associated with public transportation. - The transition to cycling and walking provides a once-in-a-lifetime chance to promote active transportation.
	Urban Design	- Density alone is not a significant risk factor for viral transmission. - Some cities lack adequate amounts of green and open space to suit their people' outdoor exercise and enjoyment needs while still meeting social distancing standards.	- Greater access to amenities and public health infrastructure reduces the vulnerability of high-density regions to pandemics. - Given the numerous additional advantages of compact urban projects, planners should continue to promote them. - More space should be set up for pedestrian zones and open spaces.

Source: The COVID-19 pandemic: Impacts on cities and major lessons for urban planning, design, and management (nih.gov)

9.3 COVID-19 in Renewable sector

The epidemic has resulted in a historic drop in crude oil demand and prices. Wood Mackenzie, an energy consultancy firm, evaluated the impact of oil priced at $ 35 per barrel on a company's 2020 investment plans and discovered that three of the four projects did not cover the cost of capital. Assume that the industry is immobilized at $20 per barrel. Is this an opportunity for India to decarburize more swiftly, as climate campaigners have suggested? It's difficult to say. Not only may sectors such as shale decline and expand for the first time in months, but infectious illnesses have also impacted each fuel differently. "Electricity is less affected than oil," claimed an unnamed PricewaterhouseCoopers energy analyst. "Solar can gain, but other renewable energies that are currently being stepped on, such as biofuels and agricultural waste, can suffer. They are only sustained when oil prices are high."

Covid-19 closed economies are contracting in a variety of industries, rendering small firms more vulnerable than major manufacturers. It is a renewable business, not an industry like Exxon, Rosneft, or Aramco, that is driving the energy sector. Large firms are at best, reviewing fresh investment plans. Aramco has the option of expanding the Saudi Arabian refinery or purchasing and delivering finished product to the missing plant without constructing the Ratnagiri refinery. You can also invest in a renewable energy firm to hedge your bets in the future.

