LUISS

Department of Economics and Finance
BA Program: Economics and Business, Major in Management
Course: Sustainable Development, Energy and Climate.

SMART CITIES FOR A SUSTAINABLE FUTURE

SUPERVISOR

Prof Aldo Ravazzi Douvan

CANDIDATE

Paolo Iossa

273041

Academic year 2023-2024

TABLE OF CONTENTS

INTRODUCTION

As urbanization accelerates, cities face mounting challenges, from overcrowded infrastructure and traffic congestion to rising pollution and resource depletion. More than half of the global population currently resides in urban areas, a number projected to grow significantly by 2050. In response to these pressures, the concept of Smart Cities has emerged as a critical solution, offering a technology-driven approach to managing urban environments more sustainably and efficiently.

Smart Cities use advanced technologies like IoT, artificial intelligence, and data analysis to optimize resource use, reduce environmental impacts, and improve the quality of life for residents. Beyond addressing immediate urban issues, Smart Cities are increasingly viewed as key players in the global sustainability movement. This is particularly relevant in the context of the United Nations' Agenda 2030, which outlines 17 Sustainable Development Goals (SDGs) to combat poverty, inequality, and environmental degradation. Two goals, SDG 9 and SDG 11, focus specifically on the need for innovation in urban infrastructure and the creation of inclusive, sustainable cities.

This thesis explores how Smart Cities contribute to global sustainability by analyzing the technological innovations, policy frameworks, and international collaborations shaping their development. Through case studies from both Europe and other regions, it aims to illustrate how cities are leveraging smart technologies to meet sustainability goals while overcoming barriers to implementation.

CHAPTER 1

1.1 Contest and Relevance of Smart Cities

Urbanization is happening faster than ever in the history of mankind with profound consequences on human settlements worldwide. As of 2020, more than 56% of the world's population resides in urban areas, and by 2050, this figure is expected to rise to nearly 68%[1] (United Nations, World Urbanization Prospects, 2018). This large-scale movement of people to cities presents significant challenges.

Urban areas are overwhelmed with problems like overcrowding, not enough infrastructure to match the population growth rate, traffic congestion, rising pollution levels, and an increasing demand for resources and energy. If not addressed, these issues have the potential to significantly degrade urban living standards and further compromise environmental quality.

Through their land-use decisions, cities hold the key to the future of our planet. They use about 78% of the world's energy and emit more than 60% of global greenhouse gas emissions[2] (International Energy Agency, 2021), contributing heavily to climate change. One of the biggest challenges cities face in the 21st century is finding ways to meet essential needs like housing, transportation, clean water, and sanitation, while also minimizing their impact on the environment. This is further complicated by the threat posed by climate change, which means cities will be increasingly exposed to extreme weather events, from floods, heatwaves, and storms.

The concept of Smart Cities emerged as a response to the growing need for technology-driven solutions to address urban challenges. A Smart City uses digital technology and data to manage resources more efficiently, making urban environments smarter, more sustainable, efficient, and resilient. Smart Cities employ information and communication technologies (ICT) to better utilize such systems as transportation, energy grids, waste disposal services, and water supply to enhance urban residents' living conditions. For example, digital tools like smart grids and IoT sensors help cities track energy use in real-time, allowing them to adjust distribution, cut down on waste, and lower greenhouse gas emissions. Cities that have implemented smart grids have seen reductions in energy loss of up to 10%, contributing significantly to reducing greenhouse gas emissions.

Similarly, intelligent traffic management systems assist cities in minimizing congestion and decreasing the harmful emissions of vehicles. In Los Angeles, for example, the average driver loses about 119 hours annually due to traffic congestion, which contributes to over 40% of urban air pollution from vehicle emissions[3] (INRIX Global Traffic Scorecard, 2020). Smart solutions like these improve the overall efficiency of transport networks, making it easier for people to interact and benefit from their urban surroundings.

---

[1] United Nations. (2018). *World Urbanization Prospects: The 2018 Revision* https://population.un.org/wup/Publications/.

[2] International Energy Agency (2021). *Global Energy Review 2021*. https://www.iea.org/reports/global-energy-review-2021.

[3] INRIX. (2020). *Global Traffic Scorecard: Los Angeles Traffic Congestion*. https://inrix.com/scorecard/.

The importance of Smart Cities goes beyond technological efficiency. Along with tackling the environmental challenges of cities, the Smart City idea also focuses on promoting social equity and boosting economic growth. Smart Cities utilize digital platforms to enhance citizen interactions, as well as enable innovation in public services, helping to make living standards more inclusive and ensuring that technological advancements benefit everyone.

Moreover, Smart Cities play a critical role in reducing resource consumption, a key aspect of sustainability. With programs like smart buildings that save energy, or new ways to store and pump water that reduce waste, cities will cut down significantly on their environmental impact. For instance, smart buildings, through automation and efficient energy management systems, can reduce energy consumption by up to 30%[4] (McKinsey, 2018). These are critical steps in minimizing the impact of urbanization on world ecosystems, making Smart Cities a key component of the global fight against climate change.

The fact that more than 50% of the global population live in urban areas allows us to understand why Smart Cities have gained so much importance and will continue to become increasingly relevant as cities grow even bigger. Not only do they address the issues caused by urbanization, but they also create an opportunity to question and redefine cities as working systems that should remain sustainable, not just for our well-being. They represent a fundamental shift in how cities are planned and managed, combining technology into daily urban life to make our world more livable for future generations.

1.2 The Emergence of the Smart City Concept

A decade ago, the idea of a "Smart City" started to feature prominently in discussions about urban development, although earlier attempts to incorporate technology in addressing urban challenges had already begun. Initially, these initiatives were aimed at improving the automation and communication technologies of cities. However, in the past few years, with the advent of IoT [5](Internet of Things), Big Data, and AI technologies, the idea of the Smart City has grown into a more complete and impactful approach to reshaping urban environments. Currently, Smart Cities derive from a combination of these technologies, with the goal of improving urban governance and infrastructure management to build more efficient but also sustainable and resilient environments.

In a modern Smart City, nearly every piece of infrastructure, from traffic lights to the power grid, is wired into an extremely complex digital system of sensors and devices that collect, transmit, and analyze real-time data. This interconnection creates an environment where city authorities are better equipped to respond more efficiently and sensitively to the needs of their people, providing an improved level of urban services as well as citizen life quality. For example, an early pioneer of Smart City technology is Barcelona, where thousands of sensors underpin the optimization of energy usage, water management, and traffic congestion.

It is important to emphasize that a Smart City is defined not only by its use of technology but also by how this technology is integrated into the city's systems and services to improve the overall well-being of its inhabitants. Smart Cities use ICT to create systems that work to optimize resources such

---

[4] McKinsey & Company. (2018). *Smart Cities: Digital Solutions for a More Livable Future*.
https://www.mckinsey.com/~/media/mckinsey/industries/public%20and%20social%20sector/our%20insights/smart%20cities%20digital%20solutions%20for%20a%20more%20livable%20future/mgi-smart-cities-full-report.pdf.
[5] IoT= network of physical devices, sensors, and systems that collect and exchange data over the internet, enabling greater automation and communication between devices without human intervention

as energy, water, and transportation. For example, utilizing smart grids allows cities to control the consumption of power in real-time, so that waste is reduced, and efficiency is maximized. Cities like Singapore have been at the forefront of using smart grid technology to decrease power outages, manage energy demand more effectively, and transition toward renewable energy sources.

