

# Sustainable Cities and green technology integration: Case Study and Best Practices

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## Abstract

Sustainability refers to the ability to maintain or support a process continuously over time. In business and policy contexts, sustainability seeks to prevent the depletion of natural or physical resources, so that they will remain available for the long term.

This paper discusses about the top three sustainable cities around the globe which are Tokyo, Oslo and Stockholm and also their method which helped those cities to achieve sustainability. This paper mainly focuses on the environmental sustainability and the infrastructure built or being built by those cities.

The focus of this paper will be on comparing those cities on the basis of PM2.5 concentration, use of renewable energy and other factors. This paper also tries to give various measures that can be applied in other cities around the globe in order to achieve sustainability.

## Keywords:

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1.Pollution Index 2. Sustainability 3. Urban Sustainability 4. Sustainable Development Goal (SDG's) 5.PM2.5 concentration 6.Renewable energy resource 7. Electric Vehicles 8.Infrastructure

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## Introduction

There have been great discussions on how to achieve sustainability on both national and international level. Sustainable development is a concept that first emerged with the publication of the Brundtland Report in 1987. He warned about the negative effects of economic growth and globalization on the environment and sought to find possible solutions to the problems caused by industrialization and population growth. Sustainable development requires an integrated approach that takes into consideration environmental concerns along with economic development. Many countries have come together to talk and find a solution to achieve sustainability with the intention that it should neither affect their economic growth or their development in any other aspect. It is expected that a country or state should not only be developed, rather it should sustainably developed.

Here, Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs and Sustainability is the foundation for today's leading global framework for international cooperation—the 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs). So, In order to achieve the sustainable development, United Nation (UN) held a conference in Stockholm, Sweden in 1972 which was the first conference for the United Nation to be focused on the issues related to the environment. Since the landmark 1972 Stockholm Conference on the Human Environment, the issue of the environment has been placed within the framework of sustainable development. All of the UN's Sustainable Development Goals (SDGs) have some connection to the environment. The SDGs with a direct connection are Goal 6 (Clean Water and Sanitation), Goal 7 (Affordable and Clean Energy), Goal 11 (Sustainable Cities and Communities), Goal 12 (Responsible Consumption and Production), Goal 13 (Climate Action), Goal 14 (Life Below Water), and Goal 15, (Life on Land).

The United Nations Sustainable Development Goals (SDGs) are the goals that all 191 UN Member States have agreed to try to achieve by the year 2030.

This research paper emphasizes on top cities around the globe that have achieved sustainability and are considered to be sustainable on not on the country level but internationally. It also focuses on the problem faced by those cities before adopting the change and how they tackled it by their different policies and rules.

It also emphasizes on the point or the policies of the cities that they adopted to achieve sustainability which can also be applied in other cities around the globe or even internationally.

### I. Objective of the Study

The main objective of the study is to understand the main importance of the sustainability and sustainable development which is done by examining various other cities that have achieved the sustainability or are very close to achieve it.

This paper discusses about the main issues in those cities such as Carbon Dioxide emission, PM2.5 concentration and the overall pollution, which was affecting the cities negatively, and it discusses about the solutions that the government of those cities opted in order to eradicate or minimise those problem.

This paper also tries to give the solution to various environmental issues in other cities by citing the solution of above said cities so that other cities around the world can also achieve sustainability like them.

It also tells us that how various cities/countries are shifting from fossil fuels to renewable energy resource and how other cities can also achieve that. It also focuses on the matter of the governments of Tokyo, Oslo and Stockholm, promoting the electric vehicles and public transport.

## II. Research methodology

This research paper follows the both methodology i.e., comparative study and library study. Comparative method is about looking at an object of study in relation to another. The object of study is normally compared across space and/or time. In addition, library research is a method of collecting data by studying and understanding data that is closely related to problems from books, theories, and documents, where the data taken is in the form of primary data.

This research paper compares the PM2.5 concentration in three of the cities, which are Tokyo, Oslo, and Stockholm. It also further compares the sales of the Electric Vehicles between Stockholm and the Oslo and the use of renewable energy resources in all the three cities. It also follows the library study approach as this paper also discusses about the various environmental issues faced by the three cities and what are they doing to overcome these environmental issues. It also discusses about the changes made by those cities through their various policies and their upcoming projects.