9.4 India's carbon emissions fall for first time since 1982

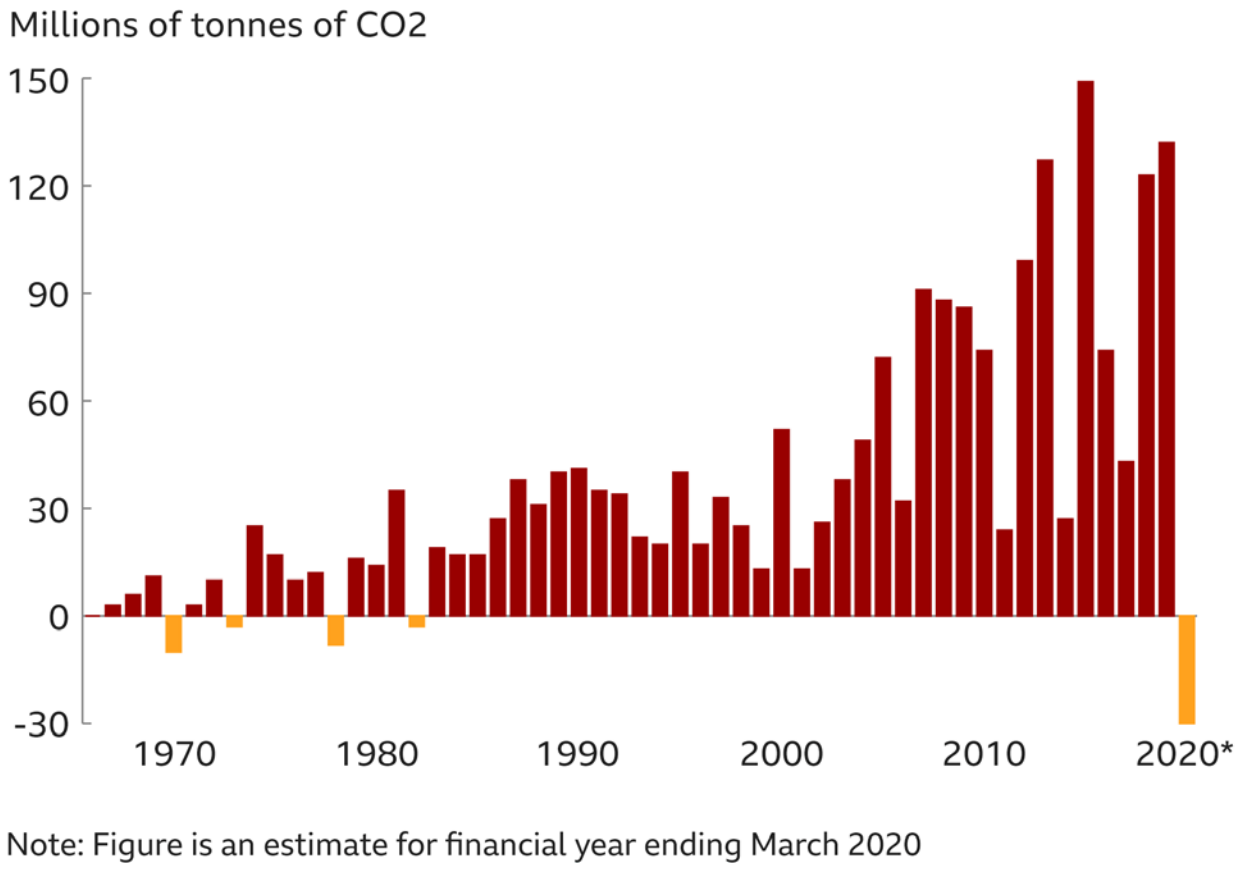


chart 7: India's CO2 emissions since 1982 *Source: India's carbon emissions fall for first time in four decades - BBC News*

India's CO2 emissions have decreased for the first time in 40 years, owing to the country's coronavirus lockdown. According to a research by the environmental website Carbon Brief,

competition from lower power consumption and renewable energy had undermined demand for fossil fuels before Corona 19 touched the big screen. The abrupt countrywide blockade in March, however, halted the rising trend in emissions in 1937. According to the poll, India's carbon dioxide emissions decreased by 15% in March and are expected to decrease by 30% in April. Almost all reductions in electricity consumption have been caused by coal-fired power plants. This explains why the emissions reductions were so drastic. According to daily statistics from the Indian National Grid, coal-fired power output decreased 15% in March and 31% in the first three weeks of April. However, even before India's unexpected coronavirus shutdown, demand for coal was dwindling.[50]

According to the study, coal supply dropped by roughly 2% for the fiscal year ending March 2020. This compares to a 7.5% annual increase in thermal power output over the past decade, as well as a minor dramatic drop.

Indian oil consumption is experiencing a similar decline in demand growth. Since early 2019, the speed has been sluggish. Again, the Covid19 locking measures' influence on the transportation industry has grown increasingly complicated. Oil usage fell by 18% in March 2020 compared to the previous year. On the other hand, since the onset of a growing epidemic throughout the year, the energy supply of renewable energy has been holding up. The renewable energy sector's tenacity in the face of a significant drop in demand caused by the coronavirus is not confined to India.

Global coal consumption decreased by 8% in the first quarter of this year, according to statistics provided by the International Energy Agency (IEA) at the end of April. Wind and solar power, on the other hand, have seen a small growth in demand globally. The primary reason coal has been pushed by the antagonism of falling energy demand is that it will be more expensive to do so on a daily basis. Because the operational expenses of solar panels and wind turbines are so low, the electricity grid usually takes precedence when they are built.

Thermal power plants that use coal, gas, or oil, on the other hand, must purchase fuel in order to create electricity. Analysts, however, caution that the decrease in fossil fuel consumption may be

[50] *India's carbon emissions fall for first time in four decades - BBC News*

short-lived. They claim that if nations try to restart their economy after the pandemic has passed, emissions would soar once more. The United States has already begun to relax environmental rules, and there are worries that other nations will follow suit. However, according to the Carbon Brief study, there is reason to assume that India will deviate from this pattern. The coronavirus issue is causing multi-year financial troubles in India's coal sector, and the Indian government has completed a bailout plan worth up to 900 billion rupees ($12 billion, £9.6 billion). At the same time, the government is debating whether to promote renewable energy as part of the recovery.

