Towards a Net Zero Future

White Paper on Taipei City 2050 Net Zero Actions

TAIPEI
臺北

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Mayor's Preface

As the effects of global climate change intensify, countries worldwide are experiencing increasingly severe climate disasters. Since the adoption of the Paris Agreement in 2015, the year 2021 has reached a new milestone for humanity in the fight against climate change. At the UN COP 26 climate summit, states and parties have signed the Glasgow Climate Pact, which requires human society to achieve net-zero emissions by mid-century. In the European Union and major trading nations such as the United States and Japan, the integration of net-zero emissions within the context of international economic trade rules, e.g., carbon tariffs, is gradually putting into practice. As a member of the global village, Taiwan is bound to be affected by this trend. We must prepare for the response measures as soon as possible.

On Earth Day in 2021, Taipei City has declared its commitment to jointly achieve the goal of net-zero emissions by 2050 to ensure climate safety with countries and cities worldwide. At the same time, under the global trend of net-zero pledges, we hope to transform the challenge of carbon reduction into a driving force for the City's industrial and energy transition. As such, we can seize the opportunity for urban climate transition to drive the growth of the City's green economy, create quality job opportunities, and build a livable and sustainable city.

To move towards a zero-carbon Taipei, Taipei City has proposed the 2050 net-zero emissions pathway, a no-regret policy for the City’s urban competitiveness in the next three decades. We cannot and will not go backward. The major sources of carbon emissions in Taipei City can be categorized into three sectors: residential and commercial, transportation, and waste. The residential and commercial sector focuses on developing smart and zero-carbon buildings. In the transportation sector, the pathway of promoting low-carbon green transportation is emphasized. As for the waste treatment sector, the principle of “full-recycling and zero-waste” needs to be implemented. These three pathways form the core to achieving net-zero emissions.

This year, the City Government has proposed an action plan based on the net-zero pathway, with approximately over NT$ 27 billion budget related to climate construction, covering 150 projects. In the meantime, we have proposed the “Taipei City Self-Government Ordinance for the Management of Net-Zero Emissions” as the principle for long-term net-zero policy, regulating necessary measures for carbon reduction and adaptation. Achieving net-zero emissions depends not only on one city’s efforts but also on the central government and national policies, such as accelerating energy transition and imposing a carbon fee. Through the cooperation between the central and local government, public-private partnerships among governments, communities, and companies, aided with behavioral changes of citizens, we will move forward together towards the vision of a zero-carbon Taipei.

Wen-Je Ko

Wen-Je, Ko

Mayor of Taipei City

2050 TAIPEI

Towards a Net Zero Future

Executive Summary

To tackle the global climate crisis brought by climate change, the world's nations agreed to adopt the Paris Climate Agreement in 2015 to jointly reduce greenhouse gas emissions and make efforts to limit global temperature rise to 1.5°C above pre-industrial levels. In 2018, a UN science report pointed out that global warming continues to worsen, and to prevent climate change from becoming an irreversible disaster, humanity must "achieve net-zero emissions by 2050".

As a member of the global village, Mayor Wen-Je, Ko declared a commitment to achieve the vision of 2050 net-zero emissions with the global trend on Earth Day in 2021. In addition, Taipei City proposed the 2050 net-zero emissions pathway in October 2021, becoming the first government organization to take the lead across the entire nation. In the next three decades, the City's promotion of carbon reduction in the residential and commercial sector, transportation sector, and the waste sector will be centered on three core pathways: smart and zero-carbon buildings, low-carbon green transportation, and zero waste, full recycling. Taipei City will make efforts to reduce carbon emissions by 30% by 2030 (compared to 2005), cut carbon emissions by 65% by 2040, and achieve net-zero emissions by 2050.

To implement net-zero practices, the City Government has proposed related policies and action plans drawing on the three core pathways (cont. on page 4):

Smart and Zero-Carbon Buildings

The primary source of carbon emissions from the residential and commercial sector comes from the daily activity in houses and office buildings, making the use of energy and resources within buildings an essential key to carbon reduction. Energy use in buildings can be managed and controlled through a series of measures such as energy efficiency requirements for new buildings, renovation of existing buildings, and inventory and disclosure of energy efficiency for new and existing buildings. Eventually, renewable or hydrogen energy will substitute for power use in buildings to achieve the goal of smart and zero-carbon buildings. The net-zero emissions pathway of the residential and commercial sector mainly builds on policies including the "Residential and Commercial Electricity Saving Project 2.0", demonstration of net-zero public buildings, transition to zero-carbon buildings, and low-carbon living development. Ten action plans such as replacing high energy-consuming equipment and counseling energy conservation of industrial and commercial businesses are implemented.

2030

- New buildings comply with grade 1 energy efficiency standard
- Public buildings renovate 27% of the total floor area
- Introduce energy efficiency inventory and disclosure in public/new buildings
- Implement a cap-and-trade system
- Net-zero demonstration of TOD/EOD/social housing
- Introduce the use of renewable energy
- Demonstration of hydrogen fuel cell adoption

2040

- Public/new buildings comply with 1^+ grade energy efficiency standard
- Public buildings renovate 57% of the total floor area
- New buildings utilize 10% renewable/hydrogen energy
- Commercial buildings comply with grade 1 energy efficiency standard
- Expand the use of renewable energy/ hydrogen fuel cell

2050

- New buildings comply with regulations of zero-carbon buildings
- Commercial buildings comply with grade 1^+ energy efficiency standard
- General buildings comply with grade 1 energy efficiency standard
- Adopt 55% of renewable/ hydrogen energy in buildings (20% for general buildings)

Low-carbon Green Transportation

Based on the construction of public green transportation, Taipei City improves the replacement for low-carbon vehicles and creates a user-friendly environment for green transportation. In addition, combined with the City's continual development of novel energy vehicles, the designation of "Low-carbon Transportation Zones" will effectively lower the carbon emissions within the municipality. The net-zero emissions pathway of the transportation sector mainly builds on five action plans, including promoting green transportation, enabling e-mobility, creating a user-friendly environment for green transportation, and subsidizing the replacement of fuel-powered vehicles.

2030

- Expand green transportation to 70%
- Install 2,000 charging stations in car parks
- All city buses go electric
- Electric scooters account for 35% of newly sold scooters
- Complete the "Taipei Metro Circular Line"
- City-wide "Air Quality Maintenance Zones"
- Increase the City's shared vehicles to 24,400
- Hydrogen buses demonstration
- Install two hydrogen refueling stations

2040

- Expand green transportation to 75%
- Install 10,000 charging stations in car parks
- Private vehicles achieve 50% of electrification
- Designate "Low-carbon Traffic Zones"
- Increase the City's shared vehicles to 25,850
- Introduce electric trucks/ hydrogen vehicles for commercial operations
- Install ten hydrogen refueling stations

2050

- Expand green transportation to 80%
- Install 20,000 charging stations in car parks
- Private vehicles achieve 95% of electrification
- City-wide "Low-carbon Traffic Zones"
- Increase the City's shared vehicles to 27,500
- Expand the use of hydrogen vehicles
- Install 20 hydrogen refueling stations

Zero-Waste and Full-Recycling

The City plans to realize the goal of resource recycling and waste reduction by setting up a circular system of reusable containers and an improved resource recovery rate. Meanwhile, we are in the process of transforming our incineration plants into green energy power plants and resource screening plants, which will turn into green energy circular parks. With the introduction of CCU(S) technology, the green energy circular parks will further reduce the carbon emissions emitted throughout the waste treatment process, turning waste into gold. The net-zero emissions pathway of the waste sector mainly focuses on the following policies: waste reduction, zero-waste, and resource recycling and reuse. Five action plans, including waste reduction at source and reusing resources, are implemented.

2030

- Achieve 70% of resource recovery rate
- Achieve 94% of the population served by sewage treatment systems
- Impose a complete ban on disposable tableware and plastics
- Launch of green energy power plant
- Launch of biomass power plant
- Launch of resource waste screening plant
- Complete reuse of incineration bottom ash

2040

- Achieve 75% of resource recovery rate
- Achieve 97% of the population served by sewage treatment systems
- CCU(S) technology introduced in green energy power plants

2050

- Achieve 80% of resource recovery rate
- Achieve 98% of the population served by sewage treatment systems
- Waste disposal facilities achieve net-zero emissions

Until the end of 2020, Taipei City has reduced its carbon emissions by 12.9% compared to 2005; by 2022, the City Government will have invested NT$ 27.321 billion in 150 energy-saving and carbon reduction projects, which are expected to reduce 185,800 metric tons of greenhouse gas emissions.

Global net-zero emissions have expanded from an environmental and climate issue to a broad spectrum of the energy transition, international trade, and climate politics. Similar to the Industrial Revolution in the 18th century, countries, cities, and companies will be marginalized if they do not follow the trend to keep up with the global movement of net-zero emissions. It is an action that requires the joint support of citizens and companies. Moreover, a report released by the International Energy Agency (IEA) indicates that behavioral changes can lead to an 8% reduction in global carbon emissions; Taipei City will also save 27% of electricity by 2050, according to the pathway proposed by this report. Thus, citizens can develop low-carbon living habits by practicing water-saving, electricity conservation, taking green transportation, food-cherishing, plastics reduction, and sharing the concept of carbon reduction with friends and relatives. With the above actions, we can together move towards a zero-carbon society.

Industrial and commercial businesses should set out a carbon reduction timeline. To reduce the carbon footprint of products and services, companies need to engage in the following actions: actively reduce waste and plastics, replace high energy-consuming equipment, choose low-carbon logistics, increase green energy generation, introduce hydrogen energy, and promote zero waste-oriented design.

In the global energy transition process, green energy such as solar, offshore wind, hydrogen, biomass, and geothermal will become emerging industries. Energy storage, energy management, novel energy vehicles, shared and circular economy, carbon capture, utilization (and storage), and even carbon inventory, verification, zero-carbon planning, and green finance will become the untapped “blue oceans” in the future. The City Government will vigorously advise and assist industrial and commercial businesses to transition towards net-zero emissions. We will also establish funds to encourage and incentivize net-zero companies and emerging technologies. Together with our partners, we will move towards a new world of zero-carbon livability, sustainability, and safety.

Foreword

Human activities have been confirmed to be the main cause of global warming, and the failure of climate action will be the greatest risk in the next 10 years. In line with the global efforts to reduce greenhouse gas emissions, the City proposed the 2050 net-zero emissions pathway assessment report, and completed the white paper on 2050 net-zero action by 2022.

Cities are on the frontline that will suffer the impacts of climate change. As the nation's capital, on Earth Day in 2021, Taipei City declared the goal to achieve net-zero emissions, and proposed the 2050 net-zero emissions pathway assessment report, and completed the white paper on 2050 net-zero actions by 2022.

Photo by shutterstock

The United Nations (UN) has set the goal to limit global average temperature to well below 2℃, and is dedicating its efforts to controlling temperature rise to within 1.5℃ after adopting the Paris Agreement in 2015. The *Special Report on Global Warming of 1.5 °C* published by the UN Intergovernmental Panel on Climate Change (IPCC) in 2018 pointed out that the world must achieve net-zero greenhouse gas emissions by mid-century, in order to control global temperature rise within 1.5℃.

Countries and cities across the world are contributing their efforts to carbon reduction. The Global Risks Report 2021 published by the World Economic Forum (WEF) indicated that extreme weather and failed climate action are among the highest likelihood risks in the next decade, and also the greatest threats to human civilization. In 2021, the IPCC published the Sixth Assessment Report (AR6), and pointed out that human activity is undoubtedly the main cause of global warming based on scientific evidence. Global temperature rise has already reached 1.07℃ and warming will continue throughout at least the middle of this century, very likely going to surpass 1.5℃ before 2040.

Currently, 135 countries and 1,049 cities across the world have declared the goal to achieve net-zero emissions before 2050 or formulated related policies to achieve the goals of the Paris Agreement and avoid climate catastrophe. The European Union (EU) has proposed the Fit for 55 package to achieve carbon neutrality by 2050 and reduce carbon emissions by 55% in 2030, expanding the scope of the carbon emission trading system, enhancing regulations for energy efficiency, promoting the carbon border adjustment mechanism (CBAM), and imposing carbon tax on products imported into the EU to prevent the risk of carbon leakage. Advanced countries such as the United States and Japan are also planning similar measures. Global carbon reduction will transform from an environmental issue into an economic issue, and expand to the aspects of industry and energy transition. Hence, achieving net-zero carbon emissions has become a matter that concerns the future competitiveness of countries, cities, and companies.

Taiwan's central government is currently revising the Greenhouse Gas Reduction and Management Act, and the Act will be upgraded as the Climate Change Response Act in response to international trends. In addition, the central government is planning to write the goal for net-zero emissions by 2050 into law. Cities are on the front line in the battle against climate change, and are also the field for verifying carbon reduction measures. Taipei City is the capital city of Taiwan, and Mayor Ko has declared on Earth Day in 2021 that Taipei City will pursue the 2050 net-zero goal, in order to fulfill its obligation and responsibility as a citizen of the global village to reduce carbon emissions. In the post-pandemic era, we see net-zero emissions not only a challenge, but also an opportunity for Taipei City to transform into a livable and sustainable city.

Taipei City's carbon emissions was approximately 11.388 million metric tons in 2020, and was already 12.9% lower than the baseline year (2005). With the vision to achieve net-zero emissions by 2050, this report collects the strategies adopted by countries across the world to achieve net-zero emissions, and simulates the required carbon reduction using the Long-range Energy Alternatives Planning System (LEAP) based on Taipei City's carbon emission characteristics. This report then formulates the pathway and strategies towards net-zero emissions, which will be used as the basis for proposing subsequent action plans to develop a zero-carbon and climate-safe Taipei.

Trends in Global Climate Change and Net-Zero Emissions

According to the projections in IPCC AR6, global warming will very likely exceed 1.5℃ the between 2040 and 2060. Only by accelerating the reduction of greenhouse gas emissions and achieving net-zero emissions before 2050, can global temperature rise be kept within 1.5℃ at the end of the 21st century. In 2021, more than 135 countries, 1,049 cities had set the goal to achieve net-zero emissions, accounting for 88% of the global emissions, 85% of the population and 90% of GDP.

Climate Change and AR6

After the United Nation Framework Convention on Climate Change (UNFCCC) was proposed in 1992, the world has dedicated its efforts to the reduction of greenhouse gases and response to climate change. The Paris Agreement was adopted in the 21st Session of the Conference of the Parties (COP 21) in 2015, setting the goal to limit global warming to 2℃ while exerting every effort to prevent it from exceeding 1.5℃. The Paris Agreement thus became the first legally binding global agreement after the Kyoto Protocol, and aims to reduce greenhouse gas emissions.

The IPCC published Global ***Warming of 1.5℃***[1] in 2018, and proposed that the world must achieve net-zero emissions by the end of 2050 to limit global warming to 1.5℃.

1992

United Nations Framework Convention on Climate Change

Stabilizing greenhouse gas concentrations in the atmosphere and prevent human interference with the climate system, while ensuring food production and economic development.

1997

Kyoto Protocol

Required 38 developed countries in Annex I to the Convention to take responsibility for reducing greenhouse gas emissions.

2015

Paris Agreement

At the end of the 21st century, control global warming within 2℃, and strive to control it below 1.5℃

2018

IPCC United Nations Intergovernmental Panel on Climate Change

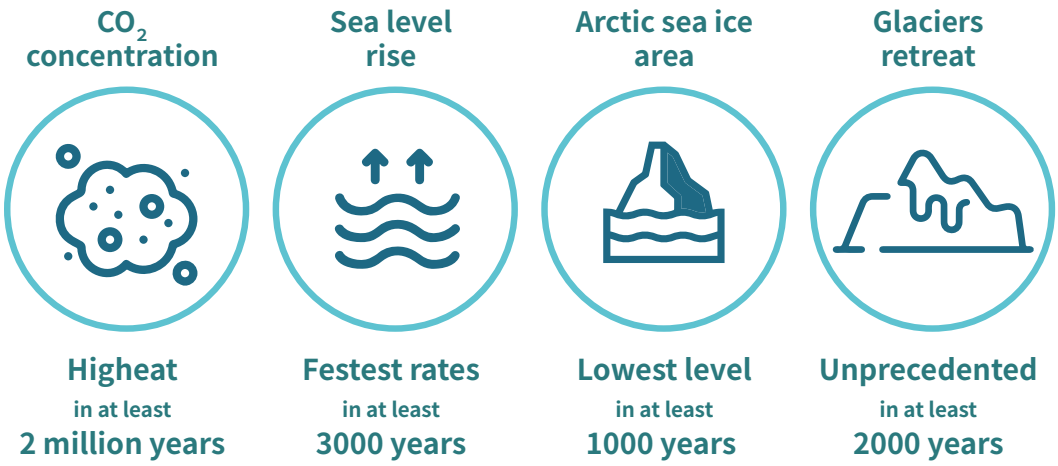
"Global Warming 1.5℃" Special Report

Global warming is accelerating, increasing by about 0.2°C every 10 years. In response to climate change actions, global warming must be controlled below 1.5°C and the world must reach net zero emissions by 2050.

▲ **History of the UNFCCC**

[1]IPCC (2018). Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

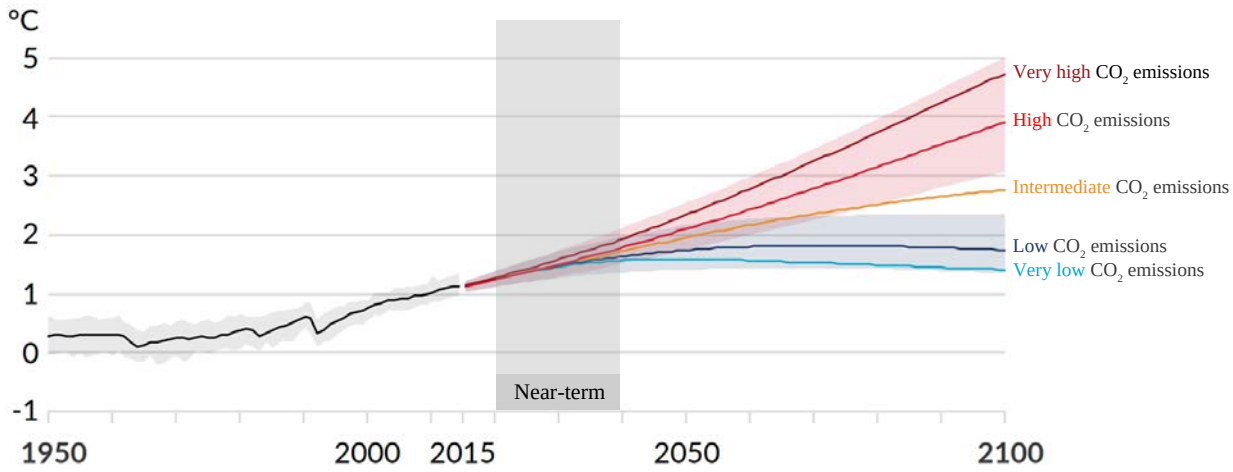
The IPCC published the AR6[2] on August 9, 2021 and verified that global warming is continually happening. The increase in greenhouse gas concentration is without doubt the result of human activity, which has made the atmosphere, ocean, and land warmer, while causing widespread and rapid changes in the atmosphere, ocean, cryosphere, and biosphere.



