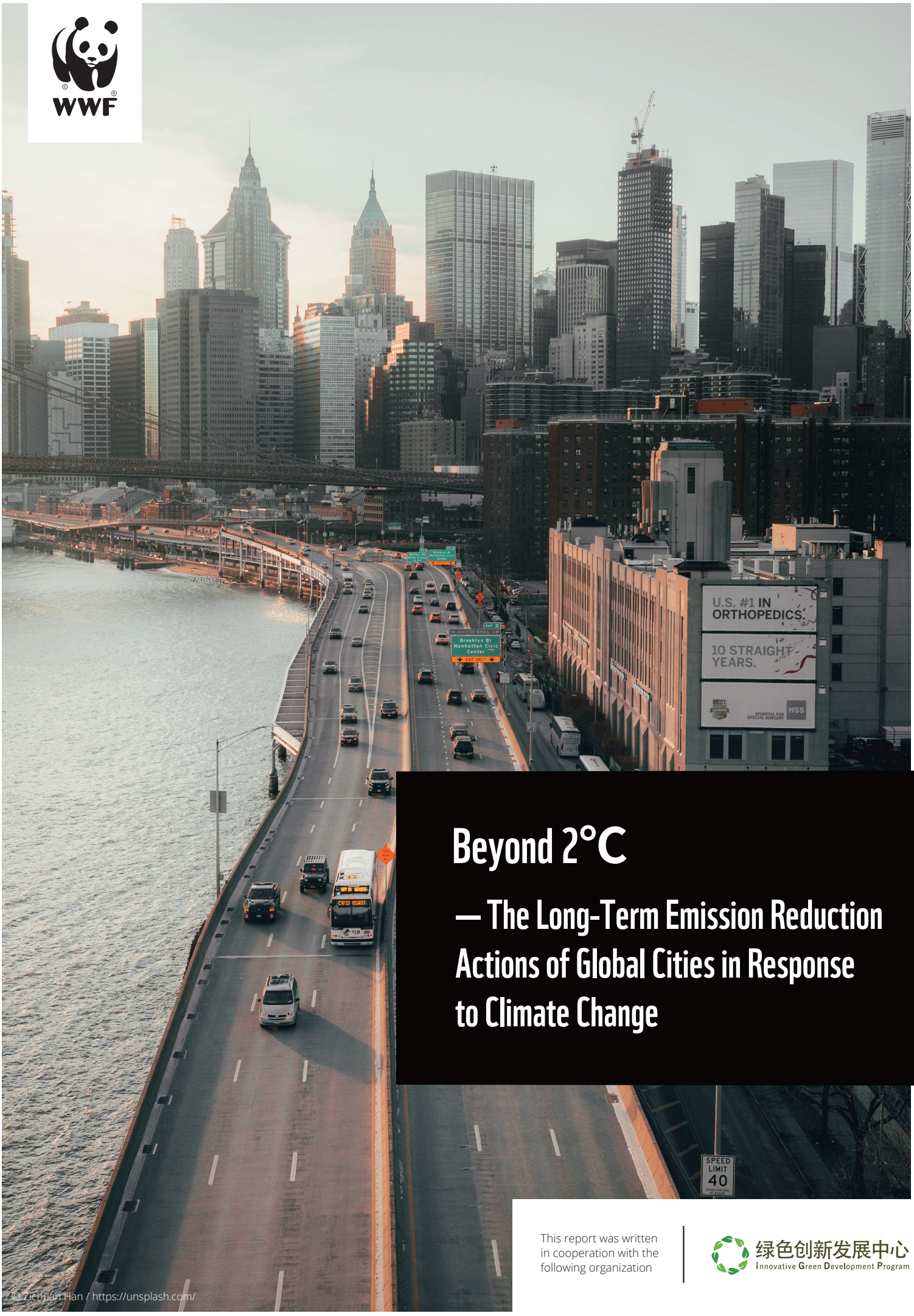

Beyond 2°C

— The Long-Term Emission Reduction Actions of Global Cities in Response to Climate Change

This report was written in cooperation with the following organization

绿色创新发展中心
Innovative Green Development Program

WWF (World Wide Fund for Nature)

WWF (World Wide Fund for Nature) is one of the world's largest and most respected independent organizations dedicated to the conservation of nature. Since the first office was founded in Switzerland in 1961, WWF has grown into a global network active in more than 100 countries with almost five million supporters.

WWF has been active in China since 1980, when it was invited by the Chinese government as the first international NGO to work on nature conservation. The Beijing office opened in 1996, and there are now 8 additional field programme offices spread across China.

WWF has more than 120 staff working in China on a broad range of conservation programmes including species, freshwater, forest, marine, climate change and energy, the green economy and footprint.

innovative Green Development Program （iGDP）

innovative Green Development Program (registered name: Beijing Green Partnership Consulting Company Limited) is a non-profit policy and strategy consultancy that focuses on green and low-carbon development. It works to strengthen China's low-carbon environmental policy design and implementation through interdisciplinary, systematic, and empirical policy research. iGDP works with a range of different stakeholders to promote a zero-emissions future and tell the story of China's green and low-carbon development.

innovative Green Development Program was initiated by Energy Foundation China. It is the secretariat of China's Green and Low-Carbon Development Think Tank Partnership, sits on China's Green Finance Association Experts Committee, and is a member of the North-East Asian Subregional Programme for Environmental Cooperation's Low Carbon City Platform.

innovative Green Development Program's research, consulting and communications focus on the following areas:

- Macro-Level Climate Policy
- Urban Green and Low-Carbon Transformation
- Green Economic Policy
- Behavioral Change

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Table of Contents

1. Summary

This report reviews and summarizes the actions taken by non-Chinese cities to achieve medium- and long-term emission reduction targets or "zero-carbon" emissions, with a specific focus on climate change-related target setting, plan development [1], and policy measures. It focuses on policies and actions that have significant reference-value for China's cities with regard to long-term actions, and serves as a practical reference for policymakers and researchers interested in medium- and long-term deep emission reductions in cities around the world.