In India, renewable energy offers the economic benefit of producing considerably cheaper power than coal. According to the research, the new solar thermal capacity costs just 2.55 rupees per kilowatt hour, but the average cost of coal-generated energy is 3.38 rupees per hour. Renewable energy investment is aligned with the country's clean air policy, which was started in 2019. Environmental groups hope that the pure air and clear sky enjoyed by Indians following the shutdown will raise public pressure on the government to clean up the power industry and improve air quality. increase.

9.5 Lessons for India’s Urban Policy

Governments must learn from this epidemic and build robust, egalitarian, and long-term infrastructure that meets the demands of all levels of society. Normal is no longer normal. After the novel coronavirus (SARSCOV2) spreads swiftly around the world, the world is adjusting and a new situation has emerged. The new coronavirus illness (COVID19) pandemic has altered everything. It has compelled humanity to develop flexion in both the short and long term. Physical and social distance are terms that are a necessary part of daily life. In India, unprecedented urban expansion is already impeding the resolution of complex urban issues such as land, water, and sanitation conditions. Informal settlements house over 65 million people, or 17% of the city's population. [51]

These two characteristics, along with the fact that slums like Dharavi, India, have a population density of 200,000 per square kilometre in Mumbai, India, make social distancing nearly impossible in India. Slum populations in cities are vulnerable to a lack of essential services such

as safe drinking water, sanitation, housing, and health care. According to the National Family Health Survey4 (NFHS4,201516), unimproved sanitation facilities were found in 4.6 %, 3.4 %, and 8.4 % of the urban, rural, and urban poor populations, respectively. Outdoor defecation was found to be 63.1 % in urban slums. India's health-care system has come a long way since the world's first cholera pandemic in Calcutta in 1847 and the 1918 flu pandemic. However, due to the complicated and highly unusual Indian phenomena of coexisting urban poor and middle-class communities, India is still at a vulnerable stage of protection against epidemics, particularly pandemic-changing diseases.

In April 2020, the Federal Ministry of Health and Family Welfare's National Centre for Disease Control issued a warning to locations with a poor population, similar to urban slums, with positive cases identified in the area. According to the guidelines, local prominent individuals are obliged to guarantee that they are not conducting work that requires general hygiene precautions at a social distance. The health management dynamics of the urban poor population differ greatly from those of the wealthier segments of society, and simple suggestions may not be an effective instrument for eradicating COVID 19 biological and social tensions in this socioeconomic class.

The Indian slums are largely populated by migrant laborers engaged in long- and short-term employment with job insecurity and a periodic demolition economy. The state's unprecedented closure to prevent the spread of the virus may have been done on purpose, but it is not appropriate for this segment of the population. Multi-Ravi is well-known as Asia's largest slum, but the Indian cityscape contains numerous similar or smaller places with less media coverage, and it is unknown whether the virus has spread to that slum. Closure is an efficient method of preventing viral transmission. However, the effect of Corona 19, which is generally "invisible," such as non-regular employment, housekeeping assistance, and street sellers, is not confined to these, and there are multifaceted hazards lying throughout the country. [51]

1. **Economic Impact:** Migrant workers, who form the backbone of the slam population, began to return home because to fear, worry, and hunger. The majority of them are

[51] *What lessons does COVID-19 offer for India's urban poor policy (downtoearth.org.in)*

everyday gamblers, and as a result of the unpredictable conditions, they have not kept any cash flow. According to the most recent India2020 publication, the unorganized sector in India employs 97 percent of the workforce, the majority of whom are cross-border/international migrants. These have a negative impact on industries such as reverse movement of labour, real estate, manufacturing, milling, textiles, transport and tourism, e-commerce, and private security and facilities management.

Flattening the COVID 19 curve will have a substantial economic impact on both the state of origin and the migrant master. While the hometowns of most immigrants, Uttar Pradesh, Bihar, Odisha, and West Bengal, can inflict extraordinary burdens on economic and social infrastructure, Delhi, Haryana, Punjab, Gujarat, Karnataka, Maharashtra, and Tamil Nadu, have seen a sharp decline in their workforce, leading to reduced capacity.

2. **Social Impact:** A random telephone survey performed by Afridi et al. in Delhi reveals the social stigma experienced by low-income families living in urban slums. Eighty-five percent of respondents stated the shutdown cost them a significant source of income, and half (53 percent) indicated they did not get their entire pay in March 2020. Without a question, the administration is on board. Free food and rations, as well as cash sent directly into your bank account, are interim measures, but they are insufficient to provide social security. Uncertainty about resuming everyday life raises fundamental issues about worry, stress, and financial well-being.