▲ **Current state of the climate system[3]**

According to projections in AR6, global warming will very likely exceed 1.5°C between 2040 and 2060. The north pole may not have any sea ice in September, and the probability of extreme rainfall events and strong tropical cyclones will increase 7%. Global water circulation will become even stronger and indirectly cause an increase in the frequency and intensity of rainfall, drought, and heat waves, which will reduce the ability of the ocean and land to serve as a carbon sink.

The report also pointed out that if the reduction of greenhouse gas emissions can be accelerated, and net-zero emissions is achieved before 2050, it is still possible to control global temperature rise to within 1.5°C at the end of the 21st century.



▲ **Temperature rise projections in different scenarios[4]**

[2]IPCC (2021). Climate Change 2021:The Physical Science Basis (AR6).

[3]Remade by this report from the IPCC AR6 presentation.

[4]Remade by this report from the IPCC AR6.

COP26 "Glasgow Climate Pact"

The 26th session of the Conference of the Parties (COP26) held in Glasgow, UK, has ended on November 13th, 2021. The goal of the conference is to secure net-zero emissions by mid-century and keep global warming under control within 1.5°C. Through consultations during the conferences, various countries have decided to adopt the "Glasgow Climate Pact", aiming to strengthen climate change adaptation while continually promoting greenhouse gas reduction actions. The key points of the final agreement are as follows:

1. All countries/Parties should propose more ambitious carbon reduction targets by 2022, in order to reduce carbon emissions by 45 percent by 2030 relative to the 2010 level.
2. All countries/Parties should gradually reduce coal-fired power generation, and accelerate efforts towards the phase-out of inefficient fossil fuel subsidies.
3. Developed country Parties should support climate fund by fully delivering the USD 100 billion goal per year, supporting developing nations' response to climate change.
4. Establish a framework for international carbon market mechanisms.
5. Reduce 30% of methane emissions by 2030.
6. Halt and reverse forest loss and land degradation by 2030.

Global Race to Zero

"Race to Zero[5]" is a global initiative of the UN to advocate climate action. Its main purpose is to encourage private companies, medical institutions, education institutions, cities, and regions to formulate transparent action plans and short-term goals in response to carbon reduction goals of the Paris Agreement, and achieve net-zero emissions before 2050. As of 2021, there are 135 countries, 1,049 cities, 35 regions, and 5,235 companies across the world participating in the Race to Zero.

Despite of the COVID-19 pandemic,the number of companies that has committed to net-zero emissions are still increasing. The threat brought by climate change is prevented through zero-carbon recovery that is healthier and better adapted to the climate, which further creates good green employment opportunities to achieve sustainable growth.

Progress of Major Countries

Among the countries that declared net-zero emissions, Suriname and Bhutan have already achieved net-zero emissions; 14 countries have already completed legislation, in which Germany, Sweden and Portugal have set the goal to achieve net-zero emissions before 2045, and the remaining 10 countries including the United Kingdom and France set the goal to achieve net-zero emissions before 2050. USA, and Australia are currently going through the legislative process. Remaining countries are currently formulating policies or discussing goals.

[5]UUFCCC. Race to Zero, Retrieved December 2021 https://racetozero.unfccc.int/join-the-race/whos-in/

▼ **Summary of commitments by different countries to achieve net-zero emissions**[6]

Status	Target Year	Country
Already achieved net-zero emissions	—	Suriname, Bhutan
Already completed legislation	2045	Germany, Portugal
	2050	United Kingdom, France, Spain, Denmark, Hungary, Luxembourg, Canada, Japan, South Korea, New Zealand, Ireland
Currently being legislated (draft)	2030	Maldives
Currently being legislated (draft)	2035	Finland
	2040	Iceland, Antigua and Barbuda
	2050	USA, Italy, Australia, Belgium, Romania, Austria, Chile, Greece, Ecuador, Panama, Croatia, Lithuania, Costa Rica, Slovenia, Uruguay, Latvia, Laos, Malta, Fiji, Belize, Marshall Islands, Monaco, Singapore
	2053	Turkey
	2060	China, Ukraine, Sri Lanka
Formulating policies	2050	Brazil, Thailand, Argentina, Malaysia, Vietnam, Colombia, South Africa, United Arab Emirates, Kazakhstan, Israel, Estonia, Malawi, Cape Verde, Andorra
	2060	Russian Federation, Saudi Arabia, Nigeria, Bahrain
	2070	Austria, Iceland

[6]Energy and Climate Intelligence Unit. Net Zero Scorecard, Retrieved December 2021 https://eciu.net/netzerotracker

Global Net-Zero Emissions Issues and Key Strategies

The International Energy Agency (IEA) released an analysis report that predicts the pathway for global energy systems to achieve net-zero emissions, aiming to help countries formulate energy-related policies. In addition to existing commercial technologies such as renewable energy, electric vehicles, and heat pumps, for the currently immature technologies such as hydrogen energy and CCUS, more funding and manpower are still needed to be invested to accelerate innovation.

Countries across the world have proposed goals and strategies in response to the vision for net-zero emissions. The main strategies include energy transformation to achieve zero-carbon electricity, gradually moving towards zero-carbon buildings through building energy efficiency requirements, combining electric vehicles and hydrogen vehicles to reduce transportation emissions, and finally remaining carbon emission can be offset through an increase in carbon sinks.

Photo by shutterstock

IEA Roadmap and Key Milestones for Net-Zero Emissions

The International Energy Agency (IEA) on May 18 this year (2021) released an analysis report "*Net Zero by 2050: A Roadmap for the Global Energy Sector*[7]" that predicts the pathway for global energy systems to achieve net-zero emissions, hoping to help countries formulate energy-related policies. Key strategies proposed by the IEA to achieve net-zero emissions by 2050 include:

1 Improve energy efficiency

Industrial process efficiency improvement, waste heat recovery and use, home equipment efficiency improvement, and building energy conservation.

2 Behavioral change of citizens

Low-carbon transportation, increase product recycling and repeated use to reduce energy consumption in manufacturing.

3 Expand renewable energy

Replace fossil fuel with renewable energy and reduce carbon emission from energy use.

4 Electrification

Replace gasoline vehicles with electric vehicles and replace gas water heaters with electric water heaters.

5 Develop hydrogen energy

Hydrogen energy can be stored for a long period of time and helps store intermittent energy.

6 Carbon Capture, Utilization and Storage (CCUS)

Capture carbon dioxide emitted into the atmosphere and develop carbon dioxide reuse technology to offset sectors that have a harder time reducing carbon emissions.

7 Develop biofuel

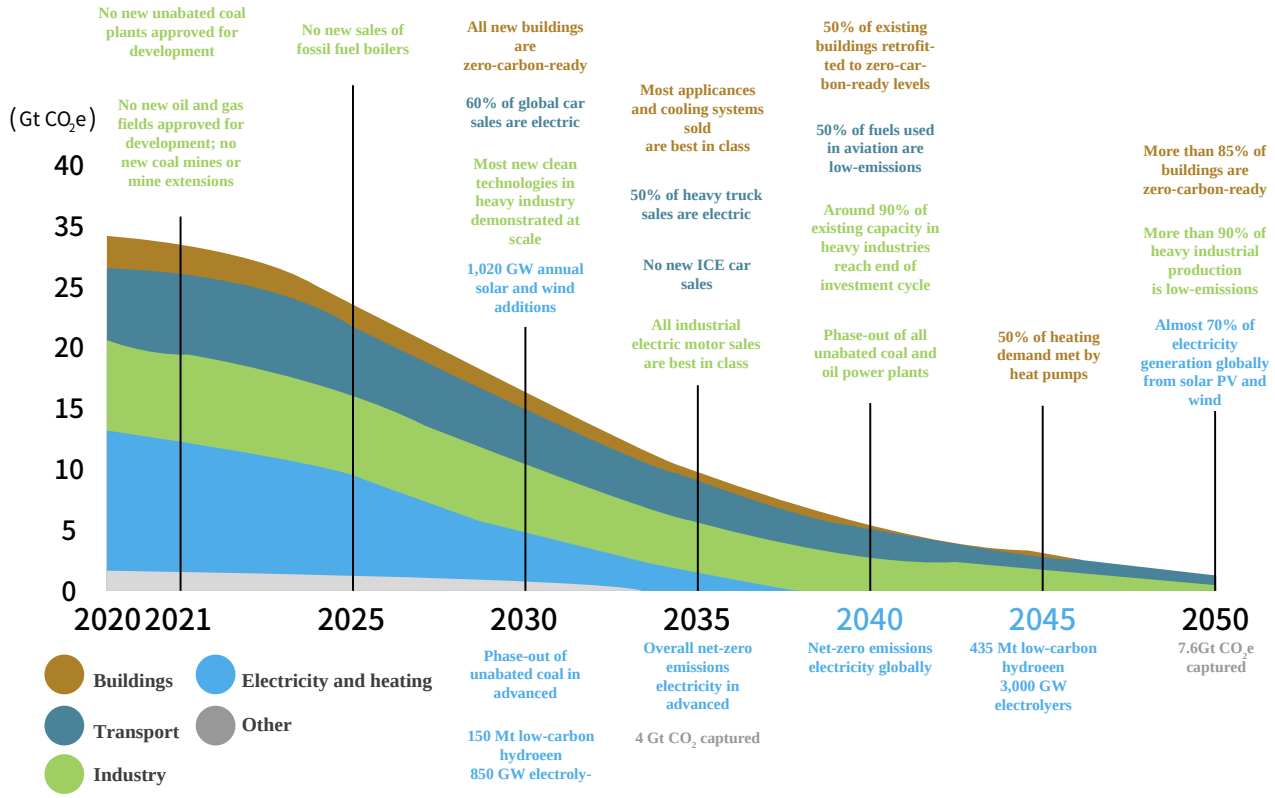
Utilize the biochar cycle as it will become an important source of energy in the future.

[7]IEA (2021). Net Zero by 2050:A Roadmap for the Global Energy Sector.

The IEA proposed goals for each stage in 2030-2050

2030 :	**All new buildings are zero-carbon buildings, 60% of new vehicles sold are electric vehicles, and 1,020 GW of electricity is generated by solar power or wind power.**
2040 :	**50% of existing buildings are zero-carbon-ready buildings, 50% of fuel used in aviation is low-carbon sustainable fuel, and all coal-fired and oil-fired power plants are replaced.**
2050 :	**Over 85% of existing buildings are zero-carbon-ready buildings and 70% of electricity is generated by solar power and wind power.**

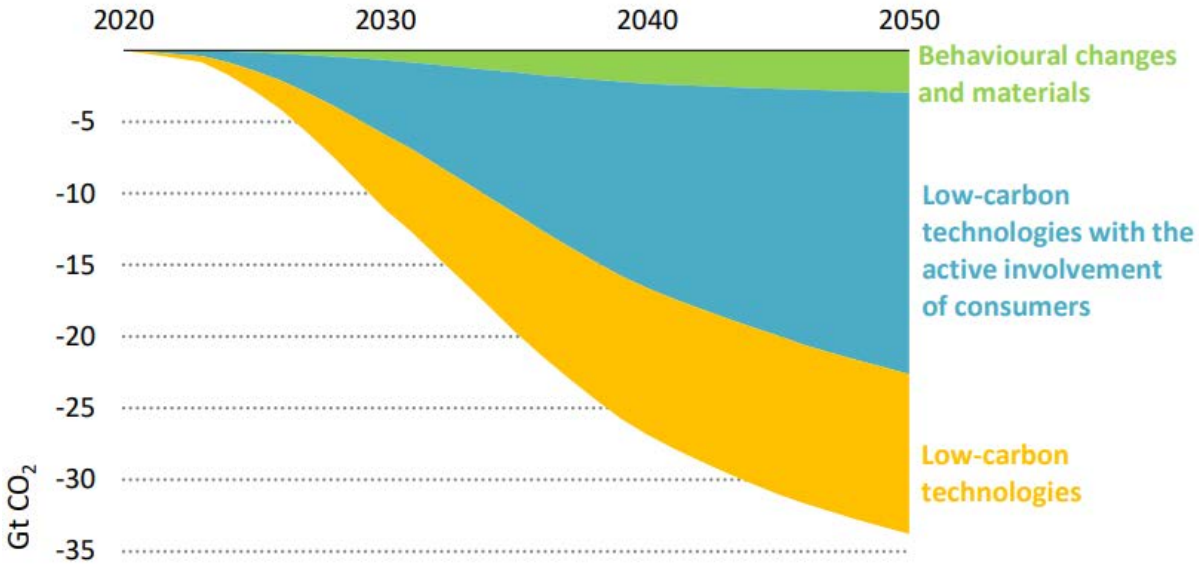
In addition, the IEA's report mentioned that existing commercial technologies for renewable energy, electric vehicles, and heat pumps are already sufficient to achieve the goal of 50% carbon reduction by 2050. However, some technologies have not yet become mainstream. This is because it takes time to replace products and also takes time to increase production and lower costs. For technologies that are not yet mature, such as hydrogen energy, biofuel, and CCUS, more funding and manpower still need to be invested to accelerate innovation.



▲ **Roadmap for the global energy sector to achieve net-zero emissions by 2050**[8]

[8]**Remade by this report from the IEA Net Zero by 2050.**

Furthermore, the IEA mentioned that energy transition cannot be achieved without active citizen participation in the process. Energy use originates from our demand in products or services. In the net-zero emissions projection scenario of the IEA, less than 40% of carbon reduction is from the use of low-carbon technologies of policies or investments, such as energy transition in the electricity generation industry or steel industry. Another 55% of carbon reduction requires citizen participation and deployment of low-carbon technologies, such as installing solar power water heaters or purchasing electric vehicles. The remaining 8% of carbon reduction come from behavioral change and increased efficiency in materials that result in lower demand on energy.



▲ **Contribution of different measures to carbon reduction[9]**

▶ **Energy Hill**

[9]IEA Net Zero by 2050, remade by this report.

Analysis of Strategies Adopted by Major Countries and Cities for Net-Zero Emissions by 2050

Net-Zero strategies of major countries

Countries across the world have proposed goals and strategies in response to the vision for net-zero emissions. The strategies of major countries to achieve net-zero emissions are summarized in this report as the following:

United Kingdom

The United Kingdom amended its Climate Change Act in 2019 and set the goal to achieve net-zero emissions by 2050, becoming the first country in the world to legislate a net-zero emissions target within law. The UK Climate Change Committee (CCC) published "The Sixth Carbon Budget" in 2020 and set the goal to reduce carbon emissions in 2035 by 78% compared to 1990 and by 63% compared to 2019.

Among the strategies proposed by the UK, the energy sector is mainly driven by wind power generation, which is expected to increase to 40GW and 100GW by 2030 and 2050, respectively. New vehicles, trucks, and boilers used in homes or buildings are required to use low-carbon energy before 2030. By 2040, all new trucks must achieve low-carbon emission. In the agricultural and forestry sectors, in addition to planting mixed forests to remove CO_2, farmland will be used to produce energy crops, increasing the area of forests from the current 13% to 18% by 2050.

Japan

Japan in October 2020 declared its goal to achieve net-zero emissions by 2050, and announced its Green Growth Strategy in December, proposing 14 key plans.

Japan focuses on decarburization in the power sector, and expects renewable energy to account for between 50% and 60% of overall power generation by 2050. Thus, besides stable growth in wind power generation and output current from storage batteries, Japan aims to develop hydrogen energy. To deliver this goal, it is necessary to develop technologies and reduce costs. The industrial sector focuses on improving production processes. Transportation tools will shift the use of fuels to biofuel and hydrogen, and the goal is to introduce hydrogen in aircrafts before 2035, strengthening infrastructure such as hydrogen supply chain and hydrogen refueling equipment. As for the residential and commercial sector, measures including net-zero buildings, electrification, and the use of hydrogen energy systems or storage batteries will be considered.

▼ Japan's Green Growth Strategy action plan[10]

Item	Action	Related measures
Energy 	Offshore wind power	● Installed capacity of offshore wind turbines reaches 30-45 million kw in 2040.
	Ammonia fuel	● Ratio of multi-fuel combustion reaches 20% by 2030, develop thermal power generation technology that uses ammonia as fuel, and conduct an empirical study within 3 years.
	Hydrogen energy	● Volume used reaches 3 million metric tons in 2030. ● Volume used reaches 20 million metric tons in 2050, and hydrogen production cost is lowered to 20 ¥/m^3 or less.
	Nuclear power	● Encourage Japanese companies to become main members of small modular reactor (SMR) international collaboration projects. ● Collaborate with nuclear power related units of other countries to popularize Japan's high temperature gas-cooled reactor specification.
Transportation/ Manufacturing 	Vehicle/Storage battery	● Ban the sale of gasoline-powered vehicles in the mid-2030s. ● Lower the price of storage batteries in vehicles to 10,000 ¥/kwh within the 2030s.
	Semiconductors/ICT	● Enact laws requiring data processing centers to use a certain ratio of renewable energy. ● Achieve net-zero carbon emission in the ICT industry by 2040.
	Shipping (Sea transport)	● Increase the efficiency of ships that use liquefied natural gas (LNG) as fuel, and reduce carbon emissions by 86% combined with slow steaming and wind-assisted propulsion systems. ● Utilize recycled methane to achieve net-zero emission.
	Logistics/Personnel/ Infrastructure	● Set up harbor equipment and introduce new generation energy and resources from overseas.
	Food/Agriculture, Forestry, and Fisheries	● Review and revise related laws to promote local production and local consumption energy systems.
	Aircrafts (Aviation)	● The goal is for aircrafts to use hydrogen energy before 2035, and strengthen infrastructure such as the hydrogen supply chain and hydrogen refueling equipment.
	Carbon capture	● Seize 30% market share of the global carbon capture market in 2050 (market scale estimated at approximately ¥10 trillion), which is converted to approximately 2.5 billion metric tons of CO_2.
Residential and commercial 	Housing/Buildings/ New generation solar power	● Encourage new houses and buildings to reach the standard for ZEH (Net-Zero Energy House) ● Accelerate the development of new generation solar PV technologies such as perovskite
	Resource recycling	● Develop Waste-to-Energy (WtE) technologies. ● Develop highly efficient WtE technologies.
	Industries related to daily life	● Digitalize application procedures for the J-credit system (carbon reduction certificate), and simplify and automate carbon emission observation data and credit certification procedures.