The report looks at 88 cities that have expressed a willingness to reduce emissions by 2050, and will further refer to these cities as "Willing Cities". these cities as "Willing Cities". Sixty-six of these are "Committed Cities" that have made explicit carbon-reduction commitments, while 34 are "Planning Cities" that have developed planning documents. The list of these cities is shown in the appendix. The report gives an overview of the characteristics of Willing Cities, describes the targets of Committed Cities, and analyzes in detail the policies and measures of Planning Cities.

Willing Cities are widely distributed throughout the world. Except for those located in cold latitudes, the cities in this category have expressed a commitment to a zero-emission future. The level of economic development of Willing Cities varies greatly, with 48 of them coming from developed economies, accounting for more than half, 35 coming from developing economies, and 5 from least developed countries. Thirty-six cities of the cities from developed economies have drawn up climate change action plans, significantly more than cities at other stages of development. The greenhouse gas emission inventories released by these Willing Cities show that the buildings and transportation sectors are their main sources of emissions.

Committed Cities with reduction targets have the following characteristics. First, all greenhouse gases are included in the scope of emission reduction. Second, they have set deep emission reduction targets by at least the year 2050. Third, by designating climate targets through policies or legislation, they ensure the stability and consistency of policies and measures. Fourth, they have translated climate goals into concrete actions and policies through the preparation of plans. Fifth, they do not have requirements on whether to include carbon offset (carbon sink) or aviation emission reduction targets.

Policies and actions proposed by Planning Cities are mostly focused on sectors such as buildings, transportation, electricity, and solid waste; and exclude industries not controlled by cities (such as power generation). Promoting emission reduction targets in these industries is a top priority that is often matched by an increase in economic incentives and support policies. Policies and actions in different cities have certain common characteristics: power industries focus on reducing fossil energy and increasing renewable energy; transportation industries mainly adopt electric vehicles (EVs), promote low-carbon fuel substitution, or develop public transportation systems; buildings industries improve energy efficiency standards and increase the electrification rate; waste management industries improve the recycling rate, increases the sorting ratio, and reduce the amount of landfill waste.

[1] At present, there is no scientific definition of "Climate Action Plan". A "Climate Action Plan" in this report refers to the guiding documents used to deal with climate change within a certain time scale. In general, the planning content includes the current status of urban greenhouse gas emissions, targets, implementation paths, measures and actions, and required resources. Cities make plans according to their own conditions and the names of planning documents are often also different.

The report finds that cities that have proposed deep emission reduction or carbon neutrality targets set more ambitious standards and policy targets. The report distinguishes between existing policies and deep emission reduction or near-zero-emission measures. Cities apply economic incentives and support policies under both scenarios.

The report concludes with case studies in industry-related and city-wide carbon reduction actions. For the industry case studies, cities with outstanding performance were selected from the four major emission areas of buildings, transportation, energy, and waste. The city case studies take a close look at factors such as level of economic development, quality of emission reduction commitments, and city scale. The case studies focus on target setting and highlight policy measures to provide a reference for Chinese cities.

The information in this report was gathered from open sources. Given language and other possible limitations, it may not provide a full picture of city actions.

2. Research Background

Climate change poses a danger to social development and economic growth. Estimates of global annual GDP loss caused by climate change range from 0.5% and 20%.[2] The Stern Review concluded that if no action is taken, the losses caused by climate change could account for 5%-20% of global GDP.[3] The 2020 Global Risk Report released by the World Economic Forum in January 2020 ranked the failure to deal with climate change as the biggest risk facing the global economy.[4]

The Paris Agreement, which went into force in November 2016, states that "the global average temperature rise should be kept well below 2℃ above pre-industrial levels, and efforts should be made to limit the temperature rise to 1.5℃ above pre-industrial levels". Limiting the temperature rise at 2℃ means that emissions in 2050 should be reduced by 40-70% compared with 2010, while controlling the temperature rise at 1.5℃ means that, before 2030, global annual emissions will need to be reduced by 45% from 2010, reaching net zero around 2050.[5]

"Long-term Low Emission Strategies" describe the long-term emission reduction efforts of the parties of the Paris Agreement. The Paris Agreement invited all parties to report to the Convention Secretariat their long-term low-emission strategies by 2020. The objective is to motivate deep global emission reduction and bridge the gap between the Agreement's ambitious target and existing emission paths. At present, 59 countries have expressed their intention to submit an intensified climate action plan (or Nationally Determined Contribution), and another 11 countries have already started an internal action process[6] to raise emission reduction targets

[2] IPCC, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland.
Stern, N. (2007). The Economics of Climate Change: The Stern Review. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511817434
Bierbaum, R., Fay, M., & Ross-Larson, B. (2010). World development report 2010 : development and climate change. Documents.worldbank.org. Retrieved 5 April 2020, from http://documents.worldbank.org/curated/zh/741071468174916445/World-development-report-2010-development-and-climate-change

[3] Stern, N. (2007). The Economics of Climate Change: The Stern Review. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511817434