### III. Data Analysis

#### Tokyo:

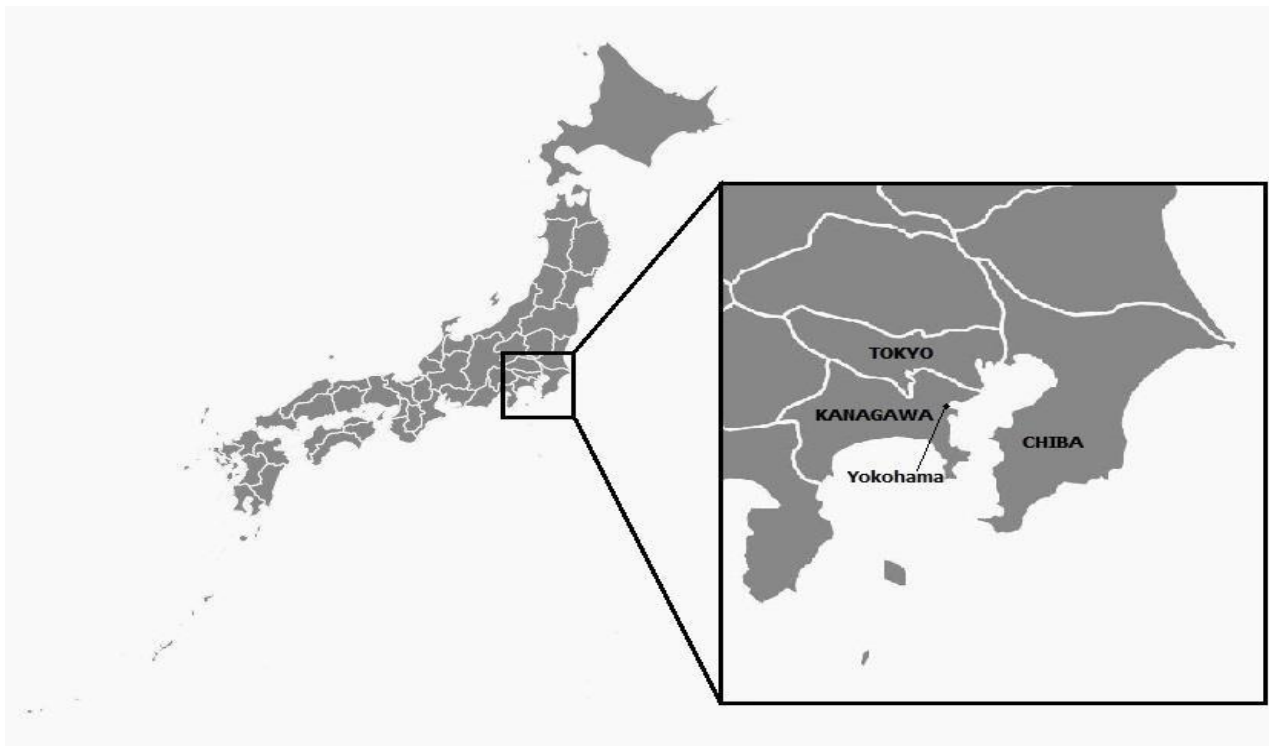


Fig 1.a Tokyo (Capital city of Japan)

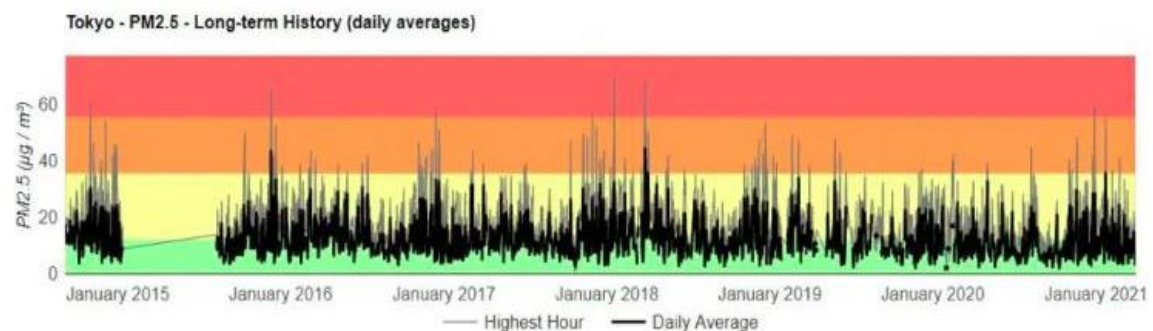
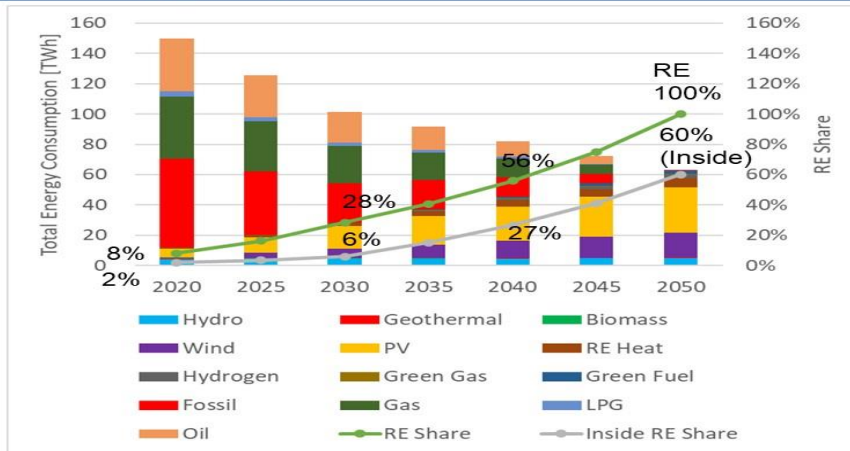


Fig 1.b PM2.5 concentration in Tokyo, Japan. It can be observed that the PM2.5 concentration has been significantly decreased in Japan in 2021 as compared to the previous years.