Energy management is just one piece of the smart city transformation; other basic urban services are being revolutionized too. As an example, Seoul's smart waste management system now includes IoT-enabled bins notify city workers when they need to be emptied, reducing inefficient collection routes. This not only decreases operational expenses but also lowers the environmental impact of city services by making waste management more efficient and sustainable. This implementation has reduced waste collection costs by 30%, cutting fuel consumption and operational inefficiencies (Seoul Metropolitan Government, 2020)

Smart Cities also take into account the social dimension of urban life. These cities are breaking down barriers to public services and building new tools for interacting with citizens digitally, crucial elements of an inclusive, participatory society. Some cities have introduced online platforms for residents, allowing them to talk directly with city officials and provide comments and suggestions.

A prime example is the "Fix My Street"[6] app in the UK, which has processed over 1.2 million reports since its launch, with a resolution rate of 85% for issues like potholes and streetlight repairs (UK Government, 2019). This allows local councils to respond effectively and improve areas where they are most needed.

From an economic aspect, a crucial role of Smart Cities is promoting innovation and allocating investments. Smart Cities facilitate the emergence of new industries by creating a digital infrastructure to promote business development and entrepreneurship. Cities like Amsterdam and San Francisco have established themselves as tech hubs by incorporating Smart City principles into their urban planning. These cities have high-speed internet, open data platforms, and policies that support startups and tech companies, allowing them to thrive.

In addition to that, Smart Cities are at the forefront of experimenting with innovative sustainability projects. In Copenhagen, for example, the Copenhill[7] waste-to-energy plant turns the city's waste into electricity, while also serving as a public recreation facility with a rooftop ski slope and hiking trails. The combination of environmental innovation and public involvement in this model shows how Smart City ideas can easily integrate sustainability with increased urban quality of life.

In essence, Smart Cities represent a fundamental shift in how cities are planned and governed. They embed technology into the fabric of urban life, not just to deliver better services and manage resources more efficiently, but also to create environments that are more sustainable, socially inclusive, and economically dynamic. Smart Cities are poised to provide a template for smarter and more adaptive urban spaces as cities face the expanding environmental, social, and economic challenges of the 21st century.

---

[6] UK Governement. 2019. *Fix My Street: Enhancing Public Services Through Digital Engagement* https://www.fixmystreet.com/.

[7] Copenhill. (2020). *Waste-to-Energy Plant and Public Facility: A Model of Urban Sustainability*: https://www.copenhill.dk/.

1.3 Smart Cities and Sustainability

The integration of Smart Cities with sustainability goals is becoming a fundamental component of modern urban development. The world is quickly urbanizing and as cities grow, their environmental and social footprints increase, making it essential for urban planners to think about ways to create a sustainable future. In the context of global sustainability targets, especially in line with United Nations' Sustainable Development Goals (SDGs) particularly SDG 9 (Industry, Innovation and Infrastructure) and SDG 11 (Sustainable Cities & Communities), Smart Cities have assumed a crucial role. The goals focus on resilient infrastructure, sustainable industrialization and creating cities that are inclusive, safe as well as durable.

One of the most effective ways Smart Cities promote sustainability is through the implementation of Smart Building Technologies. These buildings have sensors and automation systems that track energy use, water consumption, heating or cooling functionality. As an example, smart buildings across New York or Amsterdam use automated lighting and HVAC(Heating Ventilation Air Conditioning)[8] system that adjust according to real-time occupancy and environmental conditions. This results in a large saving of energy and operating costs. There are even buildings constructed from eco-friendly materials, with sustainable technologies like solar panels, which not only reduce the dependence on non-renewables, but also allows them to produce their own electricity and send leftover power back into the grid.

Urban farming and vertical gardens are other examples that have been adopted more in Smart Cities, increasingly becoming prominent solutions to food security and environmental sustainability. Singapore and Tokyo, for instance, have embraced the idea of vertical farming, which involves the use of stacked layers to cultivate crops in controlled indoor environments. Through the use of hydroponics and LED lighting, these urban farms are able to operate without taking up vast amounts of land space and reducing the water usage compared to traditional farming methods. This enables cities to produce fresh local food without the carbon cost of transporting it from rural areas and contributes more generally to urban food security.

Instead of focusing on waste-to-energy systems, cities like Stockholm have implemented advanced waste separation and recycling programs, which play a major role in promoting sustainability. To facilitate the recycling process, the Swedish capital has a system in place which divides residential waste into its fundamental characteristics such as food waste, paper, glass and metals at drop locations. Food waste is turned into biogas, to be used in public buses as fuel and the other portion are recycled or composted efficiently. This approach has allowed Stockholm to significantly cut down on landfill use and reduce emissions linked to waste disposal, showing how Smart Cities can bring innovation to waste management.

Similarly, water conservation is also an important part of the Sustainability policy, wherein Smart Cities are playing major role. Smart utilities range from the traditional smart grids to advanced water management systems that have leak detection technologies and real-time water usage monitoring. In places like Zaragoza, Spain, smart water meters help monitor water usage and detect leaks, allowing quicker repairs and reducing water waste.

---

[8] HVAC stands for Heating, Ventilation, and Air Conditioning systems, which are used to regulate indoor climate and ensure comfortable, healthy air quality.

This has allowed the city to reduce water use by more than 30%. Some Smart Cities also have recycling systems, which take water from sinks and showers to reuse it for greywater (non-drinking) uses like irrigation or toilets flushing, reducing the demand of new fresh water.

Smart Cities also need Green transportation infrastructure. It is becoming common for municipalities to incorporate electric vehicle (EV) charging stations, bike-sharing schemes and walkable zones in some of the largest metropolis. Oslo, in Norway, for example, has implemented an extensive network of EV charging points to help its residents switch from traditional internal combustion vehicles, which are a major contributor of carbon emissions. Moreover, the city offers many places as pedestrianized areas that makes it walkable and cycle friendly with less need of cars. These efforts are supported by eco-friendly public transport options, like electric buses and trams running on renewable energy, helping the city's transportation system stay in line with its sustainability objectives.

Smart Cities also improve availability and inclusivity which promote social sustainability. For example, Toronto, Canada, has already begun to offer digital signs for residents with disabilities that provide real-time information about transportation and accessibility. Similarly, public buildings and spaces are being modernized to incorporate smart technologies such as automatic doors, ramps or way finding systems for the visually impaired. Smart Cities also integrate smart street lighting solutions that adjust their brightness based on activity and time of day, which makes the city safer and more energy efficient, while making public spaces more welcoming for every citizen.

 The obvious benefits that would be derived from leveraging Smart City solutions are quite significant, but obviously there is no short way to solving all of these challenges. Financial constraints are a major obstacle, developing the infrastructure and technology requires large investments, something that can be hard for some cities, as they might not have appropriate funds available. Additionally, incorporating new technologies into aging city infrastructures can be complicated and costly, often necessitating extensive upgrades.

Another challenging issue for Smart Cities is to build an inclusive movement. The digital divide, which may result in certain populations having more access to technology than others, can lead to inequalities, leaving marginalized communities behind. Ensuring that Smart City initiatives are accessible to all residents is crucial for their success. There are also huge concerns about data privacy and cybersecurity. Because Smart Cities are strictly dependent on the collection of data to work out how improved services can be delivered, this inevitably brings with it a greater degree of exposure when you consider such cities from a cybersecurity perspective. Building resilient and robust systems to protect personal data and ensure transparency in data usage, is essential to gain citizens trust and ensuring the long-term sustainability of Smart City projects.