[4] The Global Risks Report 2020. (2020). World Economic Forum. Retrieved 5 April 2020, from https://www.weforum.org/reports/the-global-risks-report-2020

[5] Summary for Policymakers — Global Warming of 1.5 ºC. (2020). Ipcc.ch. Retrieved 11 May 2020, from https://www.ipcc.ch/sr15/chapter/spm/

[6] UN. Opening press release of 2019 Climate Action Summit. https://www.un.org/zh/climatechange/cas _ opening _ release.shtml.2019

and incorporate them into their respective national plans.[7] In addition, according to Global Climate Actions, there are 120 countries, 15 regions, 392 cities, 760 companies, and 27 investment institutions in the world that are taking action to achieve net-zero emissions by 2050.[8]

Cities are the main centers of the world's population, economic production, resource consumption, and environmental impact. In 2018, half of the world's population lived in cities. According to a report by the UN Economic and Social Council, this figure will approach 70% in 2050,[9] with about 6.5 billion people living in cities.[10] Cities consume 78% of the world's energy and generate 60% of greenhouse gases[11], and this proportion is still gradually increasing. It is estimated that among the ten major economies, [12] if non-state actors were to fulfill their public commitments,[13] the emissions of these countries would be reduced by 3.8%-5.5% by 2030 under existing policy scenarios. [14]

Energy consumption in cities mainly comes from industry, buildings, transportation, and waste, with emissions from production and consumption making a large contribution to cities' carbon footprint. Cities planning for a deep emission reduction, or net-zero carbon or zero-carbon targets, all face difficult challenges. There is no universal blueprint that works everywhere. Each city needs to take actions that are feasible and effective under local conditions.

Cities' actions to deal with climate change largely consist of the compilation of greenhouse gas emission inventories, drafting plans to deal with climate change, forming professional teams to carry out academic and policy research, setting targets and issuing specific policy measures for major emission areas, and carrying out public communications and exchange activities.

Cities around the world have been joining the effort against climate change, implementing low-carbon transformation by setting targets, drafting plans, and implementing measures. City-level long-term low-emission development strategies can serve as the basis for upgrading urban industries, improving the quality of development, and mitigating and adapting to the impacts of climate change – the components of green growth. Tracking and evaluating the progress made by these cities in formulating low-emission development strategies allows researchers and policymakers to better understand cutting-edge practices in urban low-carbon transformation and learn from the experiences of high-performing cities. This can encourage other cities to adopt innovative, locally-tailored medium - and long-term emission reduction plans, help cities develop systematic approaches to climate change policy, and prompt other actors to accelerate their low-carbon transformations.

[7] United Nations Climate Action Summit 2019 . (2020). Un.org. Retrieved 11 May 2020, from https://www.un.org/zh/climatechange/cas_opening_release.shtml

[8] NAZCA 2019. (2020). Climateaction.unfccc.int. Retrieved 8 April 2020, from https://climateaction.unfccc.int/views/cooperative-initiative-details.html?id=94

[9] 68% of the world population projected to live in urban areas by 2050, says UN | UN DESA | United Nations Department of Economic and Social Affairs. (2018). UN DESA | United Nations Department of Economic and Social Affairs. Retrieved 5 April 2020, from https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.htmlhttps://www.un.org/en/climatechange/cities-pollution.shtml

[10] World population projected to reach 9.8 billion in 2050, and 11.2 billion in 2100 | UN DESA | United Nations Department of Economic and Social Affairs. (2017). UN DESA | United Nations Department of Economic and Social Affairs. Retrieved 5 April 2020, from https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html

[11] UNITED NATIONS UN Climate Change Summit 2019 . (2020). Un.org. Retrieved 5 April 2020, from https://www.un.org/en/climatechange/cities-pollution.shtml

[12] The ten major economies include Brazil, Canada, China, the European Union, India, Indonesia, Japan, Mexico, South Africa and the United States.

[13] Non-state actors refer to the collective name of action subjects such as regions, cities and commercial fields.

[14] Kuramochi, T., Roelfsema, M., Hsu, A., Lui, S., Weinfurter, A., Chan, S., Hale, T., Clapper, A., Chang, A., & Höhne, N. (2020). Beyond national climate action: The impact of region, city, and business commitments on global greenhouse gas emissions. Climate Policy, 20(3), 275–291. https://doi.org/10.1080/14693062.2020.1740150