[10]Department of International Cooperation, Ministry of Economic Affairs (May 26, 2021). Japan's measures to achieve net-zero emissions by 2050 (Economic Division, Taipei Economic and Cultural Representative Office in Japan), retrieved from: https://mnscdn.moea.gov.tw/MNS/ietc/bulletin/Bulletin.aspx?kind=54&html=1&menu_id=33779&bull_id=8838

USA

After President Biden assumed office in 2021, he immediately returned to the Paris Agreement and committed to achieving net-zero emissions by 2050. He also committed to reducing greenhouse gas emissions in 2030 by between 50% and 52% compared to 2005. At present, the United States has proposed interstate energy transmission regulations to reach a zero-carbon power system and clean energy by 2035, reduce the carbon footprint of buildings nationwide by 50% in 2035, establish a carbon trading market, and accelerate the deployment of electric vehicles.

Germany

Germany in May 2021 declared the goal to achieve net-zero emissions by 2045, and reduce carbon emissions in 2030 and 2040 by 65% and 88% compared to 1990, respectively.

Core measures include continued retrofitting of old houses, establish energy efficiency standards, and develop in renewable energy heating systems. Other measures include strengthen the EU's existing carbon emission trading system and CCUS in the energy and industrial sectors. Reduction strategies in the transportation sector include improving the combustion efficiency of heavy trucks, using hydrogen energy, LNG, or recycled methane as alternative fuel, and actively planning power supply infrastructure. The agriculture and forestry sectors will increase fertilizer usage efficiency or reduce the use of nitrogen fertilizer and continue to increase the area of forests.

South Korea

South Korea in 2020 proposed the goal of carbon neutrality by 2050, and launched the 2050 Green New Deal. Energy and industry account for 90% and above of South Korea's greenhouse gas emissions.

Hence, South Korea is actively developing renewable energy and setting the goal for renewable energy to account for 20% and 40% of all power generation in 2030 and 2040, respectively; renewable energy will become the main source of power supply by 2050. South Korea also plans to establish 8GW of fuel cell facilities and introduce the Renewable Portfolio Standard (RPS) and Feed-in Tariffs (FIT) system by 2040.

Reduction strategies in the industrial sector include developing Low-carbon technologies, improving boiler efficiency, raising energy efficiency standards for industrial equipment such as motors, and incorporating the Emissions Trading Scheme (ETS). Reduction strategies in the transportation sector include expanding eco-friendly vehicles, increasing the use of Low-carbon fuel, promoting green logistics, and managing transportation demand to accelerate carbon reduction. The residential and commercial sector is directing towards electrification, improving the energy efficiency of buildings, and using highly efficient equipment.

▼ **Key strategies of major countries to achieve net-zero emissions**

	Year to achieve	2030	2035	2040	2050
United Kingdom	**2050**	● Increase offshore wind power generation to 40GW. ● New vehicles, trucks, and boilers used in homes or buildings substitute to low carbon energy.	–	● New trucks must be Low-carbon emission trucks.	● Increase offshore wind power generation to 100GW. ● Increase the area of forests to 18%.
Japan	**2050**	● Greenhouse gas emissions decrease 46% compared to 2013.	● Introduce hydrogen energy in aircrafts.	● Installed capacity of offshore wind turbines reaches 30-45 million kw. ● Achieve net-zero carbon emissions in the ICT industry.	● Renewable energy accounts for 50-60% of overall power generation.
USA	**2050**	● Greenhouse gas emissions decrease 50-52% compared to 2005. ● Deploy 500,000 or more new public charging stands.	● Realize a zero-carbon power system. ● Reduce the carbon footprint of buildings nationwide by 50%.	–	–
Germany	**2045**	● Carry out large scale renovation of existing houses and establish energy conservation standards. ● Increase gas mileage of heavy trucks by 28% compared to 2010.	● Reduce 70 kg nitrogen fertilizer/hectare in 2028-2032.	–	–
South Korea	**2050**	● Goal to reach 20% renewable energy. ● Sell 3,000,000 electric vehicles and 850,000 hydrogen vehicles.	–	● Goal to reach 40% renewable energy. ● Establish 8GW of fuel cell facilities.	–

Net-zero strategies of major cities

Cities are on frontline that will suffer the impacts of climate change, and have thus proposed goals and strategies for achieving net-zero emissions. The reduction strategies of different sectors include using renewable energy/hydrogen energy, low-carbon buildings, zero-carbon transportation, and recycling and reuse. In addition, with the aim of reducing greenhouse gas emissions, the remaining carbon emission can be carbon offset through an increase in carbon sinks.

Tokyo, Japan

The Tokyo Metropolitan Government launched the “Zero Emission Tokyo Strategy” on December 27, 2019, While the Strategy includes renewable energy, transportation carbon reduction, zero food waste, zero carbon and smart buildings, and plastic reduction, it establishes related measures and the mid-term and long-term roadmap for 2030 and 2050.

Besides updating the Zero Emission Tokyo Strategy in 2020, Tokyo Metropolitan Government announced that Tokyo will accelerate its actions by reducing greenhouse gas emissions and energy consumption by 50% in 2030 (compared with 2000), and renewable energy will increase to approximately 50% of power consumption. It also updated the 14 policy roadmaps for 6 sectors in the Zero Emission Tokyo Strategy, including the vision for 26 social changes, 36 methods, and 94 areas that require immediate and enhanced efforts.

London, United Kingdom

London proposed the vision for net-zero emissions by 2050. If the population of London continues to rapidly grow to 2050, it may surpass 11 million.

With regard to transportation, besides implementing an ultra low-emission area where congestion charge is collected, the current environmental plan of London will prohibit the sale of new gasoline and diesel vehicles by 2035, and will expand the ultra low emission area to the entire city. The mayor also committed to zero carbon power supply for the London Underground by 2030, and to achieve zero carbon emission in public buses by 2037.In terms of buildings, the building environment accounts for approximately 40% of the UK's total carbon footprint. Hence, material and construction method selection, as well as energy efficiency, are important strategies for reducing building greenhouse gas emissions. The goal for waste treatment is to reduce waste from food and its packaging by 50% by 2030, including funding new drinking fountains to help people in London reduce the use of disposable plastic bottles. London also committed to recycling 65% of waste by 2030, and prohibiting biodegradable or recyclable waste from entering landfills in 2026.

San Francisco, USA

San Francisco will achieve net-zero emissions by 2040 and base its new carbon reduction goals and climate action on its climate action framework (0-80-100-roots).

With regard to waste, the City's goal is to reduce solid waste generated in 2030 by at least 15% compared to 2015, and the amount of waste incinerated or buried in landfills will decrease by 50% compared to 2015. For transportation, low-carbon trips will account for at least 80% of all trips; and electrification of private vehicles will expand to 25% by 2030; and 100% of private vehicles will be electric by 2040. In terms of energy, 100% of renewable electricity and 100% of renewable energy will be provided in 2025 and 2040, respectively. As for the residential and commercial sector, all new buildings are required to use zero fossil fuel emissions starting from 2021, while all existing large commercial buildings are required to use zero fossil fuel emissions by 2035.

▼ **Carbon reduction strategies planned by major cities across the world to achieve net-zero emissions**

	Energy	Residential and commercial	Transportation	Waste	Carbon sink
Tokyo	● Mainly driven by renewable energy. ● Expand the use of hydrogen energy.	● Promote zero-carbon buildings.	● Promote zero-carbon transportation tools mobility.	● Promote the 3R policy. ● Reduce plastic. ● Promote zero food waste. ● Zero fluorocarbon emissions.	● Develop new carbon sink technologies.
London	● Composite energy grid. ● Grid energy storage system.	● Establish building energy efficiency specifications. ● Increase the area of urban greening. ● Improve household energy efficiency. ● Distributed energy network.	● Designate an ultra Low-carbon emission area. ● Zero carbon emissions government fleet. ● Zero carbon emissions taxis.	● Improve resource efficiency, reduce waste, food waste, and disposable packaging. ● Establish additional local waste treatment plants.	● Expand the area of green coverage. ● Additional projects on wildlife, landscape, and species regeneration
Amsterdam	● Install Rooftop solar panels ● Wind power development and use. ● Smart power infrastructure. ● Green hydrogen energy.	● Develop sustainable energy for regional energy integration. ● Improve building energy efficiency. ● Develop energy neutral buildings.	● Subsidies for Low carbon vehicle. ● Establish fee standards for specific parking spaces and infrastructure. ● Establish charging stations and subsidize zero carbon vehicles.	–	● Develop carbon capture and storage (CCS) technologies.
San Francisco	● Rooftop power plants in urban areas and offshore wind power systems. ● 100% of power generated by renewable energy in 2030. ● Energy storage system optimizes grid performance.	● Develop smart energy saving equipment for buildings to reduce electricity consumption by 3% a year. ● Replace natural gas heating systems with electric heating equipment. ● Strengthen the heat insulating effect of building envelope.	● Walking, cycling, and the use of 80% of people walk, ride a bicycle, or use public transportation by in reach 80% by 2030. ● 15% of private vehicles and trucks are electric in 2030 and 100% are electric in 2040.	● Reduce waste by 15% in 2030 and achieve zero waste in 2050.	● Restore ecological systems and urban greening. ● Urban forestry. ● Soil organic carbon sequestration.
New York	● Install solar power devices on the rooftop of public and private buildings in the city. ● 100% of power generated by renewable energy in 2040.	● The NYC Cool Roofs project installs reflective roof coatings to mitigate the heat island effect and conserve energy. ● Develop a smart utilities system and examine the use of utilities.	● Collect congestion charge. ● Reduce emissions from commercial vehicles and fleets, establish a green loading area, and prohibit parking by non-zero-carbon vehicles. ● Electric vehicles account for 25% of new vehicles sold in 2025.	● Reduce purchases of disposable plastic and processed meats. ● Organic waste recycling. ● Increase the recycling ratio of kitchen waste.	● Increase carbon sequestration by wetlands and forests.

Summary

To conclude the long-term goals set out by IEA, major countries or cities to achieve net-zero emissions, key strategies include:

- **Energy transition,** gradually expand renewable energy supply, continue to develop new energy, and realize zero carbon electricity.
- **Housing,** establish building energy efficiency requirements and utilize low-carbon equipment to eventually achieve net-zero emissions buildings.
- **Transportation,** prioritize electric transportation tools and gradually introduce new energy vehicles such as hydrogen vehicles.
- **Industry,** prioritize the use of new manufacturing and processing technology, improve efficiency, and utilize CCUS to achieve net-zero emissions.

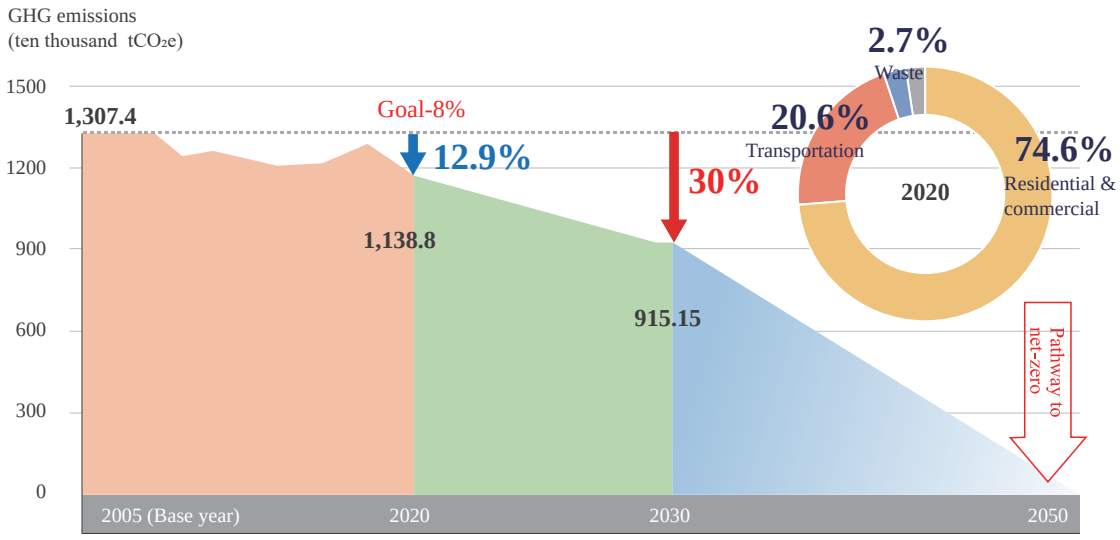
Current Status of Greenhouse Gas Emissions in Taipei City

Taipei City actively implements the reduction of greenhouse gas emissions. In 2020, the amount of greenhouse gas emissions was 11.388 million tons CO_2e, down approximately 12.9% compared with the baseline year (2005). The residential and commercial sector and transportation sector are the main sources of carbon emissions in the City, accounting for 74.6% and 20.6% of the City's emissions, down approximately 13.1% and 8.2% compared to 2005.

Photo by shutterstock

Based on long-term changes in Taipei City's greenhouse gas emissions, the amount of greenhouse gas emissions was 11.388 million metric tons CO_2e in 2020, down approximately 1.6857 million metric tons or 12.9% compared with the baseline year (2005), which is higher than the goal for a 8% reduction in 2020 compared to 2005. Taipei City raised the goal to reduce carbon emissions in 2030 from 25% to 30% compared to 2005 in an active effort to tackle climate change, and aims to achieve net-zero emissions by 2050.

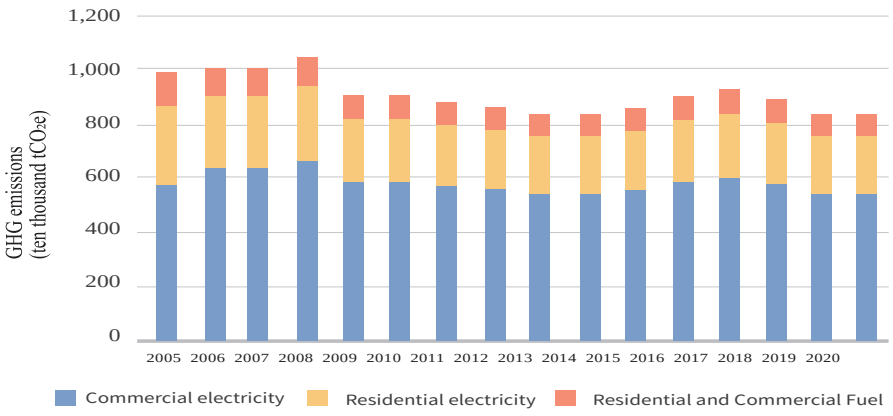
Breaking down carbon emissions by sector, the residential and commercial sector and transportation sector are the main sources of carbon emissions, accounting for 74.6% and 20.6% of the city's emissions. The waste sector accounts for 2.7% of carbon emissions. The three sectors combined account for nearly 98% of City-wide carbon emissions.



▲ **Changes in Taipei City's greenhouse gas emissions in 2005-2020**

Residential and commercial sector

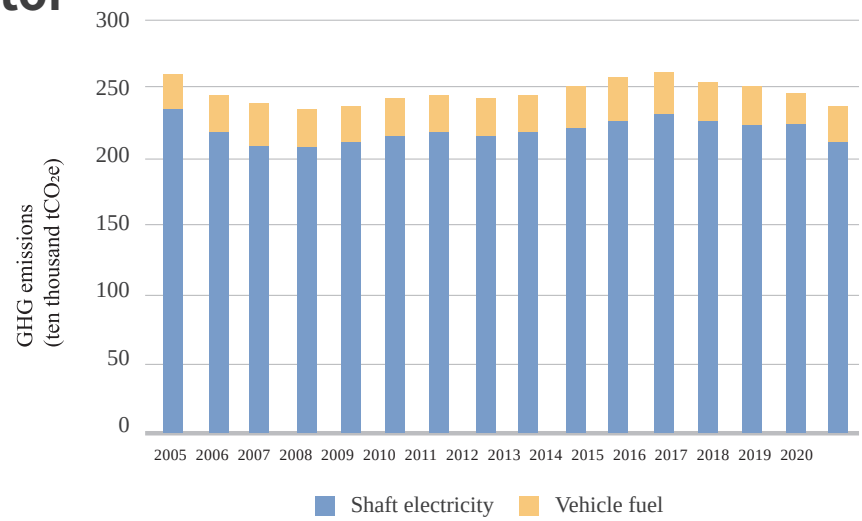
Over the years show that emissions in 2020 decreased approximately 13.1% compared to 2005; electricity use was the main source of emissions and accounted for 88-89% of the residential and commercial sector's emissions over the years; followed by emissions from natural gas and liquid petroleum gas combustion, which accounted for approximately 11-12% of the residential and commercial sector emissions over the years.