At last, gaining public trust and encouraging citizen participation is key. Without strong engagement from the local population, many Smart City initiatives may face resistance or underutilization. Smart Cities will only ever be successful if they are transparent, educational and even more importantly collaborative with their residents.

In conclusion, Smart Cities play an essential role in the pursuit of sustainability, not only by incorporating advanced technologies but also by aligning their initiatives with broader environmental, social, and economic goals. With smart buildings, waste separation, recycling systems and urban farming as well green transportation, Smart Cities demonstrate how technology can not only help us to use fewer resources but also include more people in society and often contribute for better environmental health. Dealing with issues like financial barriers, data privacy and disparities in access to technology, will help Smart Cities to be successful, fostering an eco-friendly urban space.

CHAPTER 2

2.1 Sustainable Development: Concepts and Principle

Sustainable development is a framework for keeping the balance between economic growth, environmental protections and social equity over the long term. The concept gained global recognition by the end of the 20th century, in particular through the 1987 report by the Brundtland Commission, which defined Sustainable Development as "*development that meets the need of the present without compromising the ability of future generations to meet their own need*"[9]. This definition serves as a reminder of the critical role that sustainability should play in integrating into modern policy and planning, especially in cities where the pressure of population growth and resource consumption are more pronounced.

Sustainable development is built on 3 core pillars: economic, environmental, and social sustainability. Economic sustainability seeks to create stable growth, also encouraging innovation alongside the efficient use of resources. On the other hand, Environmental sustainability, emphasizes the importance of preserving natural resources, minimizing human impact on ecosystems, and addressing climate change through practices like energy efficiency, waste reduction, and transitioning to renewable energy sources. The third pillar, social sustainability, focuses on making sure everyone, especially marginalized or disadvantaged groups, has access to equal opportunities, justice, and the resources they need to thrive in a fair and inclusive society.

Policies and strategies that make up the practice of sustainable development fall under one or more of three pillars of economic, ecological and social sustainability. In numerous cities worldwide, renewable energy projects, such as solar and wind installations, have emerged as key initiatives to decouple economic growth from environmental degradation. Countries like, Denmark and Germany are some of the global leaders, which have how economic prosperity can coexist with environmental protection. In fact, these renewable energy projects also decrease carbon emissions and open new fields of employment and create new industries, contributing to both economic and environmental sustainability.

Social sustainability is becoming increasingly important in urban planning, with a growing focus on affordable housing initiatives aimed at reducing inequality and preventing urban sprawl. Vienna, Austria, is a leading example of successful social housing programs that offer comfortable and fairly priced homes to anyone in need. This approach is essential for delivering long term urban sustainability by preventing social fragmentation and ensure housing remains accessible to everyone.

As cities face growing challenges, the concept of Resilience has taken center stage in discussions about sustainable development. Urban resilience is the ability of a city to withstand, adapt and regenerate to external shocks, such as natural disasters, economic crises or pandemics, while maintaining social, environmental and economic stability. Resilience is now seen as an essential part of sustainability, recognizing that urban areas now have to understand the need to not just plan for longtime growth, but be also able to manage shock events that could threaten their growth objectives.

---

[9] Brundtland, G.H., et al. Our Common Future. World Commission on Environment and Development, Oxford University Press, 1987.
https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf

Another new trend in the sustainable development framework has been represented by the circular economy. This contrast with the current linear economy where goods are made, used and then discarded. In a circular economy, the aim is to minimize waste and the use of primary resources by recycling everything back into the system.

Cities like Amsterdam, have embraced the circular economy principles, encouraging businesses and even residents to change their current consumption behavior to avoid unnecessary waste. The change will be good for the environment but also to boost local economies by creating jobs in recycling, upcycling and resource recovery industries.

The idea of sustainable development has evolved from its early transnational concept to be a prime feature in global policy discussions, especially with the recent endorsement of the 2030 Agenda for Sustainable Development by United Nations Member States.

This agenda outlined 17 Sustainable Development Goals (SDGs), which are supposed to be the answer to the most important issues in the world: poverty, inequality, climate change, environmental degradation. Among these, SDG 9 (Industry, Innovation, and Infrastructure) and SDG 11 (Sustainable Cities and Communities) are particularly relevant to urban planners and policymakers.

These goals highlight the need to reshape urban systems to support sustainable infrastructure, efficient resource management, and socially inclusive policies. As smart technologies become more central to how cities operate and manage resources, they can play a key role in uniting nations in the pursuit of shared global objectives.

International cooperation plays a crucial role in the implementation of sustainable development, as no single city or country can achieve these goals in isolation. Financing, technical expertise and other resources are provided to cities by the World Bank, the United Nations or European Union.

The Paris Agreement is a good example of such an international collaboration to reduce greenhouse gas emissions. Cities are at the front of both economic activity and emissions, so they have a key role to play in meeting these climate goals.

Ultimately, sustainable development represents a comprehensive approach to tackling the most pressing issues of our time. Cities that balance economic growth, environmental protection and social equity will form our tomorrow. Smart Technologies, Renewable Energies and Inclusive Policy-Integration will be essential in reaching the ambitious goals of global agreements such as Agenda 2030.

2.2 The United Nations Agenda for 2030

The United Nations Agenda 2030[10] is a comprehensive framework adopted by all member states in 2015, outlining a shared vision for achieving sustainable development globally by the year 2030. Central to this agenda are the 17 Sustainable Development Goals (SDGs), which address critical challenges such as poverty, inequality, environmental degradation, and climate change. These goals aim to balance the economic, social, and environmental dimensions of development, ensuring that growth can benefit all people while safeguarding the for future generations.

The United Nations 2030 Agenda for Sustainable Development has identified 17 SDGs, two of which are directly related to urban sustainability and smart city initiatives: SDG 9 (Industry, Innovation, and Infrastructure), and SDG 11 (Sustainable Cities and Communities). These goals emphasize the importance of sustainable infrastructure, innovation-driven industrialization, and creating cities that are inclusive, safe, resilient, and sustainable. They highlight the need to rethink how urban environments are planned, developed, and managed in response to global urbanization and growing environmental pressures.

SDG 9 focuses on creating resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation. Since urban areas are hubs of economic activity, they play a key role in driving innovation and supporting industrial development. The digital integration into urban infrastructure of Smart Cities allows them to be more efficient and sustainable. For example, smart grids may assist in controlling energy consumption in real time, reducing waste and lowering carbon emissions. Singapore has managed to reduce its power outages and better manage energy demand with the help of smart grid technology, which also contributes to its transition toward renewable energy sources.

In addition, innovation centers in smart cities accelerate progress by supporting sustainable industrial development through enabling technologies. Amsterdam[11], for example, has embraced circular economy principles, promoting business models that focus on reusing and recycling materials to minimize waste. This transition to the circular economy would not only stimulate economic growth but would also minimize the demand on natural resources, aligning with the goals of SDG 9.

SDG 11 aims to create cities and human settlements that are inclusive, safe, resilient, and sustainable. The UN Sustainable Development Goals are the concrete foundation of smart cities with ambitious goals, that promote a technological and data-driven solution, that enhances city life in an environmentally sustainable way.

In terms of smart city innovations, cities like Copenhagen or Barcelona have become models for sustainability. For example, IoT sensors play a key role in Copenhagen's[12] waste management solution by monitoring the levels of waste in each bin, so that the city can only collect when it needs to. The result leads to automating and optimizing waste management, reducing operational costs and lowering environmental impact of handling waste across the city.