**“Renewable Energy 100% scenario in Tokyo by 2050”  
Total energy composition in the 100% renewable energy scenario**



\* 50% renewable energy electricity case in 2030

Fig 1.c Trend for the use of renewable source of energy in Tokyo, Japan. It can be seen that the use of the renewable energy resources is increasing every year in Tokyo and they are planning to replace the fossil fuels completely by the year 2050.

**Stockholm:**

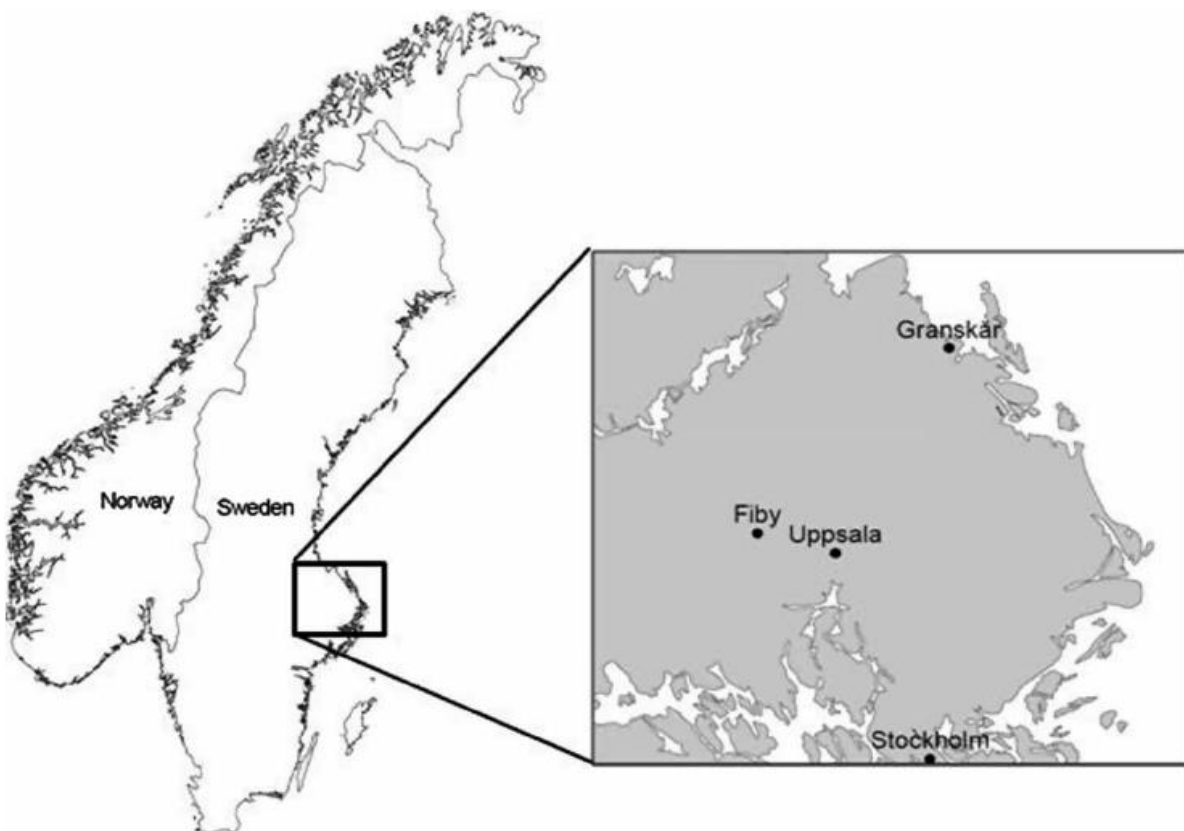


Fig 2.a Stockholm (Capital of Sweden)