▲ **Changes in Taipei City's greenhouse gas emissions from the residential and commercial sector in 2005-2020**

Transportation sector

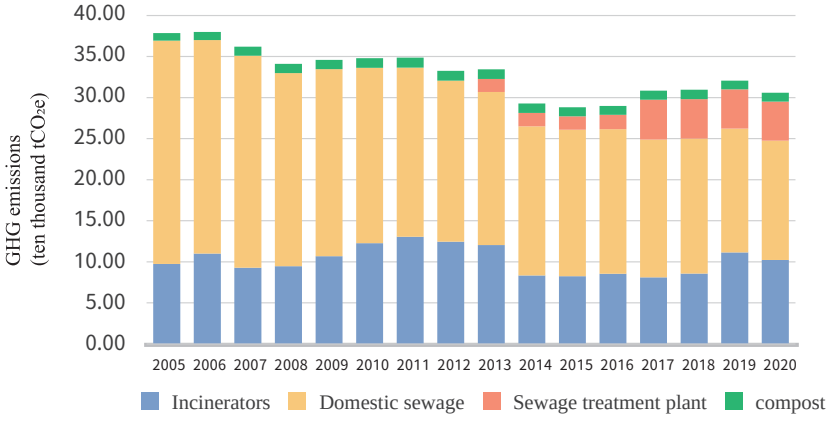
Over the years, statistics shows that emissions in 2020 decreased 8.2% compared with that in 2005. Even though carbon emissions from electricity use by public rail transportation (MRT, TRA, THSR) increased, the increment in public transportation volume significantly lowered gasoline use by private transportation tools, and was the main contributor to carbon reduction in the transportation sector.



▲ **Changes in Taipei City's greenhouse gas emissions from the transportation sector in 2005-2020**

Waste sector

Over the years show that emissions in 2020 decreased 19.2% compared to 2005. Domestic sewage was the main source of emissions, followed by incinerators, and the reduction in emissions was due to the higher ratio of pipelines connected to the sewers.



▲ **Changes in Taipei City's greenhouse gas emissions from the waste sector in 2005-2020**

Taipei City 2050 Net-Zero Emissions Pathway Assessment

Based on future demographic and economic changes in Taipei City, this report assumes that future technologies remain the same when projecting the trend of greenhouse gas emissions, which will reach 12.26 million tons of CO_2e in 2050.

Taipei City's overall strategy to achieve net-zero emissions is to work with the central government and engage in public-private partnerships to achieve smart and zero-carbon buildings, low-carbon green transportation, zero waste and full recycling, and increase of carbon sinks. The main strategies are as follows: the residential and commercial sector will incorporate building energy efficiency management, energy efficiency improvement, and the use of renewable energy/hydrogen energy to achieve zero carbon buildings; the pathway for transportation sector promotes the continuous improvement of green transportation, while introducing electric (hydrogen) vehicles; the waste sector aims to achieve zero waste and full recycling, eventually achieving zero emissions in waste treatment facilities; the pathway for agricultural and forestry sector focuses on increasing carbon sequestration through forests and wetlands conservation, in order to maintain carbon sinks.

Photo by shutterstock

Analysis of Taipei City's 2050 Business As Usual (BAU) [11] Scenario

Assumptions

Population projections

The cohort component method, a commonly used approach worldwide, is adopted for projecting Taipei City's population. The male and female population at each age registered as of the end of 2019 are used as the base, and then assumptions of birth, death, and migration are added. Each year, a new birth cohort is added to project the male and female population at each age.

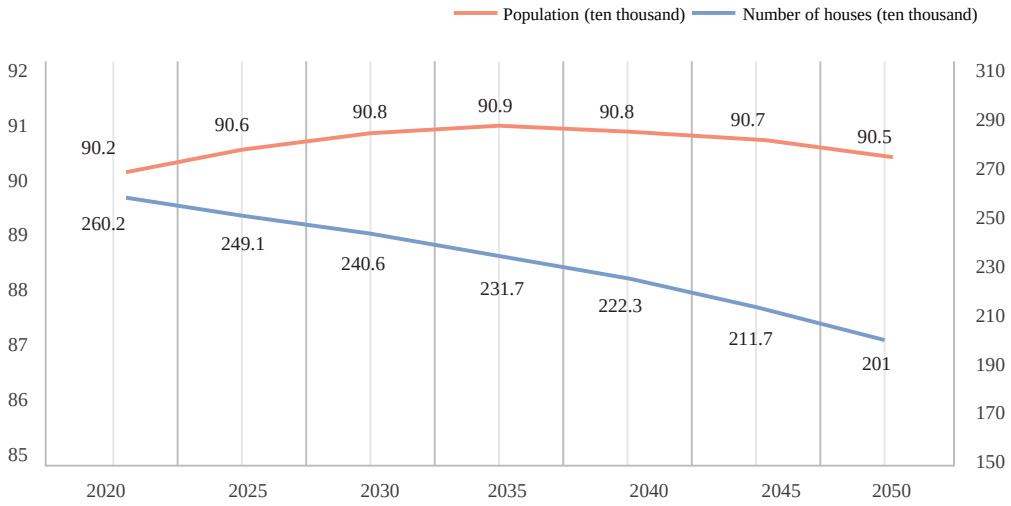
According to the *Taipei City Population Projection Report for 2020-2049*[12] published by Taipei City Government [12] in November 2020, Taipei City's population peaked in 1990 at 2.72 million people, and then declined to 2.645 million people at the end of 2019. The population is projected to continue its decline to 2.01 million in 2050.

Housing number forecasts

Taipei City's housing number forecasts are based on housing numbers in the past decade (2009-2019) according house tax statistics of the Ministry of the Interior's Real Estate Information Platform[13]. Changes in number of housing units in the past are calculated and saturation of land development is taken into consideration, using an index model to project changes in number of housing units in the future that reflect on the slowing growth. The housing stock (housing unit) in each year in the future is then calculated on this basis.

Housing statistics of the Ministry of the Interior shows that the number of housing units in Taipei City was 852,000 in 2009 and increased to 899,000 in 2019. However, the margin of growth has gradually slowed over the years. The growth in number of housing units will continue to slow in the future and reach approximately 905,000 housing units in 2050.

[11] Industrial Technology Research Institute (2021), Greenhouse Gas Reduction Result and Technology Evaluation and Application Project, project commissioned by the Environmental Protection Administration in 2020 (Project No. 109A202), not published.
[12] Taipei City Government (2020), Taipei City Population Projection Report for 2020-2049.
[13] Housing statistics of the Ministry of the Interior – Number of housing units based on house tax.

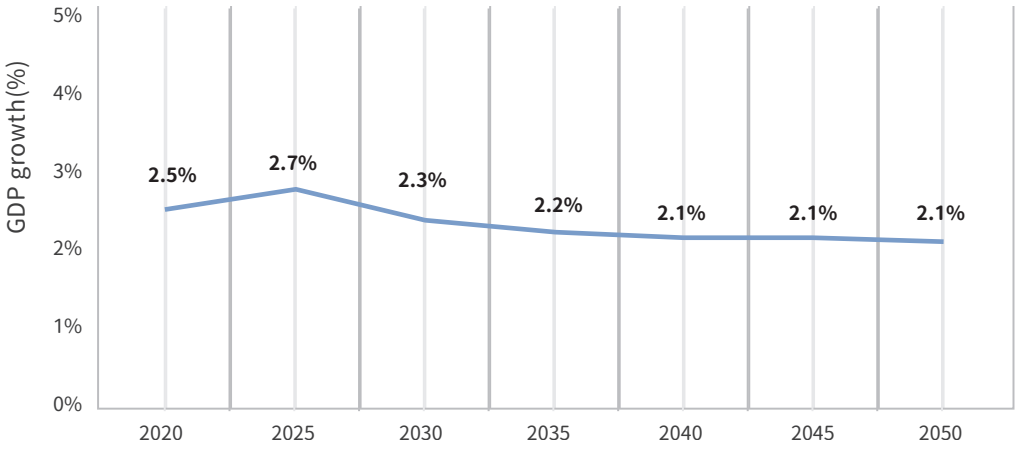


▲ **Taipei City's population and housing units in 2020-2050**

Gross Domestic Product (GDP) forecast

Taipei City's GDP forecast is mainly based on projections of the Executive Yuan in 2021 for the assessment of net-zero emissions pathway by 2050. Future changes in GDP and added value of each industry in Taipei City are projected using a time series based on the industrial structure in the baseline year (industry and commerce census conducted in 2016). The Taiwan General Equilibrium Model (TAIGEM) is then used to project the total GDP for each year in the future, and the simulated values for Taipei City each year are then calculated based on Taipei City's share of GDP and intermediate inputs.

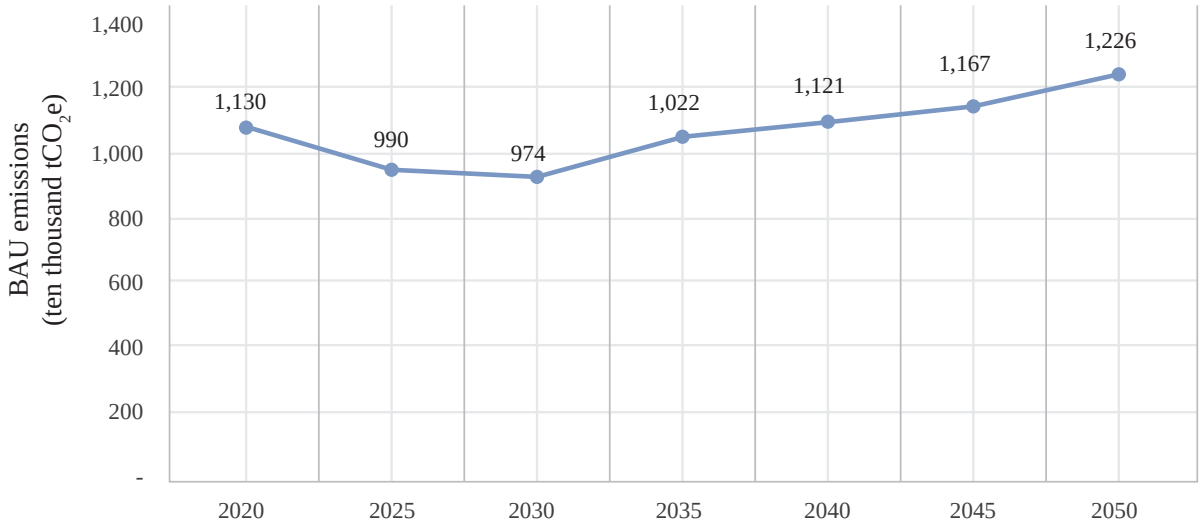
Taipei City's service sector grew 2.5% in 2020 compared to 2019, and is expected to grow 2.1% in 2050 compared to 2049. At present, Taipei City's service sector accounts for over 40% of the nation's overall GDP. It is the heart of the service sector nationwide and is expected to continue driving Taipei City's economic growth under various policies and measures.



▲ **GDP growth trend of Taipei City's service industry in 2020-2050**

Projection of future emissions

Taipei City's baseline scenario assumes that future technologies remain the same as in 2019 when projecting greenhouse gas emissions. After adding emission estimates for fuel combustion and non-fuel combustion, Taipei City's net greenhouse gas emissions in 2050 is approximately 12.26 million metric tons, up approximately 8.5% compared to 2020. This is due to Taipei City's economic growth mainly being driven by the service industry. If active reduction measures are not taken while maintaining steady economic growth, greenhouse gas emissions will show an upward trend.

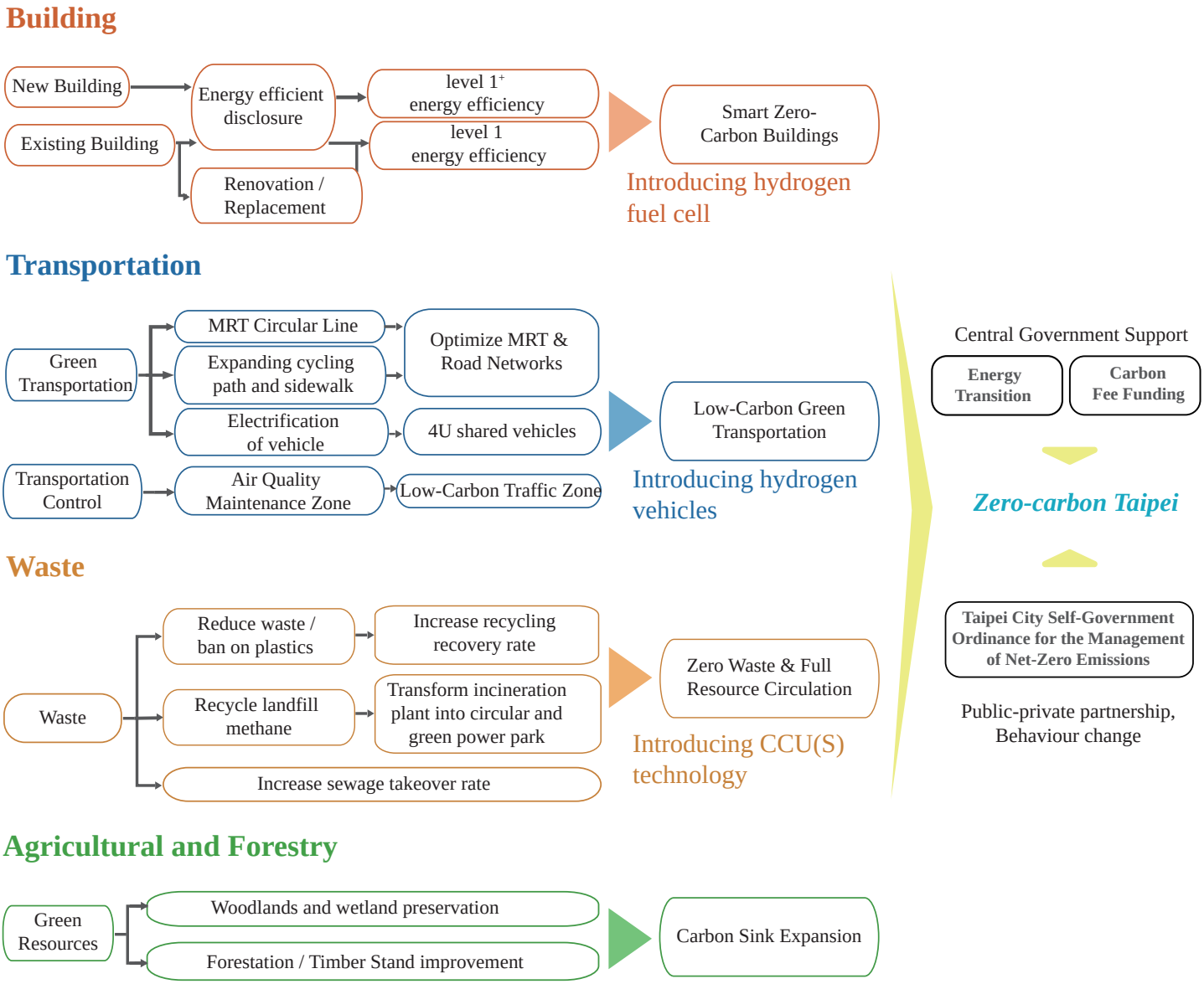


▲ **Projections of Taipei City's greenhouse gas emissions in 2020-2050 in the baseline scenario**


Photo by shutterstock

Taipei City Net-Zero Emissions Pathway in Each Sector by 2050

Taipei City's overall strategy to achieve net-zero emissions is to work with the central government and engage in public-private partnerships to achieve ***smart and zero-carbon buildings, low-carbon green transportation, zero waste and full recycling, and increase carbon sinks.*** Each sector laid out a different pathway based on its emission sources to achieve net-zero emissions by 2050:



▲ **Taipei City net-zero emissions pathway**

Smart and Zero-Carbon Buildings Pathway and Strategies

The carbon reduction pathway of Taipei City's residential and commercial sector includes building energy efficiency management, energy efficiency improvement, and the use of renewable energy/hydrogen energy to achieve net-zero emissions by 2050. The implementation of related strategies will be based on three principles: ***"from public to private sector," "new first old later," and "first demonstrate then require."*** All buildings other than general buildings will be required to meet standards for level 1^+ energy efficiency in 2050, and new buildings/commercial buildings/public buildings will be required to use at least 55% renewable energy or hydrogen energy to achieve zero-carbon buildings.[14] By continuously improving energy efficiency, the City is projected to achieve a 27% energy saving by 2050 compared to that in 2016. Implementation strategies and pathway for building energy efficiency management, energy efficiency improvement, and the use of renewable energy/hydrogen energy are as follows:

		2030	2040	2050
New buildings	Energy efficiency management	•Energy efficiency inventory and disclosure	--	--
	Improve energy efficiency	•Meet standards for level 1 energy efficiency	•Meet standards for level 1^+ energy efficiency	•Meet zero-carbon building specifications
	Renewable energy/Hydrogen energy	--	•Use more than 10% renewable/hydrogen energy	•Use 55% renewable energy/ hydrogen energy
Existing buildings	Energy efficiency management	•Cap-and-trade	•Energy efficiency accounting and disclosure	--
	Improve energy efficiency	--	•Commercial buildings must meet standards for level 1 energy efficiency	•Commercial buildings must meet standards for level 1^+ energy efficiency •General buildings must meet standards for level 1 energy efficiency
	Renewable energy/Hydrogen energy	•Import renewable energy •Hydrogen fuel cell demonstration	•Expand renewable energy •Expand the use of hydrogen fuel cells	•55% of electricity used by commercial buildings •20% of electricity used by general buildings
Public buildings	Energy efficiency management	•Energy efficiency inventory and disclosure	--	--
	Improve energy efficiency	•3% renovation of the total floor area annually •Net-zero demonstration of TOD/EOD/social housing	•3% renovation every year •Meet standards for level 1^+ energy efficiency	--
	Renewable energy/Hydrogen energy	•Import renewable energy •Fuel cell adoption	•Expand renewable energy •Fuel cell use	•Use 55% renewable energy/ hydrogen energy

Note: The 1^+ level of building energy efficiency refers to electricity density ≦ 100 kWh/m^2/year, and the 1 level is electricity density ≦ 120 kWh/m^2/year