   There have been few reported cases, but based on psychological theories, it is expected that there will be an increase in the incidence of domestic violence against women as a result of emotional and economic stress, such as crime, theft, and robbery. This pandemic highlights the urgent need for policy-level reforms to enhance the country's overall inclusive readiness to establish a more responsive framework to reduce disparities in cities in the case of a future outbreak.

3. **Health Impact:** Since the pandemic began, medical institutions, governments, and the World Health Organization have provided toilet training and social distancing workshops. However, it is unknown how this sector of the population fits into preventive recommendations in most of the country's slums, where communal faucets are the only supply of water. Epidemics are particularly likely in environments with limited resources. India cannot claim to have flattened the curve since there are no well-crafted measures in place to combat the plague of urban poverty. Basic medical centres at the bottom of the health-care system pyramid are already deficient or are in the process of becoming so.

   They are insufficient to meet the burden of infectious illnesses. Except for active COVID 19 patients, this virus poses a latent threat to those suffering from other critical conditions such as cardiovascular and kidney disease. The most essential thing is that routine check-ups, immunizations, and therapy are all disrupted. Malnutrition among children under the age of five in India's urban poor is a chronic problem. Income shortages caused by blockades can increase governments' and charities' reliance on food, and if not treated properly, complicated diseases caused by nutritional deficiencies can become more prevalent.

   Governments must develop local-specific detection, containment, and treatment procedures based on the epidemiology of COVID-19 transmission by personal contact, spray, and contaminated surface aerosols. The conventional screening containment treatment approach used in resource-rich civilizations does not function in impoverished urban areas.

Chapter 10: Favourable Construction Ideas

10.1 Precast Concrete

10.1.1 Introduction

Precast concrete is a type of concrete that is prepared, cast, and cured offsite in a controlled industrial setting using moulds that are typically reusable. Precast concrete pieces can be joined together to make a full structure. It is frequently used for structural components such as wall panels, beams, columns, floors, staircases, pipelines, tunnels, and so on.[52]

Although structural steel frames can offer a variety of prefabricated structural components, precast concrete can be more cost effective and sometimes more practical. Many buildings today use a combination of two construction methods, including structural steel, on-site concrete, and precast concrete parts.

Because of its strength, longevity, and low cost, reinforced concrete is widely utilized in structural systems. Concrete is used in the following applications:

1. To create building beams, columns, floor slabs, foundations, and other structural elements.
2. To create construction wall or cladding panels.
3. To manufacture precast pre-stressed construction components.
4. Bridge spans and metro line viaducts are frequently precast at a casting yard to manufacture components for infrastructure projects.
5. Precast water tanks, septic tanks, drainage chambers, railway sleepers, floor beams, boundary walls, and water pipes are among the goods manufactured.
6. As it can be moulded into any shape, it may also be used to make one-of-a-kind unique forms like as boats and sculptures.

[52] *Precast concrete - Designing Buildings Wiki*

Figure 26: Precast Concrete
Source: Prefab Concrete Walls Work Best for Large Projects- American Precast (americanprecastfences.com)

10.1.2 Manufacturing Procedure

Precast concrete elements are manufactured in a closed facility under regulated circumstances. This means you can accurately manage error margins, limit waste, and make thick, robust, and high-quality concrete. [52]

Concrete is poured into a mould and left to cure. Steel or plywood is commonly used to make precast shapes. Plywood forms are often restricted to castings of about 20-50, depending on the intricacy of the form, whereas precasting using steel forms allows for almost limitless castings.

Precast components are often reinforced with rebar to withstand load strains. Corrosion of reinforcement is a frequent cause of concrete building degradation. As a result, it is critical that they are incorporated in correctly constructed concrete.

Admixtures can be mixed into concrete during the production process. These are air entrainment retarders and accelerators that reduce water entrainment (to shorten curing time). Admixtures are

used to improve the quality of concrete in both the fresh and hardened states. Colour pigments can be added, such as iron oxide (red and brown), chromium oxide (green), and cobalt oxide (blue).