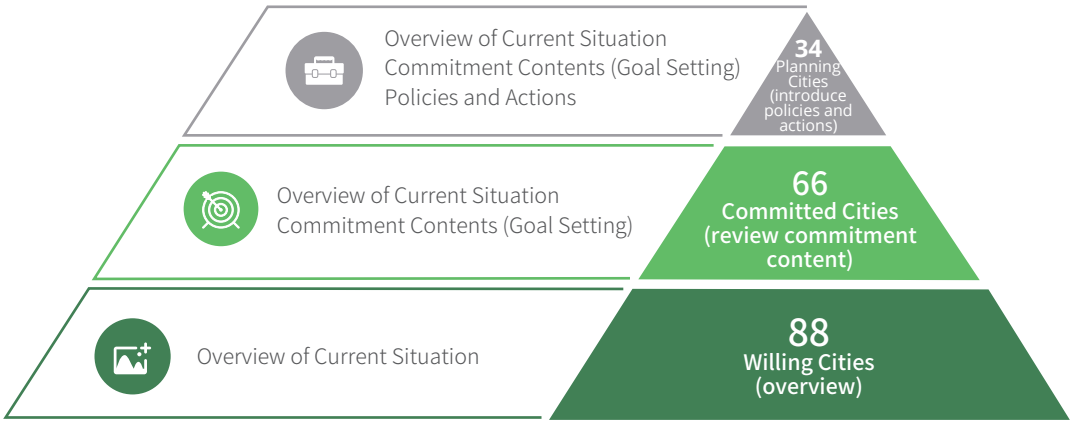
3. Research Goal

This report reviews and summarizes the actions taken by 88 cities around the world to achieve medium- and long-term emission reduction targets or "zero-carbon" emissions, with a specific focus on climate change-related target setting, plan development, and policy measures. It focuses on policies and actions that have significant reference-value for China's cities with regard to long-term actions, but it also serves as a practical reference for policymakers and researchers interested in medium- and long-term deep emission reductions in cities around the world.

4. Research Scope and Methodology

This report uses context analysis to analyze and interpret cities' medium- and long-term climate action plans, research reports of urban networks/platforms, and academic documents. It analyzes the characteristics and commonalities of urban actions by combing the commitments, target setting, and specific policy actions of each city.

According to the UN, as of September 2019, when the UN Climate Change Summit was held, 102 cities in the world have pledged to achieve net-zero CO_2 emissions by 2050.[15] However, there is no detailed list of these cities. This report looks at 88 Willing Cities that have expressed a willingness to reduce emissions by 2050. Sixty-six of these are Committed Cities that have made explicit carbon-reduction commitments, while 34 are Planning Cities that have developed planning documents. The list of these cities is shown in the appendix. The report gives an overview of the characteristics of Willing Cities, describes the targets of Committed Cities, and analyzes in detail the policies and measures of Planning Cities.



[15] Blazhevska, Vesna. 2019. "In The Face Of Worsening Climate Crisis, UN Summit Delivers New Pathways And Practical Actions To Shift Global Response Into Higher Gear - United Nations Sustainable Development". United Nations Sustainable Development. Accessed March 15 2020. https://www.un.org/sustainabledevelopment/blog/2019/09/in-the-face-of-worsening-climate-crisis-un-summit-delivers-new-pathways-and-practical-actions-to-shift-global-response-into-higher-gear/.https://doi.org/10.1080/14693062.2020.1740150

Deep Emission Reduction (80×50), Net Zero-Carbon (Carbon Neutral), or Zero-Carbon are three kinds of medium- and long-term targets used in this report. Different institutions and cities have defined these three kinds of targets in different ways. This report defines these concepts as follows:

1. Deep Emission Reduction (80×50):

Generally refers to the long-term goal of reducing emissions by 80% or more from the base year by 2050, which is adopted by cities to control global warming within 2°C.[16] Different cities have put forward different base years, such as 1990 or 2006.

2. Net Zero-Carbon (Carbon Neutral):

Some CO_2 emissions can be compensated by an equivalent amount of CO_2 absorption (negative emissions),[17] i.e, the net emissions of atmospheric CO_2 caused by human activities is zero.

3. Zero-Carbon:

There are no direct carbon emissions within a specific scope.[18] This is a strict standard, depending on the definition of the scope boundary. It can be a city, an enterprise, or an individual.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[16] Questions & answers - DDPP. (2020). DDPP. Retrieved 11 May 2020, from http://deepdecarbonization.org/questions-answers/#f808920a3703dee2a

[17] UNITED NATIONS, ENVIRONMENT PROGRAMME. The emissions GAP report 2014 a UNEP synthesis report[M]. Nairobi: UNEP, 2014.

[18] MANCHESTER CLIMATE CHANGE BOARD AND AGENCY. Draft Manchester Zero Carbon Framework 2020-2038[R]. Manchester Climate Change Board and Agency, 2019.

5. Overview of Willing Cities

The 88 Willing Cities come from 44 countries around the world and have a combined population of 500 million people. They are at different stages in their economic development, have different population sizes, different climate and geographical conditions, different major emission areas, etc. This report organizes them in terms of geographical location/climate zone, stage of economic development, city size, major emission area, and content of planning texts.

[19] Main data source: United Nations Department of Economic and Social Affairs, 2018. The World's Cities in 2018, Statistical Papers - United Nations (Ser. A), Population and Vital Statistics Report. UN. https://doi.org/10.18356/8519891f-en

Except for cold latitudes, all climate types have cities pursuing a zero-emission future

Figure 1. Urban Geographical Distribution of 88 Willing Cities

The climate type of a city affects its energy consumption, especially in the field of building energy consumption, which in turn affects its greenhouse gas emissions. The 88 Willing Cities are widely distributed across different continents, with a relatively high concentration in Europe and North America. The geographical location, altitude, and climate of these areas are quite different and include tropical, subtropical, Mediterranean, oceanic, and other climate types. Apart from the cold climate zone, all other climate zones have cities proposing deep emission reduction or net-zero carbon targets.