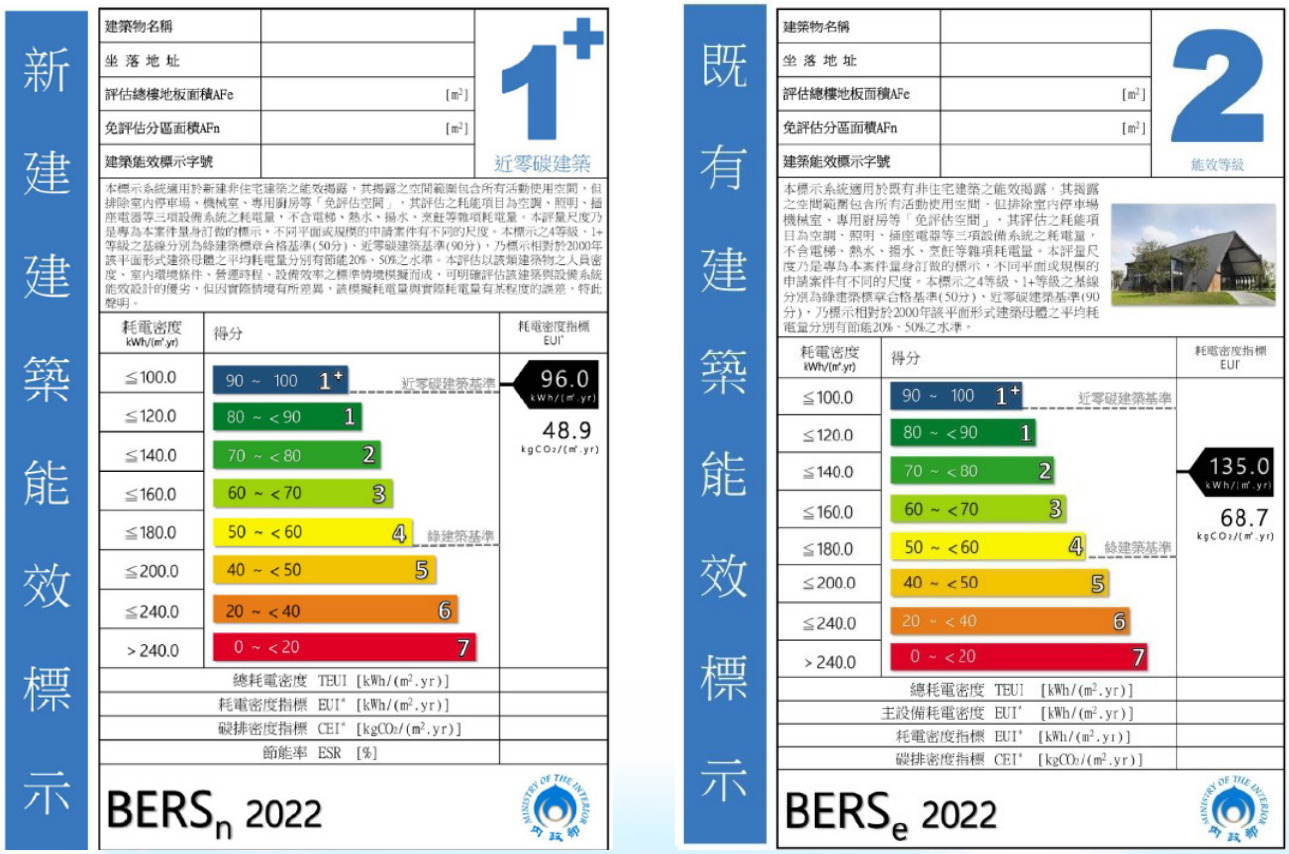
▲ Net-zero emissions pathway for the residential and commercial sector

[14] Lin Hsien-Te (2011), The First Zero Carbon Green Building in Taiwan, Science Development (Issue 460), 24-33.

Implementation strategies for building energy efficiency management

The public disclosure of building energy efficiency information not only allows citizens to understand their energy use of buildings, which is used as the basis for evaluating building energy conservation, but also provides the foundation for emission reduction management. The Architecture and Building Research Institute, Ministry of the Interior has established the building energy efficiency labeling system, and different types of buildings in Taipei City will be required to obtain building energy efficiency ratings[15] in stages in coordination with the system:

2030: New and public buildings energy efficiency inventory, disclosure, and control.
2040: Existing buildings energy efficiency inventory, disclosure, and control.



▲ **Building energy efficiency rating system**

[15]Architecture and Building Research Institute, Ministry of the Interior (2022), Green Building Assessment Manual - Building Energy Efficiency Assessment System.

Strategies to improve energy efficiency

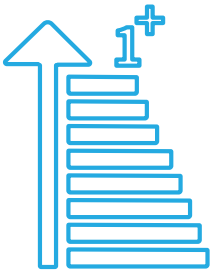
Strategies to improve energy efficiency include renovation of public buildings, raising standards for building energy efficiency, and implementing total amount control.

3% renovate public buildings

Renovate public buildings

Referencing the Green New Deal[16] in Europe, public buildings are required to renovate 3% of total floor area annually to improve energy efficiency.

Raise standards for building energy efficiency



Improve buildings meet standards for level 1^+ energy efficiency

New, existing, and public buildings will be required to reach goals for each stage based on the energy efficiency rating or level established by the Architecture and Building Research Institute:

2030: New buildings must meet standards for level 1 energy efficiency.

2040: Existing commercial buildings must meet standards for level 1 energy efficiency, and new buildings and public buildings must meet standards for level 1^+ energy efficiency.

2050: All commercial buildings must meet standards for level 1^+ energy efficiency, and general buildings must meet standards for level 1 energy efficiency.

Implement cap-and-trade

Implement cap-and-trade and carbon emissions verification system

While Taiwan's Greenhouse Gas Reduction and Management Act provides the legal basis for cap-and-trade, the residential and commercial sector accounts for the majority of emissions in both Taipei City and Tokyo. Hence, Taipei City can learn from the Tokyo Cap-and-Trade Program (TCTP) by calculating fuel, heat, and electricity consumption annually, and requiring industrial, commercial, and large buildings that reach a certain scale to verify its carbon emissions and implement carbon reduction measures. The carbon reduction compared with the baseline year must meet Taipei City's requirements, and an increasing amount must be reduced in coordination with the City's carbon budget. If the reduction in carbon emissions is higher than the requirement, the excess amount may be traded or provided to offset other buildings on the control list.

It is recommended to implement the mechanism for commercial buildings and government buildings that reach a certain scale in stage one. The buildings should be required to report and verify their emissions each year starting from 2025, so that an emissions standard can be established on this basis. As cap-and-trade system is scheduled to be implemented in 2030, other targets will be included in subsequent stages.

[16]European Commission (2021). European Green Deal - Delivering on our targets

Renewable energy/Hydrogen energy promotion strategies

Taipei City continues to step up the development of renewable energy, such as solar power, biofuel, and geothermal energy. The public sector will provide demonstrations of hydrogen fuel cell applications in 2030, expand the use of renewable energy and hydrogen fuel cells in 2040, and require buildings to comply with different percentages of renewable energy/hydrogen energy in 2050.

Public buildings: **Demonstrate building life cycle zero carbon designs through TOD/EOD, social housing, and public construction, and provide demonstrations of hydrogen fuel cell applications in 2030. At least 55% of electricity used by public buildings come from renewable energy/hydrogen energy in 2050.**

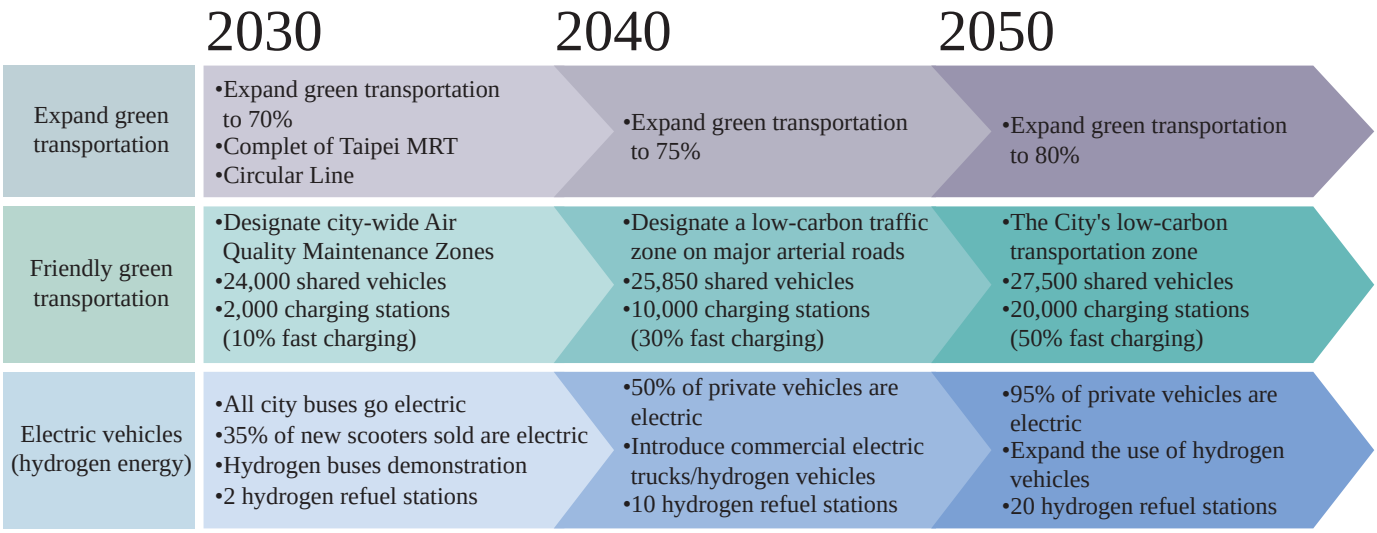
New buildings: **At least 55% of electricity used by new buildings come from renewable energy/hydrogen energy, and new buildings should meet zero carbon building specifications in 2050.**

Existing buildings: **55% of electricity used by commercial buildings and 20% of electricity used by general buildings should come from renewable energy/hydrogen energy in 2050.**

▶ Rooftop solar photovoltaic system in Tian-Mu Junior High School

Low-Carbon Green Transportation Pathway and Strategies

Taipei City's pathway for implementing green transportation mainly involves expanding the use of green transportation, creating an user-friendly environment for green transportation, and introducing electric (hydrogen) vehicles. Relevant strategies are implemented based on three principles:***"subsidize first, control later," "large vehicles first, small vehicles later," and "electric first, hydrogen later."*** Strategies and pathway for expanding the use of green transportation, creating an user-friendly environment for green transportation, and introducing new energy vehicles are explained as follows:



▲ **Net-zero emissions pathway forin the transportation sector**

Implementation strategies for expanding the use of green transportation

Build the MRT Circular Line in the nation's capital

At present, 152.3 km of MRT lines in Taipei City have been completed and are providing transportation services. Combined with the approved Xinyi Line Eastern Extension, Wanda Zhonghe Shulin Line, and Circular Line North ring Section and South ring Section that are currently under construction, in addition to the Circular Line East ring Section that is currently being planned, the City aims to complete the MRT Circular Line in the nation's capital by 2030. By building a collective infrastructure of the Greater Taipei Metro

Network, the City can improve the usage rate of green transportation by citizens in Taipei and New Taipei City. The City will continue to expand its MRT network in coordination with the development of Xidong MRT and Shezidao in 2050.

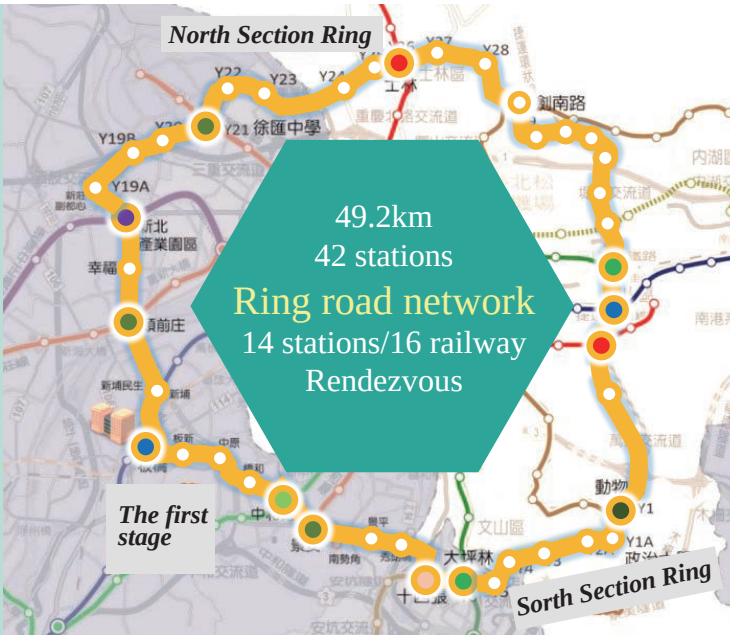
The first stage
15.4 km / 14 stations

Open to traffic in 2020

North Section Ring
14.93 km / 12 stations

South Section Ring
5.73 km / 6 stations

East Section Ring
13.2 km / 10 stations



▲ Map of the MRT Circular Line in the nation's capital

Public bicycle expansion

Besides using the MRT network as the backbone along with Taipei Metro Bus and city buses as main transit tools, the number of public bicycles will be increased to 13,240 in 2030,16,000 in 2040, and 21,500 in 2050.

▲ Youbike 2.0

Cycling path and sidewalk expansion

Citizens are provided with safe, connected, and friendly cycling paths and sidewalk network.

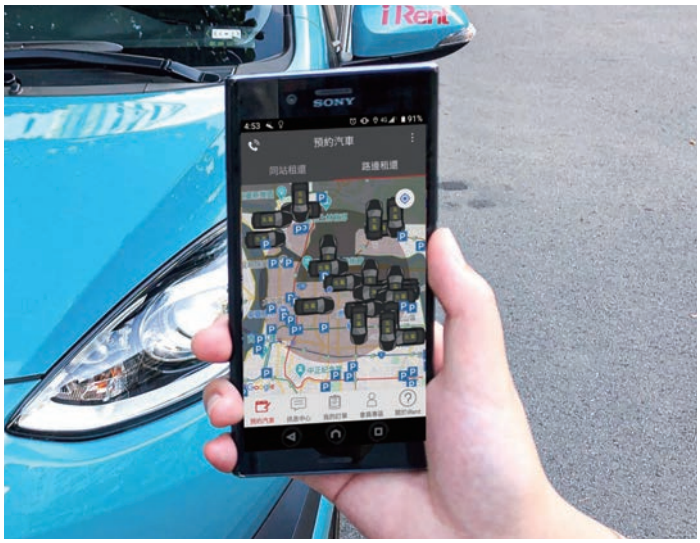
2030: Total length of cycling paths reaches 543 km
2040: Total length of cycling paths reaches 596 km

Expand shared transportation

Taipei City will properly utilize idle equipment and sites (including shared parking space, shared vehicles, and carpooling) based on the concept of resource sharing. As of 2021, Taipei City had a total of 13,556 shared scooters and 1,300 shared vehicles. Taipei City is actively implementing the "4U" initiative to integrate YouBike, U-Motor, U-Car, and U-Parking services to make transportation more convenient. Taipei City will continue to increase the number of shared transportation in the future, and goals for each stage include:

2030: 22,200 shared scooters/2,200 shared vehicles
2040: 23,500 shared scooters/2,350 shared vehicles
2050: 25,000 shared scooters/2,500 shared vehicles

▲ Shared scooters



▲ Shared vehicles

Implementation strategies for creating an user-friendly environment for green transportation

City-wide air quality maintenance zone by 2030

By implementing the "Clean Air Action Plan 2.0" to create a healthy environment for citizens to breathe freely, Taipei City has successfully lowered the annual average concentrations of $PM_{2.5}$ from 19.6 $\mu g/m^3$ in 2014 to 12.1 $\mu g/m^3$ in 2020, an improvement reaching 38.3%; the City's $PM_{2.5}$ concentration has met national standards for three consecutive years, and the city area was upgraded from a level 3 control area to level 2 control area. Taipei City will continue to dedicate its efforts to achieve the annual average concentration of 10 $\mu g/m^3$ recommended by the WHO by 2030.

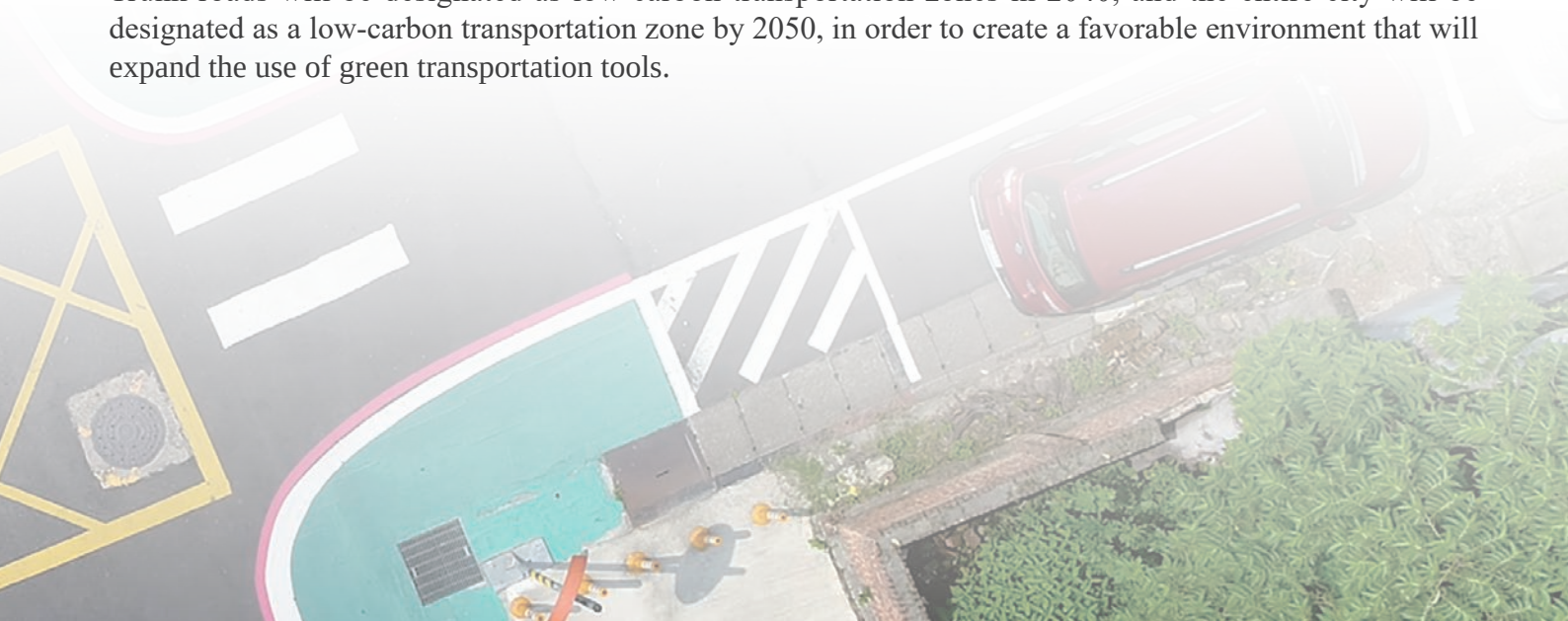
Taipei City prioritized the planning of 3 long-distance transit bus stations and 6 scenic spots into the first phase of air quality maintenance zones in 2020, in order to continue improving air quality. In 2021, Taipei City has expanded 3 incinerators and Taipei Songshan Airport into the second phase of air quality maintenance zones, and will expand the scope of the air quality maintenance zones annually, increasing the use of green transportation with the goal of expanding the air quality maintenance zones to city-wide by 2030.