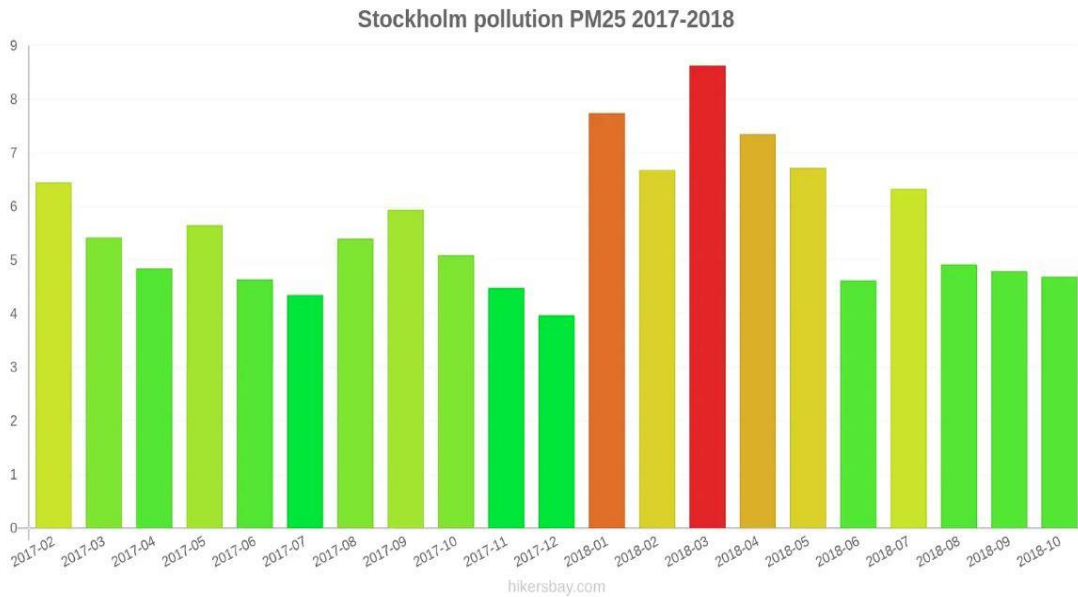


Fig 2.a PM2.5 concentration in Stockholm, Sweden. It can be observed that the PM2.5 concentration in Stockholm has been almost constant in the last few years while it hit the highest in the year 2018.

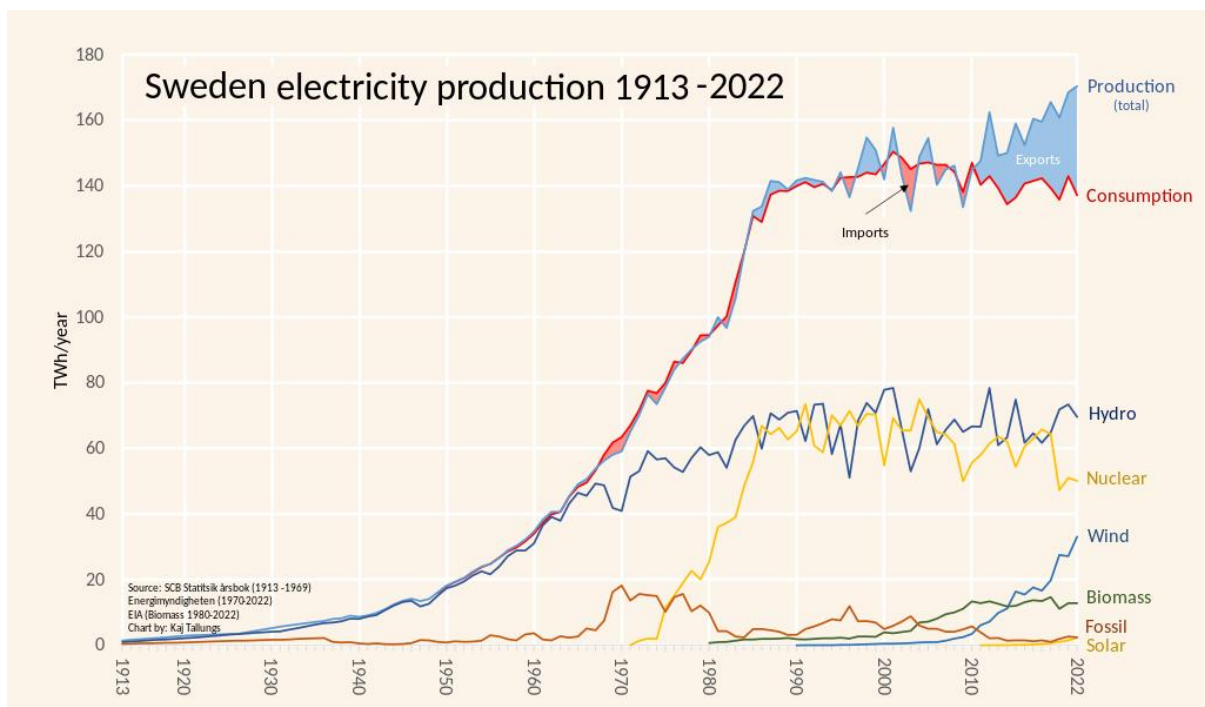


Fig 2.c Trend for the use of renewable energy resources for electricity production Stockholm, Sweden. It can be seen that the use of Hydro, Nuclear, Wind, Biomass has increased in 2022 as compared to the previous year as we can see a positive trend in the graph