Brick is an alternate kind of precast in which stress is put into structural elements during manufacture, improving both strength and performance. See Prestressed Concrete for additional details.

10.1.3 Connecting of Elements

Precast concrete components can be linked in a variety of ways, including: [52]

- Bolts can be used to connect the pieces. As a result, when laying concrete, the iron connection is recovered. This must be done with extreme precision.
- They can be grouted together or concreted together. The loops of steel reinforcement continue protruding from the precast concrete component in this manner. Between the loops is a stiffener with two pieces in place. Following that, fresh concrete is poured around the reinforcement in the area left for this reason.

Figure 27:Connecting Elements
Source: Precast Concrete Floor, Wall and Frame Construction Process - The Constructor

10.1.4 Major reasons to select prefab concrete walls [53]

1. **Lightweight and Efficient:** Precast concrete was created to resist higher loads. This eliminates the demand for extra building support as well as foundation and support requirements. Despite these lightweight structures, precast concrete has a higher strength to weight ratio than conventional building materials. Precast concrete buildings can have up to 80 storeys. Precast concrete, on average, decreases floor depth by up to 4 inches. The savings on these materials will be equivalent to the cost of adding a second level to a 60-story skyscraper.
2. **Easy to Make and Install:** Construction businesses find it very simple to install because everything is manufactured in a single facility and transported to the project site. All they have to do now is set up the panel. There are no dice or rebar to be found. Everything is handled by the precast concrete business.
3. **Weather Resistant:** Several freeze-thaw cycles show that concrete outperforms other construction materials. Floods, high winds, and heavy rain have little effect on concrete. In other words, regardless of the weather, concrete will last.
4. **Thermally Efficient:** Because of its great density, precast concrete is thermally efficient. Heating and cooling expenses can be considerably decreased when combined with insulation that can be added while installing concrete.
5. **Fireproof:** Concrete does not catch fire or burn. Fires do not spread quickly in concrete structures. Because the concrete wall panels do not burn, recovery after a fire is rapid and painless.
6. **Rust and Chemical Resistant:** Concrete is frequently utilized in places where gasoline and oil might easily leak, such as overpasses. For good reason: concrete is one of the only materials that does not degrade when exposed to the majority of chemical spills. Because the structural elements are incorporated in concrete, concrete walls are resistant to rusting, and quality concrete is difficult to fall out or wear out.

[53] *Prefab Concrete Walls Work Best for Large Projects- American Precast (americanprecastfences.com)*

7. **Highly Durable:** Because precast concrete is manufactured in a facility with optimal curing conditions, its strength is unparalleled. It is highly tough and resistant to wear.
8. **Reduces Noise Pollution:** Again, the concrete is dense, and this is the obnoxious wall. The hotel's guests can sleep peacefully, and office workers aren't bothered by the nearby offices.
9. **Pest Resistant:** Termites, rats, and other pests cannot eat their way through concrete, ensuring the safety of your structure and its contents.
10. **Customizable:** Plumbing, communication lines, windows, and utility panels are examples of built-in inclusions in precast concrete. These are all incorporated during the casting process, resulting in flawless integration and a gorgeous structure. They can also be produced with a variety of design features, such as particular colours applied directly to the concrete or ornamental pieces placed in the mould.

10.1.5 Advantages of Precast Construction

Many of the same components may be produced using free casting. For example, if you are constructing an affordable housing project in the same apartment building, you may utilize precast to create wall and floor slabs for all units and lift and join them in place. It is simple to install since it is done in a specifically designed precast yard or factory for the following reasons. [52] [53]

- Precast concrete building is less costly than traditional brick construction.
- It does not need as large a footing as a traditional brick wall. If it ever shifts, it can be reset.
- More durable than traditional masonry since there are no mortar joints to allow water in.
- Installs quickly and simply – most may be completed in a single day.
- Maintenance-free - Unlike wood fences, there is no need to paint or repair slats on a regular basis.

10.1.6 Disadvantages of Precast Construction

There are a few drawbacks of precast concrete construction: [52] [53]

- The design idea of system construction is less flexible than that of purpose-mode structures.
- Most design requirements may be met without significantly altering the original concept.
- The structural connection between precast concrete pieces can cause both design and contractual issues.