More than 80% of Willing Cities are from medium and high income countries

Stage of Development	Income Level		
Developed Economy	High Income	48	
Developed Economy	High Income	6	
	Upper Middle Income	20	
	Lower Middle Income	9	
Least Developed Economy	Lower Middle Income	3	
	Lower Income	2	

Figure 2. Economic Development Stage of Countries with Willing Cities

Willing Cities are found in countries with varying levels of economic development. According to the classification standard of the UN's "Global Economic Situation and Prospects 2019",[20] 48 cities are located in developed economies (52 are from OECD countries), significantly more than cities in other development stages. Thirty-five (because of start sentence) cities are from developing economies and 5

[20] World Economic Situation & Prospects for 2019. (2019). Economic Analysis & Policy Division | Dept of Economic & Social Affairs | United Nations. Retrieved 9 May 2020, from https://www.un.org/development/desa/dpad/publication/world-economic-situation-and-prospects-2019/

from least developed economies. Among them, the developing and least-developed economies are divided into four types according to per capita income: high income, upper middle income, lower medium income, and low income level. The specific distribution can be seen in Figure 2. Thirty-six cities have prepared plans related to climate change action. Statistics show that developed economies have significantly more planning documents than cities in other economy types, which is mainly because of the country's responsibility to reduce emissions, the ability to deal with climate change, and the availability of data. However, there are 14 cities in this sub-group that have not prepared such plans.

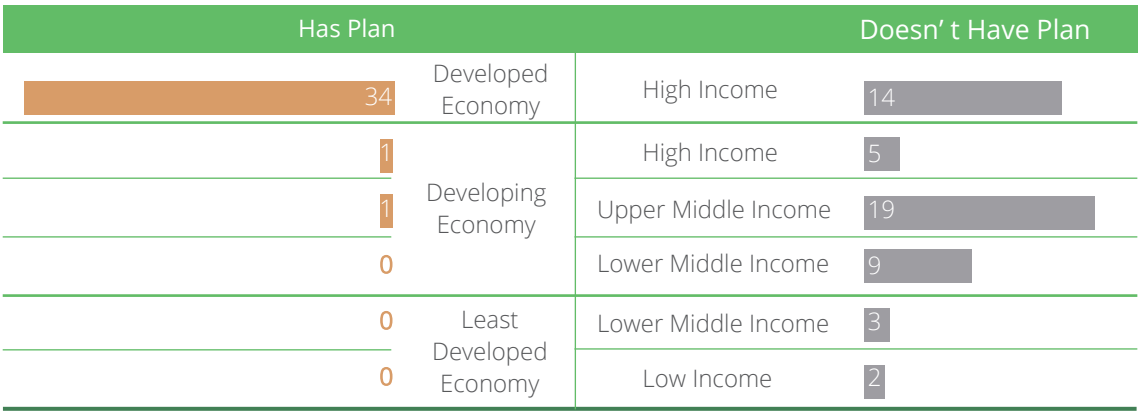


Figure 3. Planning of "Willing Cities" at Different Stages of Economic Development

Big cities account for more than 70%, and the number will continue to increase.

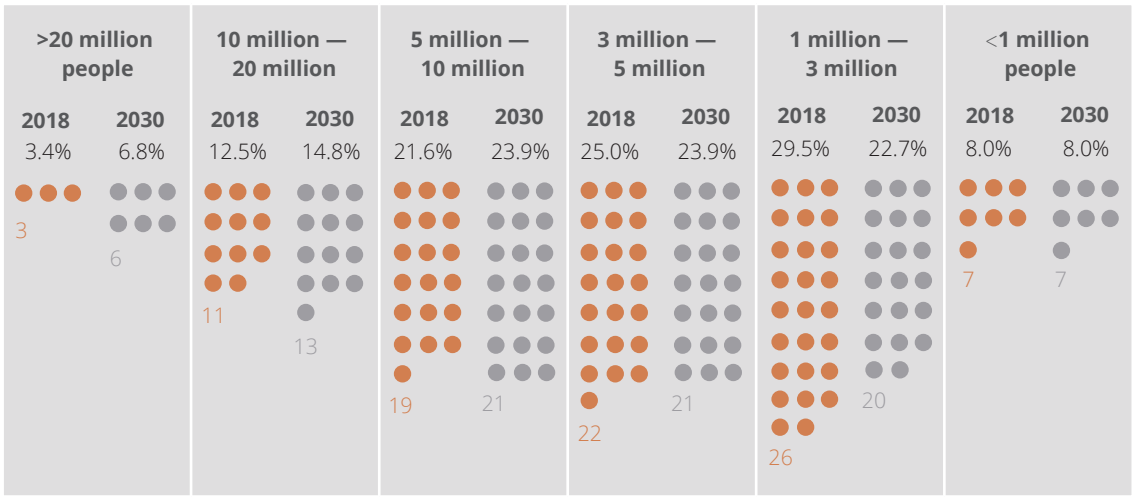


Figure 4. Population Size of Willing Cities

In 2018, the total population of the Willing Cities was about 500 million. According to the UN's "The World's Cities in 2018" report, this figure will reach nearly 600 million by 2030,[21] with the population of cities in developing countries expanding at a faster rate. In the next 20 years, the number of cities with a population of more than 5 million will increase significantly, from 33 to 40.

IThe population size of Willing Cities varies greatly. According to the city size classification criteria of China's State Council,[22] there are megacities with a population of more than 20 million (such as the Tokyo

[21] United Nations Department of Economic and Social Affairs. (2018). The World's Cities in 2018. UN. https://doi.org/10.18356/8519891f-en

[22] Circular of the State Council on Adjusting the Standards of Urban Scale Division - Government Information Disclosure Column. (2020). Gov.cn. Retrieved 5 April 2020, from http://www.gov.cn/zhengce/content/2014-11/20/content_9225.htm

metropolitan area in Japan, Sao Paulo in Brazil, Mexico City in Mexico, etc.) and small cities with a population of less than 100,000, such as Port Vila, Vanuatu's capital. The large cities (between 1 million and 5 million) account for more than half, and cities of 5 million to 10 million account for about 20%.