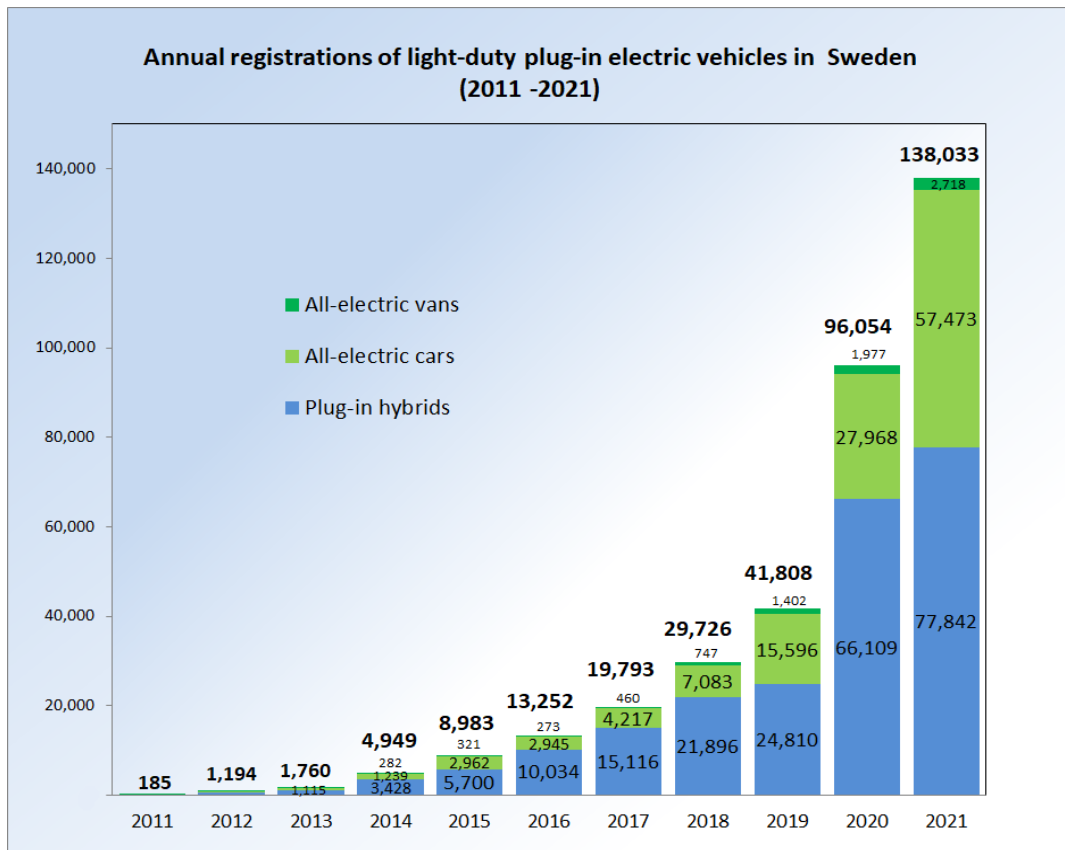


Fig 2.d Sales of Electric vehicle in stockholm, Sweden. The sales of electric vehicle increasing every year as a planned by the government in order to achieve sustainability.

Oslo



Fig 3.a Oslo (Capital of Norway)

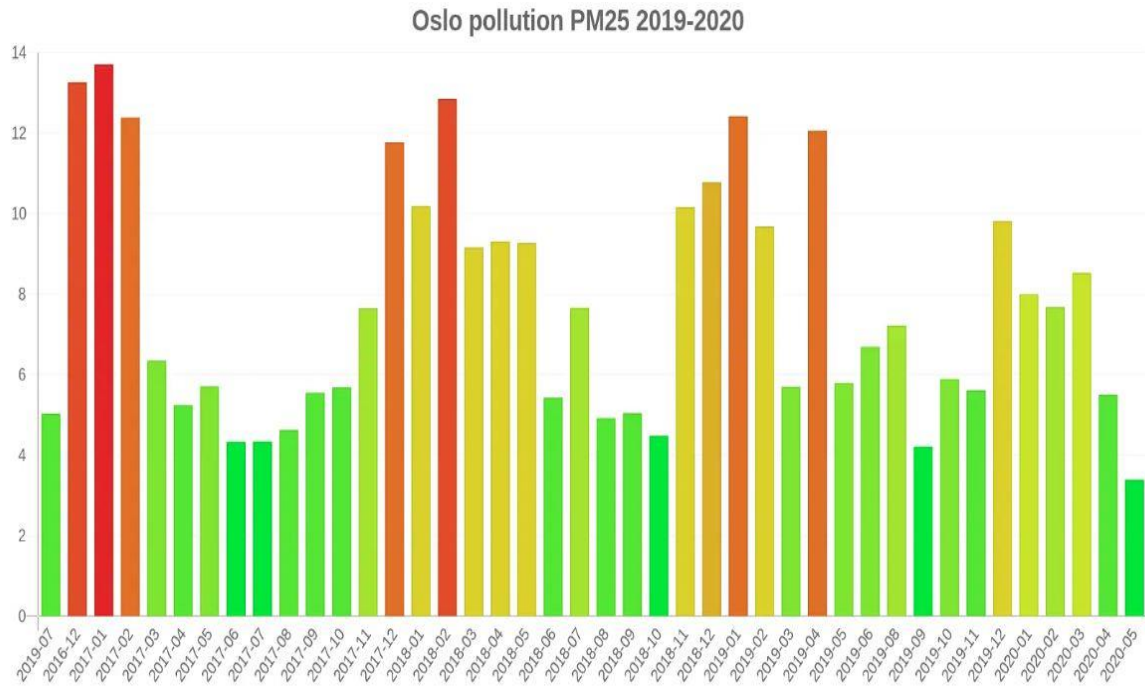


Fig 3.b PM2.5 Concentration in Oslo,Norway.The PM2.5 Concentration has hit its all time lowest in the year 2020 in the month of may.