Smart traffic lights

Taipei City has been installing smart traffic lights to improve the efficiency of traffic flow, and aims to install smart traffic lights at 576 intersections (39%) by 2030 and 1,480 intersections (100%) by 2040.

Designate low-carbon transportation zones

Trunk roads will be designated as low-carbon transportation zones in 2040, and the entire city will be designated as a low-carbon transportation zone by 2050, in order to create a favorable environment that will expand the use of green transportation tools.



Increase charging parking spaces

As of June 2021, Taipei City had completed 368 charging parking spaces. Social housing is currently required to provide electric vehicle chargers for at least 10% of parking spaces. The ratio of parking spaces with pipelines for charging electric vehicles in new buildings will be sequentially increased from 10% to 100%. Government-led urban renewal areas and TOD areas with increased volume must provide electric vehicle chargers in at least 20% of parking spaces. In the future, an increasing number of roadside parking spaces will be equipped with charging facilities, combined with a certain percentage of fast charging facilities:

2030: 2,000 roadside parking spaces with charging facilities (10% fast charging)
2040: 10,000 roadside parking spaces with charging facilities (30% fast charging)
2050: 20,000 roadside parking spaces with charging facilities (50% fast charging)

Low-carbon transportation at Taipei Songshan Airport

The goal is for Taipei Songshan Airport to achieve net-zero emissions, and domestic flights from Taipei Songshan Airport to use sustainable aviation fuel.

▶ Charging parking spaces in Taipei City Hall Building

Introduce novel energy vehicles

In light of the technological advancements made in new energy vehicles, the City's direction for promoting new energy vehicles is to prioritize the expansion of electric vehicles built on mature technology, and gradually introduce new energy vehicles in coordination with hydrogen energy vehicle demonstrations.

Increase electric vehicles

Taipei City has proposed plans to transit its city buses to electric, subsidize electric scooters, establish infrastructure in 2030, and provide citizens with a friendly environment for using electric vehicles by creating air quality maintenance zones and low-carbon transportation zones, as well as convenient charging facilities.

2030: All buses/municipal vehicles are electric and 35% of new scooters sold are electric
2040: 50% of private vehicles are electric
2050: 95% of private vehicles are electric

Establish hydrogen refuel stations

Besides expanding the use of electric transportation, the international community has begun to develop hydrogen vehicles. According to the IEA report, hydrogen energy will play a key role in achieving net-zero emissions by 2050. Hence, Taipei City will accumulate experience through hydrogen bus or municipal vehicle demonstration projects, and gradually increase the number of hydrogen refueling stations to provide a convenient environment for using hydrogen vehicles, establishing complete hydrogen infrastructure for the public sector by 2030.

▲ **Taipei electric buses**

Zero-Waste and Full- Recycling Pathway and Strategies

The City's waste management aims to achieve ***"zero waste, full recycling"*** when planning waste management policies and treatment facilities for the next 30 years. Incinerators will be gradually transformed into highly efficient green energy power plants. Combined with kitchen waste anaerobic digestion power plants, bottom ash fine screening and washing plants, and recycling plants, the City creates a Green Energy Circular Park with the principles of "zero waste, full recycling". Different types of waste will be put into corresponding treatment facilities and converted into renewable energy and reusable materials. Carbon emissions in the waste treatment process will be gradually reduced in coordination with the development of CCUS technologies, and achieve the goal of net-zero emissions in the waste sector by 2050. Related strategies and projected pathway are as follows:

		2030	2040	2050
Zero-Waste	Source reduction	•Achieve 70% resource recovery rate •Complete ban on disposable tableware •Complete ban on disposable plastics	•Achieve 75% resource recovery rate	•Achieve 80% resource recovery rate
	Increase in sewage treatment rate	•94% of population served by sewage treatment systems	•97% of population served by sewage treatment systems	•98% of population served by sewage treatment systems
Full-Recycling	Green power circular industry park	•Launch of green energy power plant •Launch of biomass power plant •Launch of resource waste screening plant •Complete reuse of incineration bottom ash	•CCU(S) technology introduced in green energy power plants	Waste disposal facilities achieve net-zero emissions

Note: Carbon Capture, Utilization (and Storage), CCU(S).

▲ **Net-zero emissions pathway for the waste sector**

Implementation strategies for zero waste

Waste treatment and sewage treatment are the main emission sources in the waste sector, and the fundamental approach is to reduce emissions source:

Increase resource recovery rate

Taipei City continues to implement recycling and reuse measures to reduce waste from the source and achieve sustainable use of materials. Taipei City is increasing resource recovery rate each year through

[17]Chiu Fan-Ping (2020), Overview of International Carbon Capture, Use, and Storage Technologies, Taiwan Industrial Greenhouse Office, special topic in May 2020.

[18]CCU(S) refers to "Carbon Capture, Utilization (and Storage)" Technologies.

public-private partnerships, reaching 64.6% as of the end of 2020. In the future, the City will continue to increase its resource recovery rate to 70% in 2030, 75% in 2040, and 80% in 2050.

Ban the use of disposable tableware and disposable plastics

In light of the environmental hazard and health risks caused by misuse of disposable tableware, the City continues to expand the ban on the use of disposable tableware, based on the principles of "from public to private sector" and from inside out. All disposable tableware and disposable plastics will be banned by 2030 to reduce waste generation.

▲ Circular containers

Comprehensive use of circular containers

The use of circular containers will be required as mandatory by 2030 to achieve the goal of waste reduction by reducing the use of disposable containers.

Increase in sewage treatment rate

In addition to Dihua and Neihu Sewage Treatment Plants, which are already operating, Taipei City continues to plan the construction of Minsheng, Binjiang, and Shezidao Water Resources Recycling Centers to increase the ratio of sewage that is properly treated. Minsheng Water Resources Recycling Center is expected to begin service in 2025. Furthermore, Taipei City will continue to connect its pipelines to sewers to increase the percentage of population served by sewage treatment plants. The goal is to increase the percentage of population served by sewage treatment plants to 94% in 2030, 97% in 2040, and 98% in 2050.

▲ Sewerage engineering

Implementation strategies for full recycling

Complete recycling of methane from landfills

All methane from Taipei City's landfills is already being recycled for power generation, and will continue to be properly managed in the future so that all methane continues to be recycled.

Transform waste treatment facilities into a Green Energy Circular Park

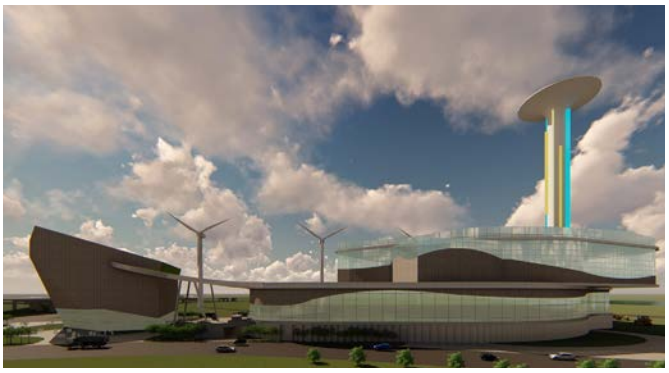
The City's highly efficient green energy power plants comply with the recognition standard of Bureau of Energy for determining "Waste-to-Energy (WtR) equipment". Waste is put into the incinerator after pre-processing, and water-cooled grate (design heating value of approximately 2,600-3,000 kcal/kg) can be used. The design unit power generation capacities amount to 750 kWh/metric tons and above, with power generation efficiency reaching 25% and higher.

Biofuel anaerobic digestion power plants also comply with the recognition standard defined by the Bureau of Energy's definition of "biomass power generation equipment". With organic materials as the material source, biogas generated through anaerobic digestion then converts into electricity. The design scale is estimated at 250 metric tons/day, and the installed utility capacity of generators amount to 1,900 kW.

Bottom ash fine screening and washing plants use multiple stage screening equipment to extract valuable metals from the products of green energy power plants (fly ash and bottom ash from incinerators), and then wash the metals to remove or reduce salt content. The materials are used as fine aggregate in construction or as raw materials of cement plants, reducing carbon emissions from mining natural aggregate.

Resource screening plants use a drum sieve, magnetic separator, reciprocating sieve, manual sorting, and optical sorting machine to divide 11 recyclable categories into 22 categories, which increases the price and industrial value of materials, achieving carbon reduction through recycling and reuse.

As for sewage treatment facilities, the goal is to develop sludge anaerobic digestion power generation by 2030, and develop co-digestion power generation by 2040.



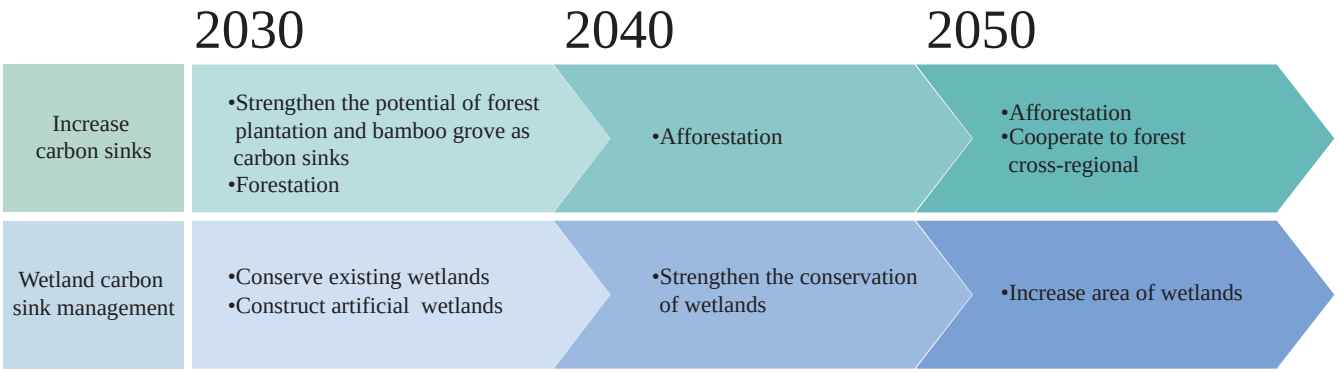
▲ **Green energy power plant (schematic diagram)**

Incorporate CCU(S) technology into waste treatment facilities

Globally, countries are currently developing CCU(S) technologies as an extremely important technology for greenhouse gas emission reduction, in order to achieve net-zero emissions. Taipei City will continue to follow international developments in CCU(S) technology, and expect it to reach maturity. Taipei City plans to begin building renewable energy power plants in 2040, and will apply CCU(S) technology to power generation equipment in the Green Energy Circular Park by 2050.

Agricultural and Forestry Sector Pathway and Strategies

Carbon sink sources are an important foundation for offsetting Taipei City's carbon emissions to achieve net-zero emissions. To increase carbon sequestration by forests and conserve wetlands to offset greenhouse gas emissions from other sectors, the carbon sink pathway for agricultural and forestry sector includes forestry management and afforestation. Relevant strategies and projected pathway are as follows:



▲ **Net-zero emissions pathway for the agricultural and forestry sectors**

Increase carbon sequestration by forests

Strengthen the management of artificial forests and bamboo forests

Taipei City currently has approximately 1,295 hectares of artificial forests, mixed forests, and bamboo forests. Through actively managing the forests, the City has gradually transformed the forests into rapidly-growing healthy artificial forests.

Afforestation

Besides managing existing forests, if Taipei City plants 10 hectares of trees annually, the forest will expand by approximately 300 hectares by 2050. Furthermore, Taipei City can increase its carbon sequestration capacity through cross-sector collaboration in afforestation.

Recycle and reused wood-based products

Wood-based products are a storage pool of carbon, showing benefits of delayed emissions, until destroyed then release carbon back to the atmosphere. If wood-based products are conserved well and reused, they can keep carbon in storaged and substitute artificial ones. Taipei City organize furniture recycling and repairment for reusing, not only reduce waste at sources but also delay carbon emissions.

Wetland carbon sink management

Currently, wetlands in Taipei City include Guandu Nature Reserve, Nangang 202 Arsenal, Shezidao, Jinrui Water Control Park, Dagou River Ecology and Water Control Park, and Menghuan Lake. Wetland ecology creation and conservation work should be carried out, and new artificial wetlands should be created to increase the carbon sequestration capacity of wetlands.

▶ Jinrui Riverside Park

Related Measures

Behaviour change of citizens and bottom-up emission reduction

▲ Promotion of circular cups

The goal of net-zero emissions cannot be achieved if the transformation process for achieving net-zero emissions relies solely on low-carbon technologies without active and voluntary participation of citizens. Behaviour change is of utmost importance. The reduction of greenhouse gas emissions cannot rely merely on policies in a top down approach. It is also necessary to change people's behavior, including reducing excessive use or waste of energy, and replacing equipment with energy-efficient products to reduce energy consumption; not buying over-packaged products and bringing one's own bags, cups, and tableware to reduce resource consumption; Providing public transportation discounts, reducing the use of private vehicles, and switching to green transportation. The IEA's report on the pathway to net-zero emissions pointed out that these changes in daily life will on average reduce 10-15% of energy-related activities, and contribute approximately 8% of carbon reduction.

Uphold fairness and justice and hold users accountable for the environment

Different emission sources must bear different responsibilities in response to carbon reduction requirements, so that it is fair to the environment. Companies must fulfill their corporate social responsibility by helping communities and SMEs reduce their carbon emissions, in order to offset the increase in greenhouse gas emissions from development or use.

Expand citizen participation and public-private partnerships to jointly create a "Zero-Carbon Sustainable Taipei"

▲ Citizen Power Plant in Guan-Du Junior High School

Climate change involves a wide range of issues, whether it is mitigation or adaptation, the issues must become a part of people's daily lives. Opinions of industries, academia, and citizens will be gathered and studied, and citizens' awareness of climate-related issues, such as adaptation, will be raised through citizen participation, enhancing their knowledge and consolidate public consensus to jointly face the issues brought by climate change.

Build urban climate adaptability to withstand the impact of extreme weather

Taipei City continues to implement its existing adaptation strategy in response to the high temperatures, cold current, rain storms, and droughts brought by extreme weather. Taipei City planned a long-term adaptation pathway with consideration to the need to improve its disaster prevention and response capability, including the capacity of sewers for rainwater and response to high temperatures. Taipei City also proposed long-term adaptation plans that consider people's needs, including water resources and food supply. With corresponding measures, Taipei City is developing into a Sponge City to increase its resilience.

Expand global participation through international cooperation

It is necessary to build international partnerships and look into international carbon reduction technologies to respond to climate change issues. This way, feasible technologies can be selected based on Taipei City's characteristics to achieve carbon reduction goals. Furthermore, Taipei City will promote its carbon reduction achievements by participating in international organizations and related events, and share its efforts in response to climate change during international exchanges with sister cities, thereby increasing Taipei City's international visibility and ensuring its international competitiveness.

▲ 2020 Taipei Climate Action International Forum

Costs and Business Opportunities Under the Net-Zero Goal

Setting out the goal of 2050 net-zero emissions is an opportunity for urban transformation and upgrade. To deliver the goal, not only does the government need to invest large amounts of resources, companies and citizens also need to invest their funds in the process of achieving net-zero emissions. The funds may be used to replace old and inefficient vehicles, electric appliances, and industrial equipment, or to renovate existing buildings, and expand research and development of innovative materials, technologies, and new energy sources for carbon reduction. Thus, despite the substantial economic costs to promote net-zero emissions, carbon reduction actions can offer enormous business opportunities. An example of investments in MRT, bus, and electric scooters in the transportation sector over the next decade would be the following:

▲ **Taipei City buses go electric**

- With the goal to complete the MRT Circular Line in the nation's capital by 2030, funding required for construction will reach NT$367.6 billion.
- To achieve 100% electric for all 3,500 buses in Taipei City, it is estimated that each electric bus costs NT$10 million. Combined with government subsidies along with investments by bus companies, the estimated cost will reach a total of NT$35 billion.
- With the goal for electric scooters to account for 30% of all scooters in Taipei City, approximately 240,000 scooters still need to be replaced by 2030. Using NT$80,000 per electric scooter for calculation, government subsidies plus the amount paid by citizens will reach NT$19.2 billion.

Take the City’s transportation sector for example. The amount of funds that needs to be invested by the government, companies, and citizens before 2030 to achieve only 3 goals already reaches approximately NT$421.8 billion. Combined with other carbon reduction strategies that will be implemented until 2050, such as renewable energy, new energy (hydrogen energy), residential and commercial, transportation, and waste, it is certain that the momentum for change and transformation in different aspects of Taipei City will be mobilized, thus allowing the green economy to thrive while creating considerable employment and business opportunities. If Taipei City can seize this once-in-a-lifetime opportunity brought by global transformation, the City will become part of the global industrial chain for achieving net-zero emissions, and can seek subsequent development opportunities.

Action Plan for Net-Zero Emissions

According to the City's net-zero pathway, the short-term goal is to achieve a 30% reduction by 2030 compared to 2005; the interim target is to reduce 65%; the long-term goal is to achieve net-zero emissions by 2050. In 2020, the City's greenhouse gas emissions were approximately 11.388 million tons. The short-term reduction target is to be achieved by 2030, the remaining carbon emissions are estimated at 2.236 million tons. It is necessary to promote the reduction strategies actively and thoroughly implement them.