Building and transportation are the main emission sources in cities

Greenhouse gas inventories are designed to capture the overall emission levels of a city and identify its major emission sources. They provide support for the setting and analysis of greenhouse gas emission targets, the formulation of policies and measures, and the assessment of the implementation of urban low-carbon planning. Under the United Nations Framework Convention on Climate Change (UNFCCC), all "Annex I Countries" are required to report annual inventories of greenhouse gas emissions by sources and by removal of sinks.[23] The Kyoto Protocol further stipulates that all parties must prepare, update, and publish greenhouse gas emission inventories of cities with national inventories of anthropogenic emissions and sinks.[24] However, there is a lack of uniform standards for the preparation of greenhouse gas emission inventories, here is also a lack of consistent and comparable greenhouse gas emission data at the city level. Through collecting and sorting the information on data platforms, city planning documents, and official websites of these cities, this report collates the emission data of 59 cities, 55 of which can be compared and analyzed.[25] Inventory compilation methods are mainly based on the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). Helsinki and Hamburg adopt different methods. Hong Kong has not explained its method.

Due to the complexity of calculating urban greenhouse gas emissions, it is necessary to define emission boundaries. Different compilation methods have different definitions of boundaries. GPC divides boundaries into Scopes 1-3, where Scope 1 refers to all direct emissions from urban areas, mainly including greenhouse gas emissions from energy activities (industry, transportation, and buildings), industrial production processes, agriculture, land-use change and forestry, and waste disposal activities; Scope 2 refers to indirect energy-related emissions occurring outside the city's jurisdiction, mainly including emissions from secondary energy sources such as power, heating and/or refrigeration purchased to meet the city's consumption; Scope 3 refers to other indirect emissions caused by activities within the city and generated outside the jurisdiction but not covered by Scope 2, such as greenhouse gas emissions from the production, transportation, use and waste disposal of all items purchased by the city from outside its jurisdiction.[26]

Due to the better monitoring of construction, energy, and other activities, and strong mobility of the transportation sector, some cities only account for urban greenhouse gas emissions in Scopes 1 and 2 in order to avoid double counting. Forty-one cities accounted for emissions in Scope 3. According to the GPC guidelines, emissions that must be included in Scope 3 include: emissions from loss of power transmission and distribution, transboundary solid waste treatment, transboundary wastewater treatment, transboundary water transportation, and aviation. Emissions from purchasing food, building raw materials,

[23] United Nations Framework Convention on Climate Change (1994) . (2020). Un.org. Retrieved 9 May 2020, from https://www.un.org/zh/documents/treaty/files/A-AC.237-18(PARTII)-ADD.1.shtml

[24] Interpretation of Climate Change Convention by Environmental Law Experts - China Climate Change Information Network. (2020). Ccchina.org.cn. Retrieved 9 May 2020, from http://www.ccchina.org.cn/Detail.aspx?newsId=27838&TId=59

[25] The main data sources are the emission inventory released by the city official website and the C40 Greenhouse Gas Protocol for Cities Interactive Dashboard.

[26] GHG Protocol for Cities | Greenhouse Gas Protocol. (2018). Ghgprotocol.org. https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities

etc. are not required to be included. Therefore, only a few cities have calculated the implied emissions from building materials, food purchases, and other purchased products. As consumers of major products, the non-local emissions brought by the industrial chain in cities may be far greater than the emissions within its initial scope. The calculation of emissions within Scope 3 is helpful to further clarify the role of cities in greenhouse gas emission reduction and identify more effective emission reduction measures.

After analyzing the emission inventories of all cities in the latest year, we found that the major emission areas of the Willing Cities are buildings and transportation, with the median of buildings emissions accounting for 55% and transportation for 29%, and that the sum of the two exceeds 80% of the overall emissions of the city. However, due to differences in industrial structure, energy structure or resource endowment, Willing Cities have relatively large differences in emissions in the industrial field, especially in the energy conversion process. In addition, in areas with relatively developed agriculture (e.g. Auckland), agricultural emissions must be taken into account. Among the cities with inventory reports, 13 cities have a method of inventory preparation and started to compile an inventory in the same year. The same analysis was made for the inventories defined by the same emission boundaries in the same year for these 13 cities. The results are shown in Figure 6. It can be seen that the industries with the highest emissions are still buildings and transportation, and the sum of the two still accounts for nearly 80% of total emissions in these cities.

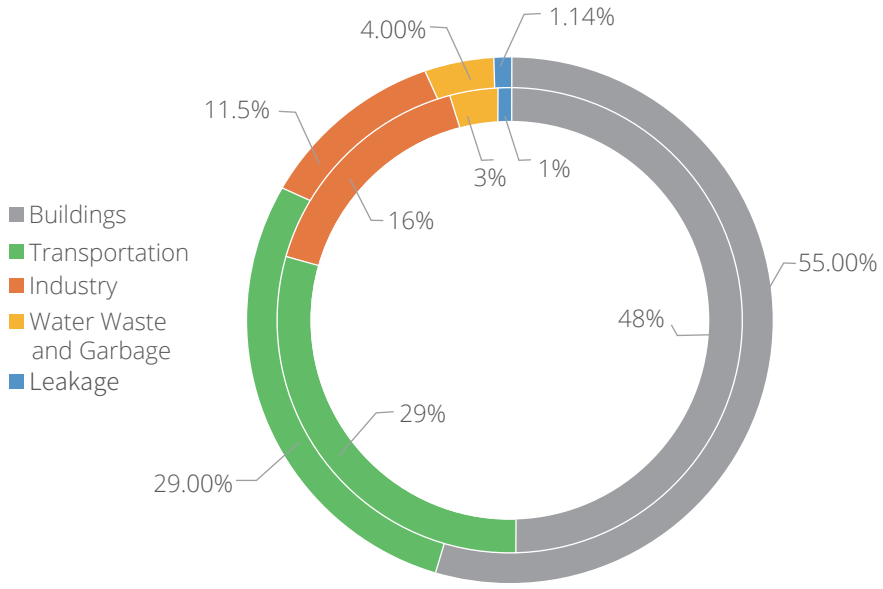


Figure 5. Emissions from Willing Cities
(outer circle: list of 55 cities; inner circle: emission inventory of 13 cities in same year)