---

[10] United Nations General Assembly. Transforming Our World: The 2030 Agenda for Sustainable Development, 2015. https://sdgs.un.org/2030agenda

[11] Amsterdam Circular Economy. Amsterdam Circular Strategy 2020-2025. https://www.amsterdam.nl/en/policy/sustainability/circular-economy/

[12] City of Copenhagen. Circular Copenhagen - Resource and Waste Management Plan (2019-2024 **https://urbandevelopmentcph.kk.dk**

Furthermore, SDG 11 stresses the importance of affordable and accessible housing, an essential element of social sustainability. The Vienna case is a very clear example of how inclusive policy can tackle social fragmentation while promoting long-term urban sustainability. The city, through well executed social housing programs, ensures that all have a comfortable and affordable home, promoting social unity and reducing the potential for inequality.

The achievement of the targets stipulated under Agenda 2030 is a matter of global cooperation and local action. Smart cities are at the forefront of this movement, offering innovative solutions to urban challenges. Smart technologies can help cities to improve their operations and work towards global goals, such as reducing carbon footprints and enhancing resource efficiency. The Paris Agreement, for instance, underscores the importance of international collaboration in addressing climate change, with cities playing a crucial role in meeting these commitments.

To conclude, the United Nation Agenda 2030, in particular SDGs 9 and 11, provides a strategic framework for the development of smart sustainable cities. These goals call for the restructuring of urban systems to promote sustainable infrastructure, innovation and inclusivity, aligning with global objectives to create a more equitable and environmentally resilient world. As smart cities continue to evolve, their role in achieving the ambitions of agenda 2030 will be even more crucial, ensuring that urban environments are not only centers of economic growth but also pillars of sustainability and social equity.

Figure 1: The United Nations Agenda for 2030

2.3 Role of Cities in the global Sustainability Agenda

Cities are at the forefront of the global sustainability agenda, serving as key actors in the effort to meet an extensive set of ambitious targets set out by the United Nations' Agenda 2030. With more than half of the world's population now living in urban areas, cities serve as engines for both economic development and innovation, but are also the primary contributors to environmental pressure, responsible for larger shares of resource consumption and greenhouse gas emissions. As hub of human settlement, Cities play a crucial role in shaping sustainable development outcomes, making them indispensable to achieving the SDGs.

Of particular relevance to urban areas is SDG 11, which calls for the creation of cities and human settlements that are inclusive, safe, resilient and sustainable. This goal highlights the necessity for urban areas to balance social equality, economic development and environment protection. Consequently, cities must reimagine their policies and resource management practices in order to build sustainable development for all residents and long-term ecological sustainability. As urban populations increase particularly in developing areas, the demand upon cities to provide sustainable infrastructure, affordable housing and optimal resource management, rises sharply.

Cities contribute significantly to the global economy and they are responsible for nearly 70% of global GDP. However, this economic dominance comes with challenges, as cities consume 60-80% of global energy supply and emit over 70% carbon emissions. Accordingly, cities must take the lead in transitioning to cleaner energy sources, new ways of transportation, and reducing industrial activity. Smart city technology utilizes resources efficiently to lower the environmental footprints of metropolises through data-driven solutions. These technologies have the potential to improve energy efficiency, reduce waste and lower emissions, all key features of sustainable cities in accordance with the agenda set by Agenda 2030.

The achievement of sustainable urban development requires a substantial financial investment and the success of Agenda 2030 will depend on how effectively cities are able to finance projects for sustainability. Building greener infrastructure, moving to renewable energy and adopting more technology solutions are all capital-intensive steps that often require partnerships between the public and private sectors. Public-private partnerships (PPP) have become a key financing mechanism, enabling cities to leverage private investment to fund large-scale sustainability projects.

In Italy, the Gestore Servizi Energetici[13] (GSE) plays a crucial role in promoting the financing of renewable energy projects, by encouraging the use of incentives through energy performance contracts, thereby reducing the need for public capital for local government investments. As a government-owned company, GSE facilitates the creation of green energy infrastructure by incentivizing private investments and managing funds directed toward renewable energy initiatives, such as solar, wind, and biomass. This collaboration between public institutions and private companies has accelerated Italy's transition to sustainable energy, showing how PPPs can support large-scale green projects. More recently, cities like Paris and New York have issued green bonds (debt securities designed to fund environmentally beneficial projects). These bonds have supported initiatives ranging from sustainable transport and renewable energy to waste management.

---

[13] Gestore dei Servizi Energetici (GSE). *Energy Performance Contracts and Renewable Energy Projects in Italy*. https://www.gse.it/en/what-we-do/energy-efficiency

In addition, international institutions, such as the World Bank and the United Nations, also support cities (especially in developing countries) with technical expertise and financial resources. Programs such as the Global Environment Facility (GEF) provides grants for cities to implement climate-resilient and environmentally friendly projects. In Europe, for instance the Green Deal of the European Union provides funding and resources for European cities to transition toward carbon neutrality by 2050, with initiatives such as 100 Cities for Net-Zero, being important opportunities to align local level actions with global sustainability goals.

At the same time, cities have assumed another global role, beyond local action, that is to collaborate on an international scale to realize international sustainability goals. Cities are increasingly forming global networks and partnerships to share knowledge, resources and best practices in preparation for sustainability. Organizations like C40[14] (Cities Climate Leadership Group) and ICLEI (Local Governments for Sustainability) help cities work together globally. Within this network, cities cooperate on solutions to common challenges like air quality, waste disposal or climate change adaption.

A key model of global collaboration is the C40 Cities initiative, which unites 97 of the world's largest cities, in taking action on climate change through sharing best practices for lowering emissions and fostering sustainable development. In 2015, the Paris Agreement marked the international recognition of cities as both significant contributors to emissions and essential actors in achieving global climate targets. Cities like London, New York, and Tokyo have committed to substantial efforts that align with the goals of the agreement, aiming to reduce their carbon footprints while fostering inclusive economic growth.

In conclusion, cities are central for the implementation of Agenda 2030 as a key economic player and having an influence on the global climate, being actors for innovative change. Cities have the opportunity to make a transition towards sustainable and create a bright future by embracing smart technologies, making the financing of sustainable infrastructure happen, and partnering with global opportunities. The pursuit of sustainable development anywhere in the world depends on the ability of cities to implement policies that promote social equity, economic development and environmental protection, making them key players in the global fight against climate change and social inequality.

---

[14] C40 Cities Climate Leadership Group. *2021 Annual Report: C40 Cities.* https://www.c40.org/news/c40-releases-2021-annual-report/

CHAPTER 3

3.1 The European union Green Deal and Climate Goals

The European Union (EU) has been a climate front-runner for many years, and the Green Deal is by far the most comprehensive set of policies aimed at making Europe the first climate-neutral continent by 2050. The Green Deal[15], announced in 2019 along with the strategy to achieve it, brings a combination of legislative, financial and innovative measures intended to help cut down greenhouse gas emissions and shift towards renewable energy sources, creating a sustainable economy.

The EU Green Deal in order to meet the shared goal, has set the objective to reduce the level of carbon emissions by at least 55% in compared to 1990 levels. This goal aligns with the broader objectives set the Paris Agreement, which mandates the reduction of the global temperature by keeping the increase below 1.5°C. To achieve this, the European Union has implemented a set of strategies in order to reevaluate traditionally high-emitting sectors such as energy, transport and agriculture.

One of the cornerstones of the Green Deal is transformation of energy systems, based on expanding share of renewable energy sources such as wind power and solar power. The plan aims at reducing the dependence on fossil fuels and increasing the use of clean energy alternatives. This includes support for offshore wind energy, increased solar power improvements on energy efficiency across the bloc. The energy sector, which accounts for 75% of the EU´s greenhouse gas emissions, is a clear priority for the European Commission as they work towards full decarbonization.