10.2 Fly-ash bricks

10.2.1 Introduction

Fly ash is a fine powder that is produced as a by-product of the combustion of pulverized coal in a power plant. Fly ash is a pozzolan, which is a material that includes alumina siliceous particles that, when combined with water, create cement. Fly ash, when combined with lime and water, creates a material comparable to cement. As a result, fly ash is an excellent choice for the primary component of mixed cement, mosaic tiles, and hollow blocks, among other building materials. Fly ash enhances the strength and separation of concrete and makes pumping simpler when added in concrete mixes.[54]

Figure 28: Fly ash Brick *Source: fly ash brick manufacturers Archives - Harden Bricks*

Fly ash may be utilized as the primary component in a variety of cement-based products, including cast concrete, concrete blocks, and bricks. Portland cement concrete pavement, often known as PCC packing, is one of the most popular use for fly ash. Road building projects with PCC may employ huge volumes of concrete and substitute fly ash with significant cost savings. The Federal Highway Administration is increasingly recognizing the usage of fly ash to fill embankments and mines.

[54] *Uses, Benefits, and Drawbacks of Fly Ash in Construction (thespruce.com)*

fly ash replacement rate in Portland is generally 1 to 1-1/2 pounds of fly ash for 1 pound of cement. As a result, the amount of fine aggregate in the concrete mixture must be reduced to compensate for the higher amount of fly ash.

10.2.2 Types of fly-ash bricks

Fly ash is classified into two types: Class F and Class C. Class F fly ash comprises particles that have been coated with molten glass. This substantially decreases the danger of sulphate-induced swelling, which can occur in fertilized soils and coastal regions. Class F is typically low in calcium, with a carbon concentration of less than 5%, but it can reach 10%. [54]

Class C fly ash is also resistant to chemical assault and expansion. It contains more calcium oxide than class F and is commonly used in structural concrete. Class C fly ash is typically high calcium fly ash with less than 2% carbon content.

Currently, fly ash is used in more than half of the concrete produced in the United States. The pace of administration varies according to the kind of fly ash and its degree of reactivity. In general, Class F fly ash utilizes 15-25 % cementitious material by weight, and Class C fly ash uses 15-40 %.

10.2.3 Manufacturing of fly-ash bricks

Fly ash bricks are nothing more than a pozzalona cement mix that hardens over time. The method is similar to that of manufacturing cement at a cement factory, except that clay and limestone are burned with coal and gypsum. And it's smashed with cement. Fly ash, which is a combustion clay particle (clay oxide) produced by the burning of coal containing clay in coal mines, is also blended. In a pot, combine slaked lime powder and gypsum and crush; the result is a slowly hardening pozzalona cement mix. A hydraulic machine developed specifically for high pressure loads at moderate speeds of about 350 kg/square inch compresses the mixture at low pressure and low water content. It provides the greatest strength of fly ash bricks to maintain pressure at this pressure rate for the specified period.[55]

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[55] *Fly Ash Bricks and Comparison with Clay Bricks - Composition, Uses (theconstructor.org)*

1. Mixing of fly-ash with cement, water and sand.
2. Pouring of mortar into the moulds.
3. Drying in atmospheric temperature and pressure.
4. Curing for a period of 28 days.
5. Removing from the moulds and its ready to use.

10.2.4 Advantages of Fly-ash Brick

In certain areas, fly ash can be a more cost-effective alternative to Portland cement. Fly ash is also regarded as an environmentally favourable resource since it is a by-product with less inherent energy, which shows the amount of energy required to create and ship construction materials. In contrast, the manufacturing of Portland cement necessitates a great deal of heat, resulting in a relatively high inherent energy. Fly ash uses less water than cement and is simple to work with in the winter. Other advantages include: [54] [55]

- Reduces CO2 emissions.
- Produces a variety of fixed times.
- Resistance to cold weather.
- Depending on how you utilize it, you can develop a lot of strength.
- Can be used as an admixture.
- Regarded as a non-shrink material.
- Produces thick concrete with a smooth surface and precise detail.
- Reduces cracking, permeability, and bleeding issues.
- When compared to no-fly-ash mixtures, allows for a lower water-cement ratio with identical slumps.