Judging from these results, the current emission situation of the Willing Cities is quite different from that of Chinese cities. Therefore, in the process of benchmarking, more attention should be paid to factors such as inventory compilation method, emission boundaries, and industrial structure within the administrative boundary of the city to fully understand the emission situation of the city. Of course, for the buildings and transportation domains specifically, benchmarking analysis based on industrial sectors between Willing Cities and similar cities in China can still serve as a useful reference for analyzing emission trends and the emission reduction potential in related industries of Chinese cities.

6. Climate Mitigation Targets of Committed Cities

Commitment to climate goals not only reflects the leadership of cities concerning climate issues but can also drive the actions of other cities. Among the 88 Willing Cities, 66 cities have promised clear climate targets, hence they are called Committed Cities here. The public information they have made available makes it possible to analyze their targets and level of ambition. The targets set by these cities in terms of greenhouse gas (GHG) types, target year, the formality of target, etc., are all different. By analyzing their contents we can have a better understanding of the respective strengths and progressiveness of their commitments. This in turn can promote comparison and exchange between Chinese and non-Chinese cities, and provide reference for Chinese cities to set ambitious medium- and long-term emission reduction commitments.

The methodology for evaluating the ambition of a stated emission reduction includes index definition, data collection, and scoring for said target. In the index definition stage, we mainly refer to the climate change targets in national and city-level planning and the target setting of the 66 Committed Cities in this study. We divide the index into primary and secondary indicators, of which the primary indicators are: GHG types, target year, formal degree of commitment, whether there is a plan, and whether carbon offset and aviation emissions are included. The secondary indicators are set according to the content of urban planning targets under the corresponding primary indicators. The secondary indicators set scores according to the ambition or difficulty of emission reduction. By default, the weight of different indicators is equal. The indicators without publicly available information get a score of zero. The sum of all indicators is the total score of the city. The higher the score, the more ambitous a city's goal is. A full score is 15 points. The Specific indicators and scores are shown in the table below.

Table 1 Committed Cities Target Setting Evaluation Index Framework and Score

Factor	Indicator	Score	Factor	Indicator	Score
Emission reduction gas type	GHGs	2	Plan is formulated	There is a plan	3
	CO_2	1		In the process of making a plan	2
	NA	0		There is no plan	1
Target year	Before 2050	3	Does it include carbon offset	NA	0
	2050	2		No	2
	Deep emission reduction	1		Yes	1
	Consistent with the Paris Agreement	0			
Formal degree of commitment issued	By the municipal government	3	Does it control aviation	Yes	2
	Under discussion by the municipal government	2		No	1
	Public commitment	1		NA	0
	NA	0			

The progressiveness of a city's commitment is determined by their performance in the above 6 primary indicators. Specifically, if a city's actions cover all greenhouse gases, do not consider carbon offsets, take aviation emissions under control, have a target year that is earlier than 2050, and the commitment has been promulgated by the government and is supported by practical planning documents, then the city's commitment is considered to be maximally ambitious. The city actions of Stockholm, which has the highest total score, cover all greenhouse gases, the target year for achieving carbon-neutrality is 2040 (and has become the government's official commitment), a long-term plan has been drawn up, and the plan includes controlling aviation emissions. Lisbon, by contrast has actions that cover only CO_2 and aim to achieve carbon neutrality by 2050. The city council has already adopted this target, but it is not clear whether it will call for controlling aviation emissions. The report considers Stockholm's commitment to be more progressive.

Fig. 6 shows the list of top 20 cities with advanced targets. The contents of Committed Cities, targets show that an advanced target has the following characteristics:

- First, all greenhouse gases should be included in the scope of emission reductions;
- Second, they at least set a deep emission reduction target by 2050;
- Third, through the formulation of policies or legislation to set climate goals, the stability and consistency of policy measures can be ensured;
- Fourth, they translate climate goals into concrete actions and policies through the preparation of plans to support the realization of these goals.

There is no requirement on whether to include carbon offset (carbon sink) or aviation emission reduction targets.