In addition to energy transformation, the Green Deal also has a focus on sustainable mobility. It promotes electric vehicles (EVs), along with public transport and the electrification of transport infrastructure. The EU plans to raise EV charger installation rates through member states and supports the manufacturing and adoption of zero-emission vehicles. By incentivizing cleaner systems of transportation, the EU aims to reduce air pollution, especially in urban areas, which remain the primary contributors to carbon emissions.

One of the signature aspects of the Green Deal is the "100 Cities for Net-Zero" initiative, launched in 2021. The program is designed to support 100 cities throughout Europe in their efforts become climate-neutral by 2030, 20 years before the EU's overall goal. Major urban centers such as Copenhagen, Amsterdam and Milan will operate as role model cities for climate innovation and sustainable solutions. They are expected to implement strategies that include policies on energy labeling, eco-design, and circular economy models, covering sectors such as transport, buildings, and waste management."

One of the notable differences within the initiative is that each city approaches the transition differently. Copenhagen[16], for example, has been a leader in sustainable development and seeks to be the first carbon-neutral capital city in the world by 2025. The city has focused heavily on energy efficient buildings, clean energy, and has invested in windmills to generate electric power. In contrast, Milan, while also part of the 100 cities initiatives, faces different challenges due to its higher population density and air quality issues. Milan's efforts are concentrated on cutting emissions by expanding public transportation, implementing congestion charges (Ecopass), investing in a bike-sharing system and promoting carpooling.

---

[15] European Commission. 2019. *A European Green Deal: Striving to be the first climate-neutral continent*. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
[16] *Copenhagen Carbon Neutral by 2025*. https://stateofgreen.com/en/solutions/copenhagen-carbon-neutral-by-2025/

Moreover, the 100 Cities for Net-Zero[17] initiative promotes shared learning and collaboration between the participating cities. Cities that have already made significant progress toward climate neutrality, like Amsterdam, share their best practices with others still in the early stages. Amsterdam's focus on integrating circular economy principles, such as its "Doughnuts Economics" model, which aims to balance ecological sustainability with social needs, sets a benchmark for other cities to follow. Another key aspect of the initiative is its focus on both inclusivity and public participation. The 100 Cities are encouraged to cooperate with local communities, ensuring that climate action plans are not just effective, but also equitable. This approach places citizens at the heart of decision-making, actively involving them in shaping policies and co-developing sustainable solutions alongside local authorities.

The EU has established the Just Transition Mechanism to guarantee that the transition to climate neutrality is fair and inclusive. This means that the poor and underprivileged are not left disadvantaged by the transition to a 'green' economy, as they continue to receive subsidies to support them through this shift. It also addresses regions where investments are still tied to carbon-heavy industries, allowing those areas to diversify their economies and provide new skills or training for workers. The program includes up to 100 billion€ in funding to help cities and regions make the necessary changes, enabling them to align with economic growth while reducing their environmental impact.

In conclusion, the EU's Green Deal and its climate goals represent a bold vision for a climate-neutral Europe by 2050. In this framework, the policies and initiatives reflect one central message: that cities lead the charge to a more sustainable future. With programs like the 100 Cities for Net-Zero, the EU is not only setting ambitious targets for emissions reduction but also creating opportunities for innovation, economic growth, and social equity. As cities continue to grow and evolve, they will remain at the heart of the EU's strategy for achieving a more sustainable and resilient future.

---

[17] *The 100 Climate-Neutral and Smart Cities Mission*. https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/missions-horizon-europe/climate-neutral-and-smart-cities_en

3.2 Italy's contribution to Net0 Cities

Italy plays a significant role in the European Union's 100 Cities for Net-Zero initiative, with nine of its cities selected to participate. These cities, including Milan, Rome, Bologna, Florence, Turin along with Venice, Bergamo, Padua and Parma are implementing various strategies to transition towards climate neutrality by 2030. Their approaches vary based on their unique urban contexts, but they all share the common goal reducing greenhouse gas emissions and promoting urban practices.

The most active in promoting sustainable mobility has been Milan[18], a metropolis of more than 1.9 million inhabitants that hosts a large number of economic and cultural institutions. The city has implemented an extensive bike-sharing service and expanded public networks of electric transport to reduce emissions. Another important feature of Milan's program is the well- known Ecopass system, a congestion charge limiting the access to the city center, that has helped to reduce vehicles emissions. In addition, Milan is focusing on energy-saving renovations, especially in buildings, but also expanding parks to improve urban livability.

Rome, the largest city in Italy, presents unique challenges due to its historical infrastructure and large population. The city plan focuses on making sure that public buildings have energy saving features and also aims to enhance its transit system, including the use of electric buses. Rome is also encouraging the use of electric vehicles by expanding its network of EV charging stations and upgrading its waste management to reduce landfill dependency. The capital's efforts are focused on reducing carbon emissions through smarter urban planning and improvements to transportation.

Bologna, a city known for its academic and cultural relevance positioning itself as a sustainable innovation hub. Bologna is focusing on sustainable power sources, with the installation of solar panels being and has implemented a more effective waste management. The city is also emphasizing citizen engagement, involving the public into environmental governance and urban planning. This inclusive approach aims to ensure that all stakeholders contribute to Bologna's sustainability journey.

Florence, with his historical and cultural heritage, is working on preserving its assets while moving toward carbon neutrality. The city focused on renewable energy, as well as increasing the energy efficiency of public and private buildings. The municipality of Florence is also expanding its electric vehicle infrastructure and improving facilities to encourage cycling instead of private car transport, as it seeks to consolidate its transportation emissions below 2017 levels. The difficulty of reconciling heritage safeguarding and urban sustainability is the challenge with which Florence has to deal.

The industrial city center, Turin, is moving towards a greener economy by promoting more circular economy models and enhancing green urban spaces. A good example has been the city's movement toward increased renewable energy and more efficient energy use with policies such as public building retrofits. Turin is also working closely with local municipalities to adopt circular economy practices that lead to a reduction of waste.

Moreover Venice, with its coastal location and vulnerability to climate change, has invested into climate adaptation strategies. Beyond reducing carbon emissions, the city has introduced measures to protect its heritage infrastructure from more frequent inundations due to rising sea levels. The Italian city of Venice has meanwhile announced its plan to move away from fossil fuels, with the substitution of its iconic water buses, with electric ones, reducing emissions in public transport.

---

[18] *Milan's Climate City Contract – Zero Emissions by 2030*. Available at: https://www.comune.milano.it/en/web/milano-cambia-aria/-/climate-city-contract.-emissioni-zero-entro-il-2030

Bergamo, being a smaller city, is making significant strides in improving its energy infrastructure. They are transforming public open spaces for a more sustainable and economic urban environment, with the provision of solar energy to raise financial revenue for the city. To do so, among other measures, Bergamo is converting the city's public transport to be 100% electric, encouraging development around local skills and professions in line with a green economy.

Padua has focused on renewable energy and green building solutions. Solar energy is being used widely both in public and private sectors, as the city actively implements the retrofitting of buildings for increased use of solar power. Padua is also focusing on reducing car dependence, publicizing electric buses to reduce emissions even further.

Each of these Italian cities contribute in unique way to the 100 cities for Net-Zero program, reflecting the diverse challenges and opportunities present in Italy's urban environments. The overarching goal of all these cities is to become climate neutral by 2030, although the methods to reach it, vary based on local conditions and priorities. For example, Milan and Rome focus heavily on new mobility solutions, while cities like Venice must prioritize adaptation to the impacts of climate change.