In line with national policies and international technology development, the City adopts a slow and then accelerated approach to carbon reduction planning. Based on the four major sectors (residential and commercial, transportation, waste, and agricultural and forestry), the City has proposed 9 key policies for carbon reduction, covering a total of 23 action plans.

The residential and commercial sector will focus on replacing high energy-consuming equipment. Through the integration of public-owned smart and green buildings demonstrations and energy-conserving design for building shell, a new carbon reduction landmark is established for buildings in the future, supporting the gradual transformation into zero-carbon buildings. The residential and commercial sector outlines 4 core policies and 10 action plans.

The transportation sector centers on constructing a complete green transportation network, and is emphasized on increasing increase the public transportation usage rate and enhancing e-mobility for vehicles. Moreover, to popularize and accelerate the transformation of low-carbon vehicles, the transportation sector outlines 2 core policies and 5 action plans.

The waste sector focuses on the gradual reduction of waste generation through reduction at source and reusing of resources. By turning incineration plants into green energy circular parks, waste treatment facilities can achieve net-zero emissions. The waste sector outlines 2 core policies and 5 action plans.

In the agricultural and forestry sector, the enhancement and management of green resources serve as the core policies. Urban green cover and carbon sequestration capacities of the City can be strengthened by combining the spaces of Garden City, green spaces in parks, and street trees and promoting the restoration of forest composition and structure. The agricultural and forestry sector outlines 1 major policies and 3 action plans.

In the future, the City's net-zero emissions operations will be carried out in accordance with the above policies and action plans, and will be adjusted on a rolling basis depending on the evolution of net-zero technologies. According to the net-zero emission action plan listed above, the total estimated investment is approximately NT$ 27.321 billion, covering 150 carbon reduction and adaptation plans in 2022. Relevant operation details, administrative organizations, and implementation fundings are shown in the Appendix. The estimated investment for each respective sector in 2022 is as followed: NT$7.007 billion for the residential and commercial sector; NT$18.469 billion for the transportation sector; NT$951 million for the waste sector; NT$ 894 million for the agricultural and forestry sector. With these actions, Taipei City can meet its second-phase greenhouse gas control goal, reducing carbon emissions by 20% in 2025.

▼ Four major sectors action plan for net-zero emissions

Sector	Policy	Action plan
Residential and Commercial sector	Residential and Commercial Electricity Saving Project 2.0	Replacing high energy-consuming equipment
		Counseling energy conservation of industrial and commercial businesses
	Demonstration of net-zero public buildings	Smart green buildings
		Urban net-zero emissions plan
		Demonstration of hydrogen energy adoption
		Energy-conserving design for building shell
	Transition to zero-carbon buildings	Building energy efficiency disclosure
		Import renewable energy
	Low-carbon living development	Climate change adaption
		Net-zero emissions education
Transportation sector	Promoting green transportation	Friendly green transportation environment
		Improve the use of green transportation used
	E-mobility for vehicles	Subsidy for phase-out of fossil fuel transportation vehicles
		Accelerate the public sector transformation
		Accelerate low-carbon transportation infrastructure
Waste sector	Waste reduction and recycling for zero waste	Waste reduction at sources
		Sewage treatment systems
	Resources recycling and reuse	Resource recycling
		Water recycling
		Green energy circular park
Agricultural and forestry sector sector	Green resources of enhancement and management	Garden city
		Increase areas of green resources
		Restoration of forest composition and structure

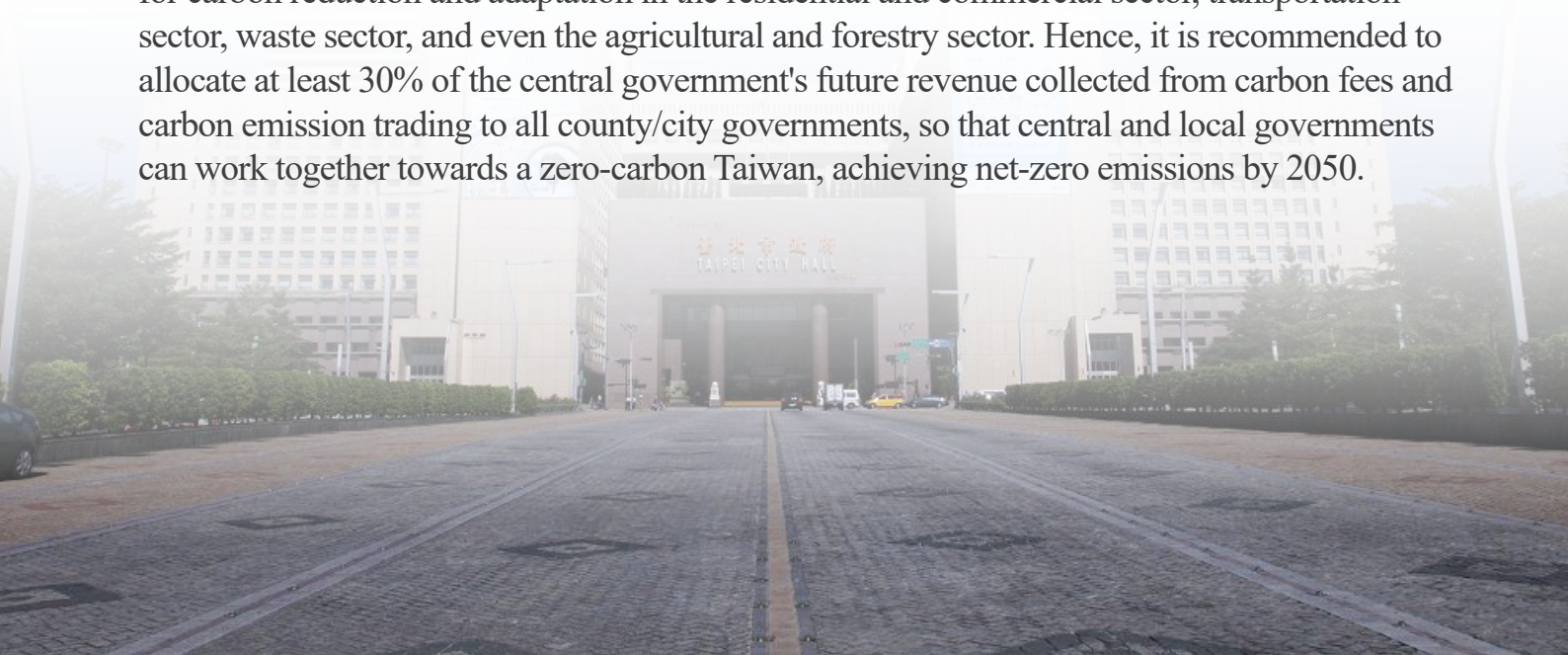
Subsequent Promotion Strategies

In addition to the proposed pathway and strategy by Taipei City, the central government needs to work with local governments in energy transformation, decarbonization of transportation and resource assistance, in order to facilitate the promotion of related reduction strategies. Moreover, Taipei City can also formulate Self-Government Ordinance, establish a climate change response supervisory Board, and establish a climate transformation fund to complete the relevant supporting facilities for moving towards net-zero emissions.

Collaboration between central and local governments to jointly achieve net-zero emissions

Taipei City's greenhouse gas emissions are mainly indirect emissions from electricity use. Instead of establishing its own large-scale power plants, Taipei City relies on national power supply, so it requires assistance from the central government for energy transition. As Taiwan works towards net-zero emissions by 2050, it is recommended that the central government complete the blueprint for the nation's energy transition by 2050 as soon as possible, in order to act faster in lowering the nation's electricity carbon emission factor to achieve decarburization. It is advised that the central government needs to work with all counties and cities in accelerating the progress of carbon reduction:

- It is recommended to set a timetable to phase out coal-fired power plants as soon as possible.
- It is recommended to build the nation's infrastructure for hydrogen energy at the earliest, establish an industrial chain from supply, transfer, to demand, formulate related technical and safety specifications, and plan for development strategies for future supply of hydrogen energy.
- It is recommended to set a timetable for banning the sale of new combustion engine vehicles, and develop towards fully electric (hydrogen) vehicles in coordination with the decarbonization of electricity.
- Cities are on the front line of carbon reduction, and all county/city governments are responsible for carbon reduction and adaptation in the residential and commercial sector, transportation sector, waste sector, and even the agricultural and forestry sector. Hence, it is recommended to allocate at least 30% of the central government's future revenue collected from carbon fees and carbon emission trading to all county/city governments, so that central and local governments can work together towards a zero-carbon Taiwan, achieving net-zero emissions by 2050.



Establish the Self-Government Ordinance for the Management of Net-Zero Emissions to write "Net-Zero goals" into law

In coordination with the central government revising the Greenhouse Gas Reduction and Management Act into the Climate Change Response Act, Taipei City will establish the ***Taipei City Self-Government Ordinance for the Management of Net-Zero Emissions*** to write the City's goals for net-zero emissions into law. The ordinance will specify the authority and responsibilities of each department relating to carbon reduction, implement the carbon budget system, guide the carbon reduction strategies and pathways of each sector and expand international cooperation. This will allow Taipei City to achieve net-zero emissions one step at a time, and enhance its competitiveness in the process.

Establish the Climate Change Response Council to oversee implementation

To raise the level of climate policy management in Taipei City, the City has established the Taipei City Climate Change Response Council. Hosted by the Mayor, the supervisory board serves as a working group that coordinates, integrates, and supervises cross-departmental operations, conducting rolling reviews of the progress and results of greenhouse gas emission reduction and climate adaptation work.

▲ **Taipei City Greenhouse Gas Reduction Supervisory Board to oversee implementation**

Establish a climate transformation fund for just transformation

The urban transformation process for achieving net-zero emissions must take into consideration the construction of a fair and just society. Taipei City will seek at least 30% of the central government's revenue collected from carbon fees, carbon transactions, and offsets to be allocated to county/city governments. Next, the funds will be used to establish Taipei City's climate transformation fund for underprivileged workers and SMEs that will have trouble significantly reducing their carbon emissions within a short period of time. Moreover, the fund will help reduce costs for citizens, companies, and laborers that are impacted the most in the transformation process, and will create re-employment opportunities to ensure just transformation.

Terminology

1. Carbon Capture, Utilization and Storage (CCUS)

CCUS refers to the separation, collection, and storage of carbon dioxide emitted in the process of industrial product production or fossil fuel being transformed into energy. The carbon may be stored in geological structures or absorbed by organisms (such as algae), and even made into other chemicals to prevent the carbon dioxide from being emitted into the atmosphere.Past efforts focused on carbon capture and storage (CCS), which successfully achieve carbon reduction goals, but also increased management costs. Adding the possibility of reuse not only realizes a circular economy, but also creates whole new industrial chains and economic models.

Given that the storage technology is not deemed fully mature yet, and the storage potential and feasibility of carbon dioxide geological storage in Taiwan are still under investigation and assessment, Taipei City will focus on carbon capture and utilization (storage) of the CCU(S) technology.

2. Zero-carbon buildings (Net-zero buildings)

With consideration to the carbon emissions in a building's life cycle, nearly zero energy consumption and net-zero carbon emissions is achieved through the selection of construction materials, reduction of energy demand, improvement of energy efficiency, and use of renewable energy.

3. Air Quality Maintenance Zones

A designated area where actions that may cause air pollution are controlled. Pursuant to Article 40 of the Air Pollution Control Act: Competent authorities at all levels may, depending on air quality and characteristics of pollution, plan and install air quality maintenance zones and implement control measures for mobile pollution sources. Controls of mobile pollution sources in the preceding paragraph may include the following measures:

- Prohibit or limit access of specific motor vehicles;
- Prohibit or limit any fuels, power types and operation conditions used by mobile pollution sources, status of operation, and access; or
- Take other control measures that improve air quality.

4. Low-carbon transportation zones

Can be defined as areas where only specific types of vehicles (electric vehicles, hybrid vehicles, or hydrogen vehicles) or vehicles that meet standards for energy efficiency or carbon emissions per kilometer may enter during specific hours; other vehicles will be required to pay a fee or even denied entry.

5. Business As Usual (BAU)

BAU refers to projections of trends in greenhouse gas emissions if no carbon reduction measures are taken.

Appendix – Action Plan for Net-Zero Emissions

Residential and commercial electricity saving project 2.0

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
1	Replacing high energy-consuming equipment Replacing high energy-consuming equipment	Adopt indoor energy-saving lighting equipment in public rental housing and social housing.	Replace 1,200 lamps with energy-saving ones	Replace with 10,800 energy-saving lamps cumulatively	Department of Urban Development
2		Replace old air conditioners.	Replace 14 air conditioners: 9 ceiling type air conditioners(8.0 kW), 2 concealed air conditioners(7.1 kW) and 3 concealed air conditioners (10 kW)	Replace 289 air conditioners in total	Department of Civil Servant Development
3		Replace pumping stations in existing buildings.	Replace 7 pumping stations	Upgrade 28 pumping stations	Public Works Department
4		Adopt energy-saving air conditioners in existing buildings.	Replace 47 old air conditioners in factories and offices	Replace 268 old air conditioners in factories and offices	
5		Air conditioning system improvement at 8F, 10F and climbing gym in Youth Development Office by 2022.	Reduce 5,053 kg CO_2e	Reduce 5,053 kg CO_2e	Youth Development Office
6		Replace old lamps with LED ones and air conditioning ice water temperature increased moderately in equipment rooms.	Reduce electricity by 31,200 kWh	Reduce electricity by 31,200 kWh	Astronomical Museum
7		Replace old air conditioners with environmentally friendly inverter or level 1 energy efficient air conditioners.	Replace 3,791 old air conditioners	Replace 2,605 old air conditioners	Department of Education
8		Replace water chillers with high efficient ones.	Replace 8 water chillers	Replace 15 water chillers	
9		Replace old lamps with high efficient LED lamps.	Replace 5,000 lamps	Replace 10,000 lamps	
10		Replace lamps in school's gyms with LED.	23 schools (replace up to 1,973 lamps)	236 schools cumulatively	
11		Replace old equipment, including air conditioners, fluorescent lamps and power supply improvement.	Replace 30 air conditioning equipment and 800 lamps	Replace 125 air conditioning equipment and 1000 lamps	Taipei Zoo
12		Replace high energy-consuming equipment in gym.	A gym replaces 113 light tubes with high energy efficient ones.	Replace old lamps in one gym high energy efficient ones	Department of Sports

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
13	Replacing high energy-consuming equipment	Replace old air conditioners with environmentally friendly inverter or level 1 energy efficient air conditioners.	Replace 25 air conditioners	Replace 260 air conditioners	Department of Sports
14		Replace water chillers with high efficient ones.	Replace 2 water chillers	Replace 8 water chillers	Fire Department
15		Replace old air conditioners with environmentally friendly inverter or level 1 energy efficient air conditioners.	4 air conditioners	A cumulative total of 20 air conditioners	Department Of Compulsory Military Service
16		Lamps in offices are all replaced with LED.	100%	100%	Taipei Water Department
17		Lamps in offices are all replaced with LED.	100%	100%	Engineering Division, Taipei Water Department
18		Ductless air conditioner are all replace by 2025.	Replace 24 ductless air conditioners, equal to 22% completion progress	Replace a cumulative total of 111 ductless air conditioners, equal to 100% completion progress	Taipei Water Department
19		Replace old air conditioners with environmentally friendly inverter or level 1 energy efficient air conditioners.	Replace 1 air conditioner, equal to 6% completion progress	Replace a cumulative total of 17 air conditioners, equal to 100% completion progress	Engineering Division, Taipei Water Department
20		Replace water chillers with high efficient ones.	6 water chillers	1 water chiller	Department of Land Administration
21		Replace old air conditioners with environmentally friendly inverter or level 1 energy efficient air conditioners.	8 air conditioners	123 old air conditioners	Department of Civil Affairs
22		Replace old lamps with high efficient LED lamps.	1,285 lamps	-	Arts Promotion Office
23		Replace old air conditioners with environmentally friendly inverter or level 1 energy efficient air conditioners.	8 air conditioners	-	Taipei Fine Arts Museum
24		Replace water chillers with high efficient ones.	1 water chiller	-	
25		Replace old lamps with high efficient LED lamps.	2,3000 lamps	About a cumulative total of 170,000 lamps	Taipei Rapid Transit Corporation
26		Replace old hydraulic elevators with machine room-less elevator.	4 elevators	A cumulative total of 52 elevators	
27		Replace old lamps with high efficient LED lamps.	Replace 140 lamps and 140 bulbs	-	Hakka Affairs Commission

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
28	Replacing high energy-consuming equipment	Replace old air conditioners with environmentally friendly inverter or level 1 energy efficient air conditioners.	1 air conditioner	2 air conditioners	Department of Health
29		Replace old air conditioners with environmentally friendly inverter or level 1 energy efficient air conditioners.	2 air conditioners	0 air conditioner	Department of Traffic Engineering Office
30		Subsidy for replacing with energy-saving equipment for service industry.	Reduce an estimate of 17.5 million kWh of electricity annually	A cumulative total of 173 million kWh of electricity annually	Department of Economic Development
31		Subsidy for replacing household energy-consuming equipment, including lighting, air conditioners and refrigerators.	Subsidize 30 thousand energy-consuming equipment replacement, including 18 thousand air conditioners and 12 thousand refrigerators	A cumulative total of 270 thousand equipment	Department of Environmental Protection
32		Subsidy for replacing community energy-consuming equipment, including lighting, air conditioners and refrigerators.	Implement in 100 communities	A cumulative total of 900 communities	
33	Counseling energy conservation of industrial and commercial businesses	Energy efficient lighting signboard advertising.	Newly applied lighting signboard advertising equip with energy-saving lighting. Reduce 80.884 CO_2e/yr in 2022.	Reduce a cumulative total of 210 tons CO_2e/yr	Department of Urban Development
34		Promote energy saving in businesses.	Energy-saving consultation for 90 industrial and commercial companies; track 270 businesses under guidance in past 3 years; law inspection and advocacy for 3,000 businesses	A cumulative total of energy-saving consultation for 810 industrial and commercial businesses; track 2,430 businesses under guidance in nearly 3 years; law inspection and advocacy for 27,00 businesses	Department of Economic Development
35		Strengthen the guidance of energy-saving for industrial and commercial businesses(energy usage above 800 kW).	Energy-saving consultation for 280 industrial and commercial businesses	A cumulative total of consultation for 2,520 industrial and commercial businesses	Department of Economic Development