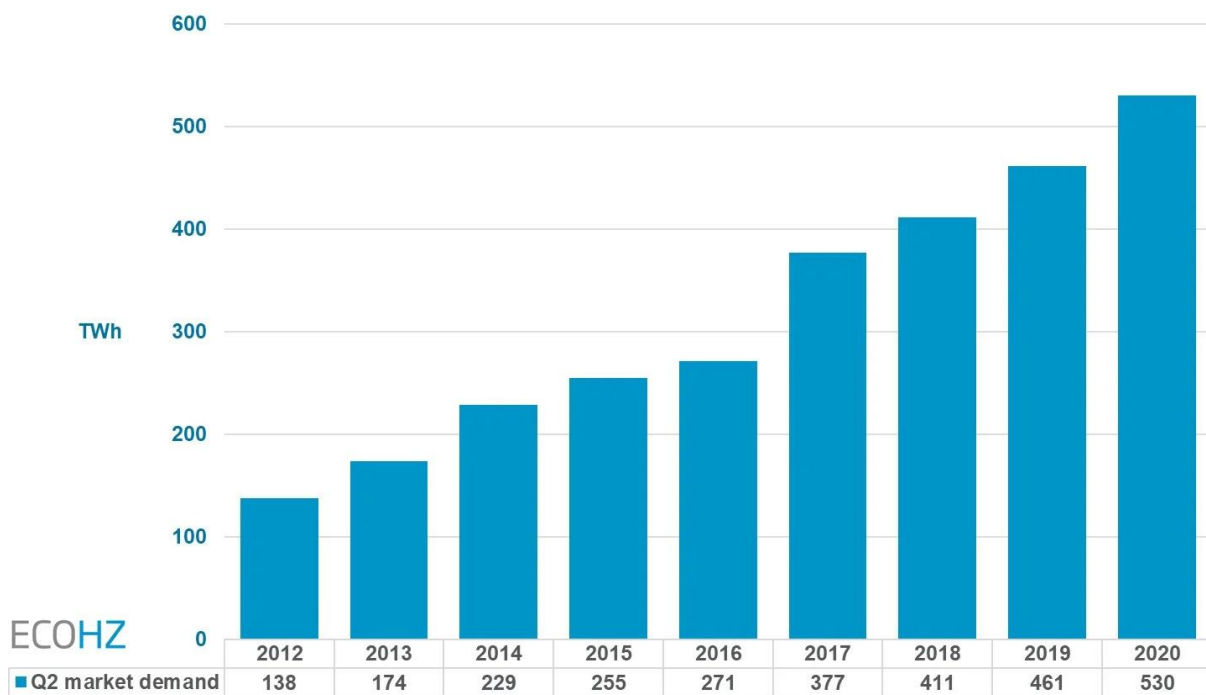


Fig 3.c It has been seen that there is a gradual increase in the demand for the renewable energy in the european cities including Oslo and Stockholm which has helped many european cities to emerge as sustainable cities especially, Oslo

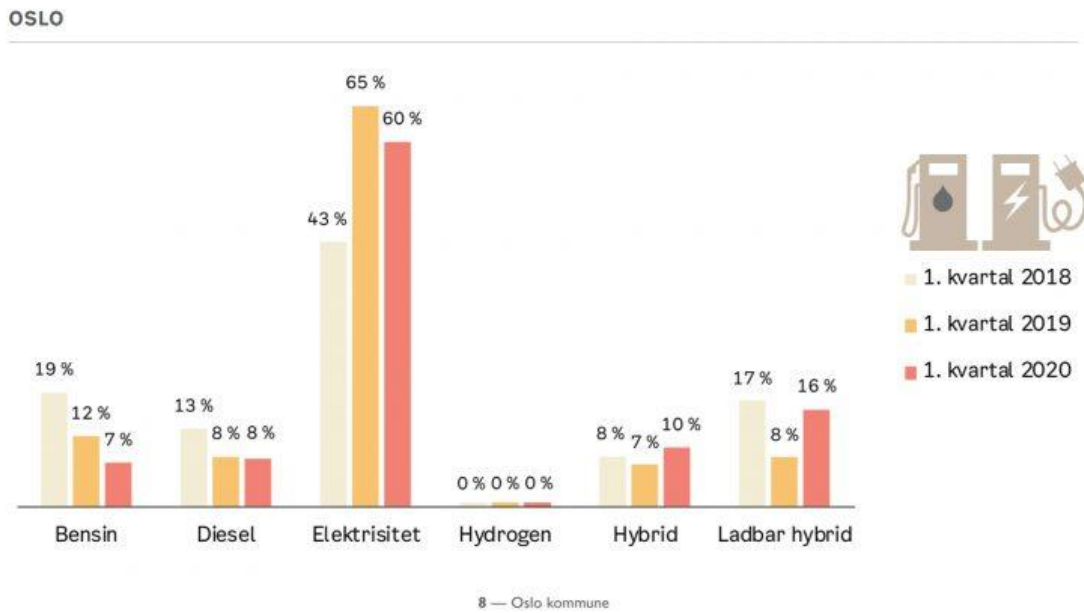


Fig 3.d Sales of electric vehicles in Oslo, Norway. The use of Electric vehicle has been the highest in Oslo with 43%,65% and 60% in the year 2018, 2019 and 2020 respectively as compared to the diesel , hydrogen or bensin cars.