10.2.5 Disadvantages of Fly-ash Brick

Fly ash products may be new to small builders and homebuilders. Fly ash products can have a variety of properties depending on where and how they were collected. Furthermore, conventional builders may be opposed to the use of fly ash due to worries regarding freezing/thawing performance and bleaching tendencies. Other issues raised by the use of fly ash in concrete include:[54] [55]

- Slower strength gain.
- Seasonal limitation.
- There is a greater need for air-entraining admixtures.
- Higher amounts of fly ash cause an increase in salt scaling.

10.2.5 Comparison of Clay Bricks and Fly Ash Bricks

Table 18: Comparison of Clay Brick and Fly Ash Brick

PROPERTIES	RED BRICK/CLAY BRICK	FLY-ASH BRICK	REMARKS
Density	1600-1750 kg/m^3	1700-1850 kg/m^3	Higher load bearing
Compressive strength	30-35 kg/cm^2	90-100 kg/cm^2	Higher load bearing
Absorption	15-25%	10-14%	Less dampness
Dimensional stability	Very low tolerance	High tolerance	Saving in mortar up to 25%
Wastage during transit	Up to 10%	Less than 2%	Saving in cost up to 8%
Plastering	Thickness vary on the both sides of wall	Even on both sides	Saving in plaster up to 15%.

Source: Fly Ash Bricks and Comparison with Clay Bricks - Composition, Uses (theconstructor.org)

Chapter:11 Conclusion

According to the study's findings, the issues of urbanization and carbon emissions are inextricably connected. Where the population is quickly rising these days, consumption and production rise as well, which might have a direct impact on the country's carbon output, specially like in countries India and China because of its population and cheaper labour for industrial production. The average carbon emission per person ranges from 4 to 16 tons per year, but it must be less than 2 tons per year to achieve a 2-degree Celsius temperature drop.

There are several distinct methods emerging from each location these days to address the rising urbanization challenges. Because of various sources of income and a better standard of living, the majority of the people from rural regions tends to relocate to metropolitan areas. This essentially results in a huge extension of city borders. According to estimates, the bulk of the population will relocate to cities in the coming years, demanding a better solution. As we all know, as the city's population grows, the city must expand its boundaries with a slew of new planned sites, the most of which are for housing.

According to the key principles of India's National Urban Policy Framework, governments tend to have a single source of financing at all phases of the country to preserve a shared equitable corridor for everyone and draw residents to federal, state, and local government agencies. Welcoming all cities and states with their approaches and suggestions for mitigating the effects of urbanization. Encourage residents to participate in greater commercial finance for the benefit of the country's growth as well as their own. The Indian government has devised such initiatives for the benefit of its inhabitants and the country.

A framework created by the government with three distinct levels (City/State/Central) and three different time periods (Short-term/Mid-term/Long-term) results with essential elements has clearly

described the country's future orientation. Whereas Urban Planning, Housing and Affordability, Environmental Sustainability, Transportation and Mobility, Social Infrastructure, and Urban Economy clearly reveal all of the country's future moves in a highly predictable systematic manner. This framework assists us in understanding the country's methods and in active participation.

I'd like to recommend a few ongoing advanced building approaches, such as the use of precast concrete and fly-ash bricks. We can improve the quality of precast concrete and get a better solution out of it by making it more optional, so that it may be disassembled and reused after a few years of construction. This reduces the amount of carbon emitted during the manufacturing of a new element as well as the amount of carbon emitted during shipment. Such techniques can assist us in taking steps toward our objectives. Because of its material characteristics, fly ash bricks are less in weight and completely recyclable many times. Because bricks are light in weight, they may be utilized to build structures with less materials than are often required, and their easy accessibility in any size and form saves labour time and effort. When compared to popular clay bricks, these bricks provide significantly more advantages. These bricks are also well-known for their fire resistance. When these bricks are reused, they do not require a large quantity of extra resources to form them back into shape, unlike red clay bricks, which require fresh ingredients such as red ground soil which cannot be reused after its process.

To summarize, all we need to realize is the alarming situation of our country and start worrying about it. As each individual's work is important, because all of the outcomes are only achievable when residents begin to change their habits toward a more sustainable and eco-friendlier attitude. Most essential, individuals must grasp how sustainable living benefits their health criteria as well as their long-term expenditures. People should also realize that the sustainable living lifestyle does not have drawbacks or negative effects.

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