Milan and Rome are two such cities where efforts to improve the sustainable mobility have started but they differ in scope. In Milan, this consists of a tool for discouraging congestion and encouraging cycling through the city's Ecopass system developments, while Rome is working to electrify its bus network and facilitate electric vehicle (EV) infrastructure development. Milan's focus - on integrating green spaces and energy efficient buildings - sets it apart as a leader in urban sustainability, with a more comprehensive approach to reducing emissions across multiple sectors.

In conclusion this paragraph serves as an overview of the initiatives of the Italian cities in the 100 Cities for Net-Zero, highlighting the different strategies adopted, leading to the common goal of reaching carbon neutrality.

3.3 Milan's Sustainability Journey

Milan, Italy's economic powerhouse, has emerged as a leading city in the !00 cities for Net-Zero initiatives. As an industrial hub, with a population of exceeding 1.3 million, reducing CO_2 emissions brings out considerable challenges for the city. Yet, by using targeted policies and innovations, it has become a model for urban sustainability.

Sustainable mobility accounts for a large percentage of Milan's achievements in reducing emissions. Traffic congestion and vehicle emissions have contributed to air pollution in a significant way for the city, with 30 % of total Milan emissions being produced by transport sector. In response, Milan launched the Area C[19] congestion charge, which charges a fee on vehicles entering the city center. This policy has led to 30% reduction in traffic, leading to a reduction in nitrogen dioxide, a key air pollutant.

Edoardo Croci, a renowned environmental economist and academic, played a critical role in the design and implementation of the Area C policy during his tenure as Milan's city councilor for mobility, transport, and the environment. His efforts in spearheading this initiative have significantly reduced emissions, making it a cornerstone of Milan's urban sustainability strategy.

Milan also wants to establish 1,200 electric buses in operation by 2030[20], all of which together would form its entire public transport fleet. Milan is also increasing its bike-sharing program, which includes 5,000 bikes, while adding more than 220 kilometers of new cycling paths since it began its green transition. Therefore, the city's transport system has set a goal to reduce transport emissions by 50% in 2030.

To improve the energy efficiency of its building stock, Milan has implemented several measures. With almost 60% of Milan's energy usage originating from residential and commercial buildings, the city has focused on retrofitting existing structures and improving the use of efficient technologies in new constructions. Bosco Verticale (Vertical Forest) is one of the key projects, developed by architect Stefano Boeri: it is made from two residential towers, both covered in over 20,000 plants and 800 trees that contribute to urban cooling and CO_2 reduction. The project demonstrates the city commitment to integrate green spaces with urban development, leading to measurable carbon reductions.

Furthermore, Milan offers financial incentives to support energy-efficient building, such as tax credits for insulation upgrades and renewable installations, contributing to an estimated 30% reduction in energy use in retrofitted buildings. The city aims for 100% of its new public buildings to be near-zero energy by 2030.

Milan has long been a frontrunner in the transition towards a circular economy, focusing on reducing waste, increasing recycling and reusing materials. Currently the city recycles about 58% of its municipal waste, which is one of the highest rates for a European metropolis and aims to reach 70% by 2030. The city's food waste program, implemented in partnership with NGOs, has made substantial progress. In Milan, its separate organic waste collection system processes 130,000 tons of

---

[19] *Area C Milano Guide – Zone C Hours, Map, Payment and more*. https://www.areacmilano.it/en

[20] City of Milan. 2023. *Milan's Climate City Contract – Zero Emissions by 2030*. https://www.comune.milano.it/en/web/milano-cambia-aria/-/climate-city-contract.-emissioni-zero-entro-il-2030

food waste each year, which is turned into high-quality compost and biogas. These efforts have decreased the amount of food waste in landfills by 12%, which is a way to reduce methane emissions.

Public involvement and synergy between local government and the private sector were crucial to the success in Milan. A public consultation process on sustainability initiatives is often held in Milan, ensuring that its citizens are active participants in climate action. Through the sharing cities initiative, Milan works with citizens on energy efficiency, e-mobility and digital innovation projects which have resulted in reducing energy consumption of households by 15- 20%.

An exemplary case of a public-private partnership in Milan is the "Sharing Cities" initiative together with London and Lisbon, as part of the European Commission's Horizon 2020 program. This project integrates smart solutions for the urban environment especially in the area of energy efficiency, mobility and digital infrastructure. A key result for Milan is the smart lampposts they installed in their city, which provide energy-efficient lighting, air quality sensors, and EV chargers stations. The initiative helps to lower energy consumption and also serves the city's advancing goal of increasing electric vehicle infrastructure. These scalable solutions that Milan has implemented are now possible due to a collaboration of public and private expertise and partnership with companies like Siemens, as well as local research institutions, which other cities in Europe can replicate.

Milan's ambitious goal to achieve net-zero emissions by 2030 requires ongoing innovation and investment. The city must further extend its sustainable transport systems and make building even more energy efficient to meet these targets. Milan has also set the objective to cut its carbon emissions by 45% by 2030, in line with EU targets. However, Milan is still facing challenges, particularly in balancing economic growth with sustainability efforts. The city continues to be a major center of finance and industry, which makes carbon emissions problematic for the sake of economy. Nevertheless, Milan's strategies and achievements make it a model for other cities in Italy and Europe seeking to follow a similar path toward carbon neutrality.

Figure 2: Bosco Verticale

3.4 Global Smart Cities Initiatives

Smart cities are emerging as a critical solution to global urban challenges, but approaches vary significantly across different parts of the world. European cities, backed by recently launched Green Deal and new initiatives such as 100 Cities for Net-Zero, are moving towards the deployment of renewable energy generation technologies in combination with innovative approaches on sustainable mobility and circular economy models. Milan, for instance, exemplifies the use of public-private partnerships in advancing sustainable urban projects. However, strategies adopted by smart cities in developing countries, often prioritize addressing infrastructure gaps and enhancing climate resilience.

In Costa Rica, the Greater Metropolitan Area of the Central Valley is undergoing a comprehensive energy transition, as highlighted by IRENA's report[21]. The area aims to increase the share of renewable energy, focusing on the integration of solar and wind energy projects with the objective to reduce fossil fuel dependence by 40% by 2030. This initiative is important for reducing the energy demand growth in one of the most rapidly urbanizing regions of the country, contributing to both economic and environmental goals respectively.

Similarly, in Wuzhong District, Suzhou, China, IRENA's "Net-Zero Pathways" report offers a detailed model for transitioning high demand urban areas to low carbon future. According to the report, China's cities like Wuzhong consume 85% of total energy use and are responsible for 70% of national CO2 emissions. This case study illustrates that even the most energy-intensive urban regions can develop a pathway to net-zero through creative energy management.

A notable emerging smart city is Nusantara[22], Indonesia's up-coming new capital to be developed on the island of Borneo. The announcement comes as Jakarta, the current capital and one of the world's fastest-sinking cities, faces critical environmental challenges, primarily flooding and rising sea levels, prompting the Indonesian government to relocate. Nusantara is intended to be launched by 2035, utilizing smart solutions for water resources and sustainable energy system in addition to green public transportation. The city will use solar and wind energy to power its infrastructure, supported by smart grids to optimize energy efficiency. With 100% of public transportation expected to be electric, Nusantara aims to be a model for climate resilience in Southeast Asia.