#### IV. Discussion

##### Case study 1: Tokyo

Tokyo is the capital of Japan, located in North-east Asia, with 14.06 million population. Major challenges facing Tokyo are the ageing population and decline in birth rates. Japan has faced crises of climate change, global warming, and CO2 emissions, unpredictable extreme weather conditions and diseases, and so has Tokyo.

Tokyo Metropolitan Government formulated a strategy "Tokyo's Long-Term Strategy" in March 2021 to encourage sustainability and inclusive growth where no one is left behind in society. It was upgraded to have three main directions: first, Creation of Sustainable city using green technology and urban development even during ageing population. Second, digital transformation and third, establish a new environment that creates a standard and opportunities for everybody.

TMG formulated Strategies to lower carbon emissions in 2017 towards net zero emissions by 2050 and further, decarbonisation in world. TMG in need to decarbonize the city launched Zero Emissions Strategy, to purify Tokyo from carbon by 2050. The tracing of carbon source concluded two roots: power generation and Urban activities. Approximately 70% of emissions are related to power consumption. A roadmap was adopted with three stages: limit temperature increase, reduce CO2 emissions and decarbonisation using next-generation technologies.

The Zero Emission Execution Plan Targets Industry sector, Energy sector, Building sector and transport Sector.



The industry sector is reformed by focusing on 3Rs, Plastic control, Zero food waste and Fluorocarbons Control. Energy Sector shifts its source to renewable sources especially, Hydrogen and Solar. Tokyo's solar electricity installation has increased 10 times from 2008 to 2017. This is to promote decarbonisation of thermal energy and utilization of locally available renewable sources.

Zero Emissions Buildings and Vehicles and Energy sufficient home appliances were encouraged. Replacing conventional fridge, TV, air-conditioners and lights with non-conventional ones, 459kg (about 1011.92 lb.) of CO<sub>2</sub> would be saved per household and 3.7 million from all. TMG will continue full scale promotion of Electrical vehicles, EV chargers and Hydrogen stations to build supportive infrastructure.

Reforms related to resource consumption are disposable lifestyle, utilization of ICT technology, green technology, Expanding the use of eco materials, Ensuring entirely green procurement in companies

There are 20+1 strategies for 2030 and 122 projects for executing strategies that are envisioned for 2040's Tokyo. Initiatives taken mainly from the perspectives of integrating green technology includes Strategy for making Tokyo a city filled with water and Greenery and Strategy for Zero Emission Tokyo.

Tokyo Smart Agriculture, Forestry and Fishery Project aims at improving productivity by using cutting-edge technologies. Promotion of Agri-Tech in R&D platform, creation of cloud system to report forest related information and operate a system to improve efficiency and safety of fishing operations.

## **Case Study 2: Stockholm**

**Stockholm** is the capital of and most populous city in Sweden as well as the largest urban area in the Nordic countries. Approximately 1 million people live in the municipality,<sup>[9]</sup> with 2.1 million in the urban area, and 2.4 million in the metropolitan area.

One of the major environmental issue faced by the Stockholm is the vehicular pollution despite the fact that the major portion of the population use cycles for their daily commute.

Stockholm has a long history of conducting methodical research on the environment and climate. The City has worked diligently to construct well-developed infrastructure for transportation, electricity, garbage, water, and sanitation since the early 1900s. In the 1970s, the City enacted its first environmental program. Hammarby Sjöstad was the first development area in Stockholm to be given an environmental profile in the middle of the 1990s and Stockholm was designated as the first European Green Capital in 2010.

Sweden has a long history of effective governance that manages forests and landscapes with multiple uses, in addition to knowledge-based laws. Sustainability is important for Sweden's public transportation systems, which include electric trains and eco-friendly buses that run on biogas and ethanol. At least 98% of the new trams purchased by Stockholm Public Transport (SL) are recyclable. It solely purchases clean electricity from hydroelectric or wind sources for trains. In Stockholm, the entire underground network is powered by green electricity, and as of 2017, all buses are powered by renewable fuels, exceeding the 2025 target.

Sweden is on track to become the first country in the world without fossil fuels. The Swedish government founded Fossil Free Sweden in advance of the COP21 climate change conference in Paris in 2015. Sweden set aside \$3.5 million in 2016 for R&D in renewable energy in India. Sweden has passed a new climate law obliging it to achieve zero emissions by 2045. Sweden wants to eliminate all atmospheric greenhouse gas emissions. 70% of the emissions from transportation are expected to decrease by 2030.