Demonstration of net-zero public buildings

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
36	Smart green buildings	Complete introduction of Green Building Labeling Regulation in social housing.	8 social housing	Depend on the planning of social housing to set goals	Department of Urban Development
37		Complete introduction of new buildings energy efficiency index in social housing.	1 social housing	Depend on the planning of social housing to set goals	
38		New buildings obtain green building labels based on Taipei City's Green Buildings Self-Governance Ordinance.	New buildings reduce 33,620 tons CO_2e/yr	Reduce a cumulative total of 495,800 tons CO_2e/yr	

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
39	Smart green buildings	Ratio of green building materials used in interior decoration of existing buildings.	65% of green building materials used in interior decoration	1. Increase to 80% for general buildings 2. Increase to 82% for social housing and public-owned buildingss	Department of Urban Development
40		Reward for urban renewal green buildings.	Green buildings aim to achieve 1,747.81 tons CO_2e/yr carbon reduction	Carbon reduction of green buildings achieve 1,747.81 tons CO_2e/yr	
41		New construction of school dormitories.	Completion of 4 smart and green school dormitories	A total of 47 smart and green school dormitories	
42	Urban net-zero emissions plan	Complete construction of green roof in social housing.	4,187.88 m^2 green roof area	Depend on the planning of social housing to set goals	Department of Urban Development
43		Incorporate circular economy model.	Build a circular economy social housing demonstration (Build from February 2019 to April 2024)	Depend on the planning of social housing to set goals	
44		Revise a detailed project for “Taipei City's public transportation-oriented areas that can apply for development licenses”.	Complete detailed project revision	-	
45		Increase green coverage ratio.	Maintain the construction of green roof of 236 schools	236 schools	Department of Education
46		EOD.	2 EOD schools	A cumulative total of 39 schools	
47		Carbon reduction research for public works excluding buildings	Complete the research on the “strategies of public works (exclude buildings) towards Net-zero emissions by 2050”	Based on the result of the “strategies of public works (exclude buildings) towards net-zero emissions by 2050 research” to implement the subsequent low-carbon operations	Public Works Department
48		Engineering materials carbon verification.	No appropriate works	2 cases (1: bridge; 1: road; database construction)	
49		Smart zero-carbon residential building planning projects for Shezi Island.	Complete Shezi Island residential PCM project and engineering outsourcing, as part of smart zero-carbon building planning	Residential building projects achieve level 1 energy efficiency	Department of Land Administration
50	Demonstration of hydrogen energy adoption	Hydrogen energy transition of environmental education cabin.	Complete the expansion of solar PV system and construction of hydrogen fuel cell.	-	Department of Environmental Protection
51	Energy-conserving design for building shell	New buildings obtain gold level green building labels based on Taipei City’s Green Buildings Self-Governance Ordinance.	2 buildings	2 buildings	Fire Department
52		New buildings obtain bronze level green building labels based on Taipei City’s Green Buildings Self-Governance Ordinance.	1 building	1 building	

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
53	Energy-conserving design for building shell	New buildings obtain diamond level green building labels based on Taipei City's Green Buildings Self-Governance Ordinance.	1 building (complete in 2021 and obtain diamond green building label in 2022)	1 building	Fire Department
54		New buildings obtain diamond level green building labels based on Taipei City's Green Buildings Self-Governance Ordinance.	1 building (complete in 2023)	1 building	Department of Education
55		New buildings (Second Funeral Phase II Reconstruction Project) obtain gold level green building labels based on Taipei City's Green Buildings Self-Governance Ordinance.	1 building (complete in 2023)	-	Mortuary Services Office
56		Existing buildings' shell improvement obtain diamond level based on Taipei City's Green Buildings Self-Governance Ordinance.	1 building (complete in 2023)	1 building	Department of Education
57		Existing buildings' shell improvement obtain gold level based on Taipei City's Green Buildings Self-Governance Ordinance.	1 building (complete in 2023)	1 building	

Transition to zero-carbon buildings

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
58	Building energy efficiency disclosure	Large buildings energy efficiency disclosure.	Visit and assist 50 buildings	100%	Department of Environmental Protection
59	Import renewable energy	Recycling of biogas for reuse.	Complete the carbon reduction inventory of biogas recycling for reuse	Replace 17 anaerobic digestion equipment gradually and reduce 21,000 tons of CO_2e compared to that in 2022	Public Works Department
60		Promote Taipei City's solar PV electricity.	Install 55,000 kW of solar power capacity	Cumulative installed solar capacity of 66,000 kW	Department of Economic Development
61		Assist large energy households with a certain contracted capacity to build renewable energy, energy storage, or purchase renewable energy certificates.	2,541 kW electricity generation	15,919 kW electricity generation	
62		Introduce renewable energy.	Install 21,000 kWp of solar capacity on roofs	21,000 kWp	Department of Education
63		Introduce renewable energy.	Install 100 kWp of solar capacity on court	A cumulative total of 2,000 kWp	

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
64	Import renewable energy	Introduce renewable energy.	Introduce renewable energy roof in a school with solar installation	A cumulative total of 7 schools	Department of Education
65		Renewable energy generation system widely installed in social housing.	Installed capacity of 363.13 kWp	Depend on the planning of social housing to set goals	Department of Urban Development
66		The municipal building participates in the planning of solar power installation on the public premises of the Department of Economic Development.	Participate in the assessment of solar power installations (50%)	Participate in the tender of solar equipment (100%)	Secretariat, Taipei City Government
67		Renewable energy action plan.	200 million kWh electricity generation	200 million kWh electricity generation annually	Taipei Feitsui Reservoir Administration

Low-carbon living development

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
68	Climate change adaption	Increase the permeable pavement in parks.	Increase 13,000 m²	117,000 m²	Public Works Department
69		Increase rainwater harvesting in park.	Increase capacity of 300 m³	2,700 m³	
70		Increase the share of runoff in parks.	25,000 m²	200,000 m²	
71		Permeable pavement for sidewalks.	25,000 m³	200,000 m³	
72		Porous asphalt concrete (PAC) pavement.	13,400 m²	107,200 m²	
73		New or existing buildings/urban large flood detention pond.	The volume of detention pond accumulates to 210,500 m³	The volume of detention pond accumulates to 221,500 m³	
74		New or existing building/ base development outflow suppression.	Water retention volume accumulates to 15,000m³ under public and private land development	Cumulative increase to 63,000 m³	
75		Set up permeable pavement and recycle surface water to conserve groundwater resources.	3,000 m²	27,000 m²	Department of Education

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
76	Net-zero emissions education	Organize energy-saving workshops for hotels.	Reach 200 participants	Reach 200 participants	Department of Information and Tourism
77		Recommend low-carbon theme travels.	Recommend 3 low-carbon theme travels	Recommend 3 low-carbon theme travels	
78		Convene net-zero emissions environmental education courses.	Net-zero emissions courses hours accounts for 25% of total environmental education hours	Net-zero emissions courses hours accounts for 50% of total environmental education hours	Department of Cultural Affairs
79		An alternative for spirit money by using rice.	Temples and village offices cooperate to use rice instead of spirit money or other alternatives (account for 53.07%)	Temples and village offices cooperate to use rice instead of spirit money or other alternatives (account for 57.89%)	Department of Civil Affairs
80		Environmental education.	Employees need to finish 4 hours of environmental education trainings each year	finish at least 4 hours of environmental education training each year	Department of Social Welfare
81		Fuel conservation project.	No growth in the consumption of fuel in 2022 compared with 2015 (the baseline year) (fuel consumption in baseline year: 10,345 liters)	Not exceed than fossil fuel consumption in baseline year	
82		Electricity conservation project.	Not exceed than EUI in 2015 (the baseline year) (EUI in baseline year: 7.6, 194,932 kWh)	Not exceed than EUI in the baseline year	
83		Water conservation project.	Not exceed than the water consumption in 2018 (the baseline year) (Waster consumption in baseline year is 52,814 m^3)	Not exceed than the water consumption in the baseline year	
84		Net-zero emissions environmental education training.	Participants for environmental education training score above 70/total training hours*100%	Participants for environmental education training score above 95/total training hours*100%	Department of Compulsory Military Service
85		Net-zero emissions environmental education.	4 hours per capita	4 hours per capita	Department of Finance
86		Environmental education.	Learning the knowledge of energy-saving and carbon reduction	100%	Department of Health
87		Green planting in offices.	Beautify the environment	100%	
88		Greenhouse gas reduction educational workshop.	Hold a greenhouse gas reduction educational workshop	Hold a greenhouse gas reduction educational workshop annually	Department of Sports
89		Environmental education courses implement the concept of Net-zero emissions.	The ratio of holding environmental education, including net-zero emissions, up to 100%	100%	Taipei Feitsui Reservoir Administration

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
90	Net-zero emissions education	Campus net-zero emissions environmental education.	Hold 5 sustainable development courses or seminar	A cumulative total of 45 courses or seminar	Department of Education
91		Greenhouse gas reduction education and training project.	4 sessons	4 sessions	Department of Budget, Accounting and Statistics
92		Outdoor health and integrity environmental education course.	A environmental education course	Continue to achieve the goals of carbon emission reduction and education promotion	Department of Government Ethics
93		Convene courses related to net-zero emissions policies.	3 hours/yr (Courses hours held each year)	4 hours/yr	Department of Civil Servant Development
94		Strengthen the promotion of 2050 zero–carbon Taipei.	12 pieces of news/yr	12 pieces of news/yr	Department of Personnel
95		Learn the knowledge of energy-saving and carbon reduction.	All employees complete 2 hours online courses.	All employees complete 2 hours online courses.	
96		Physical or online environmental education course on climate change (over 300 participants).	Net-zero emissions education training achieve 100%	100%	Taipei Water Department
97		Energy conservation cabin at zoo becomes the interpretation spot of net-zero emissions.	Hold 5 workshops, speeches, and institution visit	Energy conservation cabin set up environmental education courses constantly, educating 1,000 visitors	Taipei Zoo

Promoting green transportation

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
98	Friendly green transportation environment	Designate Air Quality Maintenance Zones.	A total of 13 zones (9 zones in 2021, while Taipei Songshan Airport and three incinerators are designated in 2022)	City-wide Air Quality Maintenance Zones	Department of Environmental Protection
99		Implement smart traffic signals project.	33 traffic signals	A cumulative total of 327 traffic signals	Department of Transportation
100		Expand sidewalk.	Accumulate 53% sidewalk and pedestrian arcade inhibit scooters	Accumulate 62% sidewalk and pedestrian arcade inhibit scooters	
101	Improve the use of green transportation used	Implement monthly tickets to public transport.	A cumulative total of 90,000,000 tickets	A cumulative total of 110,000,000 tickets	Department of Transportation
102		Expand bikeway.	Cumulative 509.64 km	Cumulative 543 km	

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
103	Improve the use of green transportation used	Expand public bicycle system.	A cumulative total of 1,200 stations and 13,240 bikes	A cumulative total of 1,200 stations and 13,240 bikes	Department of Transportation
104		Promote shared vehicles.	A cumulative total of 1,700 shared cars and 20,000 shared scooters	A cumulative total of 2,200 shared cars and 22,000 shared scooters	
105		Expand MRT & road networks.	Cumulative length of MRT networks up to 152.3 km Continue constructing 44.9 km MRT networks and planning 13.3 km MRT networks	Cumulative length of MRT networks up to 197.2 km Continue constructing 13.3 km MRT networks	Department of Rapid Transit Systems

E-mobility for vehicles

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
106	Subsidy for phase-out of fossil fuel vehicles	Subsidize bus operators to replace and purchase electric buses.	A cumulative total of 400 electric buses	A cumulative total of 3,600 electric buses	Department of Transportation
107		Taipei City's electric scooters subsidy from 2021 to 2023.	Registration of electric scooters accounts for 9%	30%	Department of Environmental Protection
108	Accelerate transition in public sectors	Purchase electric compression garbage trucks.	10 electric compression garbage trucks	120 electric compression garbage trucks	Department of Environmental Protection
109		Replace official scooters with electric scooters.	2 electric scooters	39 electric scooters	Public Works Department
110		Subsidy for replacing and purchasing electric scooters in 2022.	Plan to replace 300 scooters, accounting for 9.5% (300/3,154)	100%	Police Department
111		Project for replacing business scooters with electric scooters.	Plan to replace 9 scooters, accounting for 37% (9/24)	100%(cumulative)	Fire Department
112	Accelerate low-carbon transportation infrastructure	Expand charging facilities in public parking lots.	Set up 100 charging spaces, including fast charge, with a cumulative total of 500 charging spaces	Set up 100 charging spaces each year, including fast charge, with a cumulative total of 1300 charging spaces	Department of Transportation
113		Subsidy for the construction of charging facilities in public parking lots.	Subsidy for setting up 160 charging spaces	Subsidy for setting up 160 charging spaces each year	
114		Build smart car-searching system in parking lots.	Build in 104 parking lots cumulatively	Build in 122 parking lots cumulatively	

Waste reduction and recycling for zero waste

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
115	Waste reduction at sources	Increase resources recycling rate, including Happy Youli Recycling Station.	65.4% resource recovery rate	70%	Department of Environmental Protection
116		Ban plastic cups from beverage store chains.	Reduce 30 million plastic cups	Comprehensively ban disposable plastics and disposable tableware	
117		Expand circular containers rental System.	Circular containers rental system reaches 60,000 rented cups	100,000 circular cups rented each year	
118		Convene waste reduction and recycling maintenance courses or speeches.	5 courses or speeches	45 courses or speeches cumulatively	Department of Education
119		Food waste reduction and recycling.	236 schools achieve food waste reduction, sharing of leftover food and food waste recycling	236 schools	
120		Reduce the use of paper.	Reduce 2%	Each year lessen 2% than the previous year	Department of Personnel
121		Resource recycling.	≦ 9,000 kg/yr (total weight of recycling each year)	≦ 9,000 kg/yr (total weight of recycling each year)	Department of Civil Servant Development
122		Food waste reduction and recycling.	≦ 800 kg/yr (total weight of recycling each year)	≦ 7800 kg/yr (total weight of recycling each year)	
123		Plastics reduction on activities.	538 sport activities reduce the use of plastic products	580 sport activities reduce the use of plastic products	Department of Sports
124		Food waste reduction.	80 kg food waste per month	40 kg food waste per month	Department of Compulsory Military Service
125		Waste recycling and reuse in offices (2021 as baseline year).	53% recycling rate	70%	Taipei Water Department
126		Implement the resource recycling project.	54%	55%	Taipei Zoo
127		Promote the ban on disposable and melamine tableware.	100%	100%	

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
128	Waste reduction at sources	Promote the ban on disposable and melamine tableware.	Two stores sign the convention	2 stores	Taipei Zoo
129		Implement the Food-Cherishing Convention.	One store implement Cherish Food Convention	1 store	
130	Sewage treatment systems	Subsidies for the destruction of existing septic tanks and completion of the destruction works.	840 septic tanks	6,620 septic tanks	Public Works Department
131		Subsidies for the destruction of existing septic tanks and completion of the destruction works.	Launch the sludge drying system in Bali Sewage Treatment Plants	Reduce 1,200 tons of carbon emissions	
132		Increase sewage treatment rate.	Increase the sewage treatment rate to 87.57%	Increase the sewage treatment rate to 94.58%	

Resources recycling and reuse

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
133	Resource recycling	Comprehensively reuse of bottom ash.	94.9 thousand tons/yr	94.9 thousand tons/yr	Department of Environmental Protection
134		Implement recycled furniture.	165 tons	Depending on the amount of waste furniture from households of the current year	
135		Factory road maintenance improvement and milled materials recycling.	1,250 m^3	9,000 m^3	Public Works Department
136		Mountain road maintenance improvement and milled materials recycling.	115 m^3	A cumulative total of 1,035 m^3	
137		General road maintenance improvement and milled materials recycling.	17,375m^3	139,000 m^3	
138		Use reclaimed material in milling.	An accumulative of 4,600 tons of reclaimed materials replaced	An accumulative of 36,000 tons of reclaimed materials replaced	
139		Make fallen leaves compost.	50 kg/yr (total amount of compost made each year)	50 kg/yr (total amount of compost made each year)	Department of Civil Servant Development
140	Water recycling	Rainwater recycling.	1,000 l/yr (recycled rainwater each year)	1,500 l/year (recycled rainwater each year)	Department of Civil Servant Development

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
141	Water recycling	Rainwater recycling.	Increase 1% of resource recovery rate	Increase 4% of resource recovery rate	Department of Education
142		Other measures for water recycling.	Maintain 100% recycling of backwashing wastewater in Zhitan Purification Plant	100%	Taipei Water Department
143	Green energy circular park	Transform incinerators into green energy plants.	Complete the efficiency assessment of incinerators transformation	Launch Green Energy Circular Park (Generate 221.7 million kWh per year)	Department of Environmental Protection

Green resources of enhancement and management

No.	Action plan	work items	2022 KPI	2030 KPI	Executive organization
144	Garden city	Increase Taipei City's garden basement.	Increase 1,200m² of green area and improve carbon sequestration by 996kg	6,000 m²	Public Works Department
145	Garden city	4,980 kg	Public Works Department	6,000 m² 4,980 kg	
146	Increase areas of green resources	Expand green area in parks.	Increase 20,000m² of green area and improve carbon sequestration by 16,600 kg	100,000 m²	Public Works Department
147		Newly-planted street trees.	Increase 400 newly-planted trees and improve carbon sequestration by 6,400kg	83,000 kg	
148		Newly-planted trees in wastewater treatment plants.	Increase 100 newly-planted trees	1,850 trees	
149		Increase green coverage rate.	Install green walls in 5 demonstration schools each year	29,600 kg	Department of Education
150	Restoration of forest composition and structure	Timber Stand Improvement.	Completion of timber stand improvement accumulate to 5%.	Completion of timber stand improvement accumulate to 23%.	Public Works Department

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This publication represents not only Taipei City's determination and action to move toward net-zero emissions by 2050, but also the strategies and steps needed for future promotion. Together, let us join hands for a net-zero future.

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