Indonesia's bold move to shift the capital reflects an essential global trend, resilience against climate change through smart city planning. The initiative is seen as a way to address both the environmental risks Jakarta faces and to present a vision of urban design for the future. This project will include data-driven sensors to build in intelligent water-management systems that can preemptively predict and manage drinking water distribution in flood-prone zones. The low power waste-to-energy system is an integral part of Nusantara smart urban planning, ensuring a minimal environmental footprint. This focus on technology showcases the interlinkage between smart infrastructure and climate resilience in emerging economies.

---

[21] International Renewable Energy Agency (IRENA). 2023. *Cities and Renewable Energy Reports*.
https://www.irena.org/Search?query=cities&orderBy=Date&orderBy=Relevance&contentType=2973584f-e344-4511-b43e-28543f6aede4
[22] *Nusantara – Indonesia's New Tech-Enabled Smart City*. https://govinsider.asia/intl-en/article/indonesias-new-capital-nusantara-to-become-tech-enabled-smart-city

These examples from Costa Rica, China and Indonesia show the diverse strategies employed globally to create sustainable cities. While Europe leads with coordinated regional efforts and advanced infrastructure, cities in developing regions are making strides by focusing on energy transitions, resilience to climate change, and addressing pressing urban challenges. The international cooperation, facilitated by platforms such as IRENA is essential in sharing best practices and advancing urban sustainability goals.

Additionally, as IRENA points out in its "Wuzhong District" report, the potential for green hydrogen could revolutionize how cities in regions with moderate renewable resources generate and store energy. In Wuzhong (China), pilot projects involve hydrogen as a central element in decarbonizing transport and heavy industries. By 2050, China aims to integrate hydrogen into its broader net-zero pathways, reinforcing the role that urban centers play in leading innovation for national sustainability goals.

With the combination of energy-efficient transportation systems, enhanced urban planning, and innovative solutions such as building-integrated photovoltaics (BIPV), these international smart city models not only drive their respective regions toward sustainability but also serve as important learning examples for other global cities. The success of these cities relies heavily on aligning local policies with global climate targets while fostering partnerships across sectors to meet ambitious net-zero goals.

Figure 3: Solar Panels

3.5 Masdar City - A Pioneer in Sustainable Design

Masdar City[23] is one of the most prominent examples of a smart city, which was established with a focus on sustainable urban development and renewable energy in order to set new standards for future urban projects, especially those implemented in arid areas. The city was developed in Abu Dhabi as part of UAE (United Arab Emirates) efforts to diversify its economy and reduce reliance on fossil fuels. Masdar City integrates advanced renewable energy technologies, urban design and smart infrastructure to create a nearly zero-carbon and zero-waste city.

One of the core aspects of Masdar City[24] is the intensive use of solar energy. It houses one of the largest solar farms in the Middle East and rooftop solar panels are installed throughout the city to meet its energy needs. For instance, the solar panels at IRENA's headquarters in Masdar generate more than 305,000 kWh of electricity every year, an amount equivalent to over 10% of the total building's energy demand. The city also uses much less energy than conventional buildings, in fact its infrastructure has been designed to use approximately 42% less energy than traditional ones. This is done through passive cooling techniques and smart energy systems that are crucial in Abu Dhabi's harsh desert climate.

Moreover, the city's buildings are strategically designed to optimize airflow. The angle and positioning of the buildings create natural wind tunnels that funnel cool air through public spaces and between structures, significantly reducing the need for air conditioning. These wind currents help cool the city, even during the hottest months, enhancing energy efficiency and occupant comfort.

In terms of water conservation, Masdar City has implemented systems that reduce water usage by 50% compared to conventional buildings in Abu Dhabi, and solar water heaters meet 75% of its hot water demand. The city's water management system enables the recycling of 80% of water, making it a global reference for sustainable water use in one of the most arid regions.

Masdar's global influence extends beyond Abu Dhabi through its partnerships. In 2023, Masdar and IRENA signed a Memorandum of Understanding to set a roadmap for COP28 Dubai, seeking to triple global renewable energy capacity by 2030. This initiative forms part of the UAE's larger climate action strategy, positioning Masdar as a global leader in renewable energy, with its projects spanning over 40 countries and generating nearly 20 GW of clean energy. This collaboration highlights the expansion of solar, wind and hydropower deployment, cementing Masdar as a driver of global sustainability.

When compared to other smart cities such as Songdo in South Korea or Copenhagen, Denmark, Masdar City stands out for being built from scratch with sustainability at its foundation. In contrast, Copenhagen focuses more on retrofitting existing infrastructure approach to achieve carbon neutrality by using wind and district heating systems. Meanwhile, Songdo shares Masdar's ambition as a purpose-built smart city, but with a focus on technology integration across urban services.

---

[23]   Irena. 2021. *Collaboration on Global Renewable Energy Roadmap for COP28*. https://www.irena.org/news/pressreleases/2023/May/Masdar-and-IRENA-set-a-roadmap-for-COP28-to-triple-global-renewable-energy-capacity-by-2030

[24] Masdar City. 2020. *A Template for Sustainable Urban Development*. https://masdarcity.ae/sustainable-urban-development/sustainable-design

Both cities serve as examples of how sustainability and smart technologies can transform urban living, though Masdar's primary challenge remains the financial and logistical complexities of large-scale sustainable development. Initially planned for completion by 2016, the project's timeline of Masdar City has been extended to 2030, with future goals of hosting 50,000 residents and attracting cleantech businesses.

Masdar City highlights how Abu Dhabi is transitioning towards a more diversified economy, moving away from its dependency on oil. Thanks to its environmentally sustainable power sources, water efficiency and climate-resilient infrastructure the city positions itself as testbed for innovative urban planning in extreme environments. Moreover, its collaborations with leading global organizations such as the International Renewable Energy Agency (IRENA) emphasize the city's role as a hub for renewable energy research and development, shaping the future of sustainable cities global.

Figure 4: Masdar city

3.6 The Role of International Organizations

The role of international organizations in promoting urban sustainability and renewable energy has become increasingly crucial as cities are now central to tackling climate change. Agencies like the United Nations have played a significant role in providing frameworks and policies that guide cities towards sustainable development. Among them, UN-Habitat and the United Nations Framework Convention on Climate Change (UNFCCC) stand out for their contribution in urban sustainability.

An important international actor in promoting sustainable urban development is UN-Habitat[25], the UN agency for human settlement. Its New Urban Agenda, adopted in 2016, calls for cities to prioritize sustainability in their infrastructure, governance and economic system. This agenda aligns with the Sustainable Development Goal (SDG) 11. By supporting smart city projects, affordable housing programs and climate adaptation policies, UN-Habitat can assist cities across the world to lower their environmental impact while promoting social equality.

UNFCCC (United Nations Framework Convention on Climate Change) also plays an important role, by integrating cities within global climate action frameworks. These global climate conferences, from the auspices of the Paris Agreement[26] and carrying onwards even into COP26 in 2021, have highlighted the importance of cities in achieving global climate targets. Cities are major emitters of greenhouse gases and the UNFCCC frameworks are a key guide for what needs to be done in urban areas in order to decarbonize. As cities contribute to about 70% of CO_2 emissions by global cities, negotiating climate agreements at city level and enforcing emission policies in alignment global carbon reduction targets has become increasingly important for local governments.