Sweden's international outreach initiatives are sustainable. The primary motto of Sweden's agricultural community is "financial and environmental sustainability." Sweden is establishing a flexible agricultural framework that supports global food security in emerging markets. This approach does not lead to the most affordable solution for the nation's customers. The Swedes, however, have staked that the short-term expense is worthwhile in order to invest in national sustainability and international security.

### **Case Study 3: Oslo**

**Oslo** is the capital of Norway and its largest city. It is a municipality as well as a county. The population of Oslo municipality was 709,037 in 2022, 1,064,235 in the city's wider urban area, and 1,546,706 in the metropolitan region, according to estimates from 2021.

The main environmental issue faced by Oslo, Norway was the "Air Pollution" just like any other major capital city of the world but Oslo faced it quite nicely and tackled this problem very smartly.

The city relies heavily on renewable energy sources, including hydroelectricity, which accounts for about 60% of the city's total energy use. Since 2013, the Norwegian capital has significantly reduced its emissions and is on track to reach a near-zero emissions target by 2030.

The city is monitoring and recording its emissions across the board, and the municipal fund is investing in renewable energy projects instead of fossil fuels. The city is aiming for a car-free citycentre, and is offering incentives such as electric transport bicycle credits, improved access to public transport, waived tolls on electric cars, and tax credits.

The city has put a lot of effort into promoting public transport and cycling. The city has extended and improved the quality of the public transport infrastructure, introduced real time information, digital ticketing, and an "enhanced travel guarantee" covering 10-service related issues. Apart from the toll ring (which is used to finance improvements in the public transport), the city has a restrictive parking policy, including the removal of spaces and increasing the fees, to discourage the use of cars in the city. The city has good car and bike sharing schemes, and is experimenting with fossil free construction.

The city is promoting electro-mobility in a variety of ways, such as free parking, bus lane access grants, EV charging points, and a fossil free target for the bus company. The municipality is also replacing its fleet of cars with electric vehicles, and there are electric scooters all over the city. In line with the city's compact city vision, Oslo is reshaping its infrastructure accordingly.

## V. Implication of those cities

From the above-discussed case studies, it can be implied that:

### In Tokyo, Japan:

- Focusing on the 3Rs, Plastic Control, Zero Food Waste, and Fluorocarbons Control has helped to change the industrial sector. The energy sector is switching to renewable energy sources, particularly solar and hydrogen. From 2008 to 2017, Tokyo's solar electricity installation expanded by a factor of ten. This is done to encourage the use of locally accessible renewable energy sources and the decarbonisation of thermal energy.
- By switching out conventional refrigerators, TVs, air conditioners, and lights with non-conventional ones, 3.7 million pounds (or 459 kg) of CO<sub>2</sub> would be saved worldwide. To provide the necessary infrastructure, TMG will continue its extensive promotion of electric vehicles, EV chargers, and hydrogen stations.
- use of ICT technology, adoption of green technologies Increasing the usage of eco-friendly materials ensuring that firms only purchase green products

### In Stockholm, Sweden:

- In Stockholm, all buses are powered by renewable fuels as of 2017, exceeding the 2025 target, and the whole subterranean network is powered by green electricity.
- At least 98% of the new trams purchased by Stockholm Public Transport (SL) are recyclable
- A flexible agricultural framework that supports global food security in developing markets is being established by Sweden.

### In Oslo, Norway:

- The city relies heavily on renewable energy **sources** such as hydroelectric power, which account for approximately 60% of the city's total energy consumption.
- The city fully monitors and records the Carbon dioxide emissions, and the city is also investing in renewable energy projects instead of fossil fuels.
- Communities are also replacing cars with electric vehicles, and the electric scooters are also available throughout the city

### *What measure can the other cities apply to achieve sustainability?*

The other cities around the world can adopt many policies of Tokyo, Stockholm and Oslo to achieve the sustainability such as:

1. Invest more in the renewable energy resources
2. Spread awareness among the uneducated citizens in order to have a unified action in achieving the sustainability.
3. The city officials or the government should promote the use of bicycle in short commute which can further help in reducing the carbon footprint.
4. The government should invest their time and money in making the industries to shift to renewable energy resources rather than the fossil fuels.
5. Like Oslo, the electric vehicles should be promoted so that the electric vehicles can replace most of the vehicles.

6. The cities should invest in making the public transport into electrical as well as good enough for the public so that they can be more drawn towards the public transport rather than their personal vehicles.
7. The city should aim for a car-free city centre, and should offer incentives such as electric transport bicycle credits, improved access to public transport, waived tolls on electric cars, and tax credits.
8. As it is known that, many cities/countries have agriculture as their main occupation so the city/country should make an infrastructure that support the farmers as well as help the city to achieve sustainability such as establishing a flexible agricultural framework that supports global food security in emerging markets.
9. The city should promote shared car and bike rides.
10. They should constantly monitor the environmental condition of their surroundings.

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