Global organizations such as IRENA[27] (International Renewable Energy Agency) also play a key role in advancing renewable energy in urban settings. In particular, IRENA targets renewable energy deployment in cities and in developing countries. Its most recent reports such as those on Wuzhong District, Suzhou and the Greater Metropolitan Area in Costa Rica, demonstrate practical transition pathways to clean energy use within cities, with a particular focus on solar power, wind energy and hydrogen technology integration into an urban infrastructure. IRENA's guidance is particularly valuable for cities with high energy demand and scarce local renewable resources, which face complicated transitions to a low-carbon future.

A major step forward in the global conversation around cities and climate change is the Intergovernmental Panel on Climate Change (IPCC) announcement of their new Special Report on Cities and Climate Change as one of three special reports within AR7 cycle. Announced in August 2024 in Sofia, Bulgaria, this report applies to cities that need to adapt and mitigate their realities with

---

[25] United Nations Human Settlements Programme (UN-Habitat). 2016. *New Urban Agenda*. https://unhabitat.org/sites/default/files/2019/05/nua-english.pdf

[26] United Nations Framework Convention on Climate Change (UNFCCC). 2015. *The Paris Agreement*. https://unfccc.int/sites/default/files/resource/parisagreement_publication.pd

[27] International Renewable Energy Agency (IRENA). 2020. *Rise of Renewables in Cities: Energy Solutions for the Urban Future*. https://www.irena.org/publications/2020/Oct/Rise-of-renewables-in-cities

global climate changes. This is the first time cities will receive dedicated attention in an IPCC[28] report, reflecting their central role in fighting climate-related challenges. The report fills a critical gap by examining how urban planning, infrastructure development, and energy transitions can be coordinated in order to also meet global climate objectives.

The special emphasis on cities by the IPCC underscores the growing recognition that urban areas are both vulnerable to climate change and essential to solving it. Cities face distinctive challenges such as sea-level rise, heatwaves, and air pollution; but they also offer unparalleled opportunities for climate mitigation through dense populations, innovation hubs, and resource efficiency. The IPCC's new special report is to enable cities to implement climate science into urban planning on a path towards more resilient and sustainable futures.

In conclusion, the combined efforts of international organizations such as UN and IRENA, play a crucial role in shaping the global response to urban sustainability. These agencies provide the frameworks, technical expertise, and financial resources that cities need to transition toward climate resilience and decarbonization. The upcoming IPCC Special Report on Cities and Climate Change underscores the importance of cities in climate action, identifying that international cooperation will be crucial to providing sustainable urban futures.

---

[28] Intergovernmental Panel on Climate Change (IPCC)**.** 2024. *Special Report on Climate Change and Cities*. Agreed outline at the 61st Plenary Session in Sofia, Bulgaria. https://sdg.iisd.org/news/ipcc-agrees-outlines-of-reports-on-cities-short-lived-climate-forcers/

CONCLUSION

The development of Smart Cities has demonstrated that urban innovation is essential for a sustainable future. Throughout this thesis, it has become clear that Smart Cities are not just a technological response to urban challenges, but a crucial component of broader efforts to combat climate change and promote social equity. By integrating smart technologies, cities can lower carbon emissions, enhance public services, and create more livable environments for residents.

However, the success of Smart Cities depends on overcoming significant obstacles. Financial constraints, the digital divide, and resistance to change can limit the adoption of smart solutions, especially in developing regions. Moreover, inclusivity remains a pressing concern, as some communities risk being left behind in the transition to more tech-driven urban systems. It is essential that Smart City initiatives not only prioritize environmental and economic sustainability but also ensure that all residents benefit from these advancements.

International collaboration and strong local governance will play a key role in scaling these solutions globally. The examples discussed, such as the EU's 100 Cities for Net-Zero initiative, highlight how cities can work together to share best practices and align with global climate targets. As urban populations grow, the role of cities in shaping sustainable development becomes even more critical.

In conclusion, Smart Cities have the potential to redefine urban living by fostering innovation, sustainability, and inclusivity. Their success in aligning with global sustainability goals will determine the future of urban development, making them indispensable in the fight against climate change and in creating a more equitable world for future generations.

BIBLIOGRAPHY

1. **City of Copenhagen**. 2023. *Copenhagen Carbon Neutral by 2025*. State of Green. Available at: https://stateofgreen.com/en/solutions/copenhagen-carbon-neutral-by-2025/
2. **City of Milan**. 2023. *Area C Milano Guide – Zone C Hours, Map, Payment, and more*. Available at: https://www.areacmilano.it/en
3. **City of Milan**. 2023. *Milan's Climate City Contract – Zero Emissions by 2030*. Available at: https://www.comune.milano.it/en/web/milano-cambia-aria/-/climate-city-contract.-emissioni-zero-entro-il-2030
4. **Copenhill.** 2020. *Waste-to-Energy Plant and Public Facility: A Model of Urban Sustainability*: https://www.copenhill.dk/.
5. **GovInsider**. 2023. *Nusantara – Indonesia's New Tech-Enabled Smart City*. Available at: https://govinsider.asia/intl-en/article/indonesias-new-capital-nusantara-to-become-tech-enabled-smart-city
6. **Intergovernmental Panel on Climate Change (IPCC)**. 2023. *AR7 Cycle: Cities at the Forefront of Climate Action*. Available at: https://www.ipcc.ch/reports/ar7/
7. **International Energy Agency (IEA)**. 2021. *World Energy Outlook Special Report: Cities and Energy Transition*. Available at: https://www.iea.org/reports/cities-and-energy-transition
8. **International Renewable Energy Agency (IRENA)**. 2020. *Renewable Energy Solutions for Climate-Safe Cities*. Available at: https://www.irena.org/News/articles/2020/Nov/Renewable-Energy-Solutions-for-Climate-Safe-Cities
9. **International Renewable Energy Agency (IRENA)**. 2020. *Renewable Energy in Cities: Energy Solutions for the Urban Future*. Available at: https://www.irena.org/publications/2020/Oct/Rise-of-renewables-in-cities
10. **International Renewable Energy Agency (IRENA)**. 2023. *Masdar and IRENA Set a Roadmap for COP28 to Triple Global Renewable Energy Capacity by 2030*. Available at: https://www.irena.org/news/pressreleases/2023/May/Masdar-and-IRENA-set-a-roadmap-for-COP28-to-triple-global-renewable-energy-capacity-by-2030
11. **International Renewable Energy Agency (IRENA)**. 2023. *Net-Zero Pathways for Cities: The Case Study of Wuzhong District, Suzhou, China*. Available at: https://www.irena.org/publications/2023/Mar/Net-Zero-Pathways-for-Cities
12. **International Renewable Energy Agency (IRENA)**. 2023. *Urban Energy Transition for the Greater Metropolitan Area of the Central Valley of Costa Rica*. Available at: https://www.irena.org/publications/2023/Urban-Energy-Transitions-Central-Valley-Costa-Rica
13. **Seoul Metropolitan Government**. 2020. *Smart Waste Management System in Seoul*. Available at: https://english.seoul.go.kr/smart-waste-management-system
14. **UK Government**. 2019. *Fix My Street App and Public Service Digital Solutions*. Available at: https://www.gov.uk/fix-my-street
15. **United Nations Framework Convention on Climate Change (UNFCCC)**. 2015. *The Paris Agreement*. Available at: https://unfccc.int/sites/default/files/resource/parisagreement_publication.pdf
16. **United Nations Human Settlements Programme (UN-Habitat)**. 2016. *New Urban Agenda*. Available at: https://unhabitat.org/sites/default/files/2019/05/nua-english.pdf

17. **World Bank**. 2023. *Climate Investment Funds: Supporting Sustainable Urban Development*. Available at: https://www.climateinvestmentfunds.org/topics/cities