City	CO_2 or GHG	Target Year	Formal Degree of Commitment	State of Plan-Making	Does it include carbon offset	Does it include aviation emissions	Score
Stockholm	✓	☺	☺	☺	!	✓	14
Adelaide	✓	☺	☺	☺	!	!	13
Paris	✓	✓	☺	☺	!	✓	13
Helsinki	✓	☺	☺	☺	!	!	13
Washington	✓	✓	☺	☺	✓	!	13
London	✓	✓	☺	☺	!	✓	13
Manchester	!	☺	☺	☺	✓	!	13
Oslo	!	✓	☺	☺	✓	!	12
Austin	✓	✓	☺	☺	!	!	12
Barcelona	✓	✓	☺	☺	!	!	12
Boston	✓	✓	☺	☺	!	!	12
Portland	✓	!	☺	☺	✓	!	12
Toronto	✓	!	☺	☺	✓	!	12
Philadelphia	✓	!	☺	☺	✓	!	12
Gwangju	✓	✓	☺	☺	!	!	12
Heidelberg	!	✓	☺	☺	✓	!	12
San Francisco	✓	✓	☺	☺	!	!	12
Los Angeles	✓	✓	☺	☺	!	!	12
Minneapolis	✓	!	☺	☺	✓	!	12
Melbourne	✓	✓	☺	☺	!	!	12

Index: Score ! 1 ✓ 2 ☺ 3

Figure 6. List of Top 20 Cities with Advanced Goal Setting

Cities' medium- and long-term goals are broken down into phased goals to facilitate the formulation, evaluation, and adjustment of measures. Within the scope of the study, 34 cities have set phased targets,

as shown in Figure 7. The type of targets can be roughly divided into three types: phasing out of fossil energy, carbon neutralization, and deep emission reduction. Only Stockholm's carbon neutralization target is to be realized mainly by phasing-out fossil fuel. Cities with carbon neutralization targets do not necessarily put forward a clear carbon offset ratio, and most cities only indicate when they will achieve carbon neutralization. For example, Adelaide proposed to achieve carbon neutrality by 2025, but its emission reduction actions can only contribute to 65% of the emission reductions (based on 2007-levels), and it can be interpreted that another 35% of the emissions needs to be achieved through carbon offset. Most of the cities set deep emission reduction targets above 80%, but the base year of emission reduction varies.

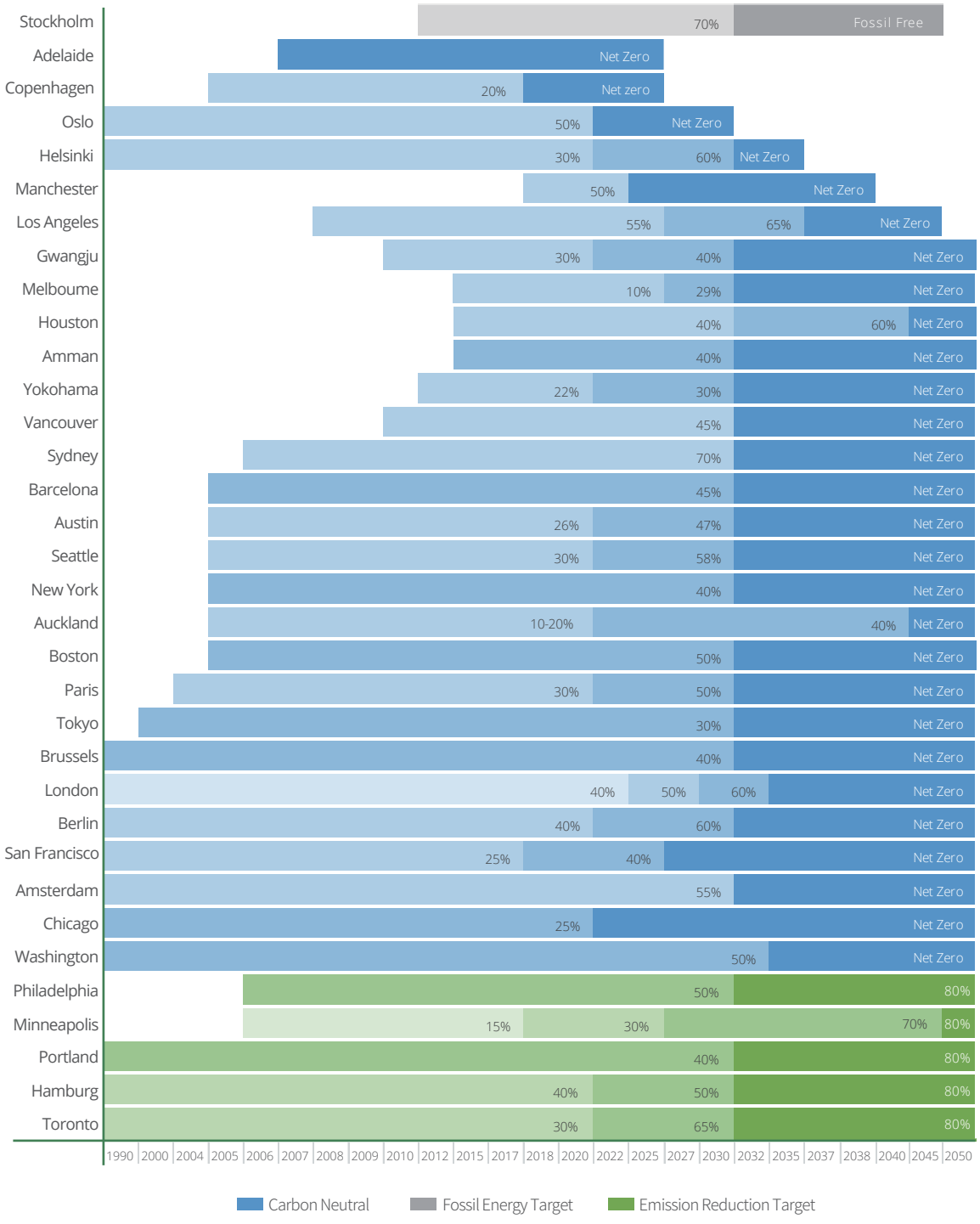
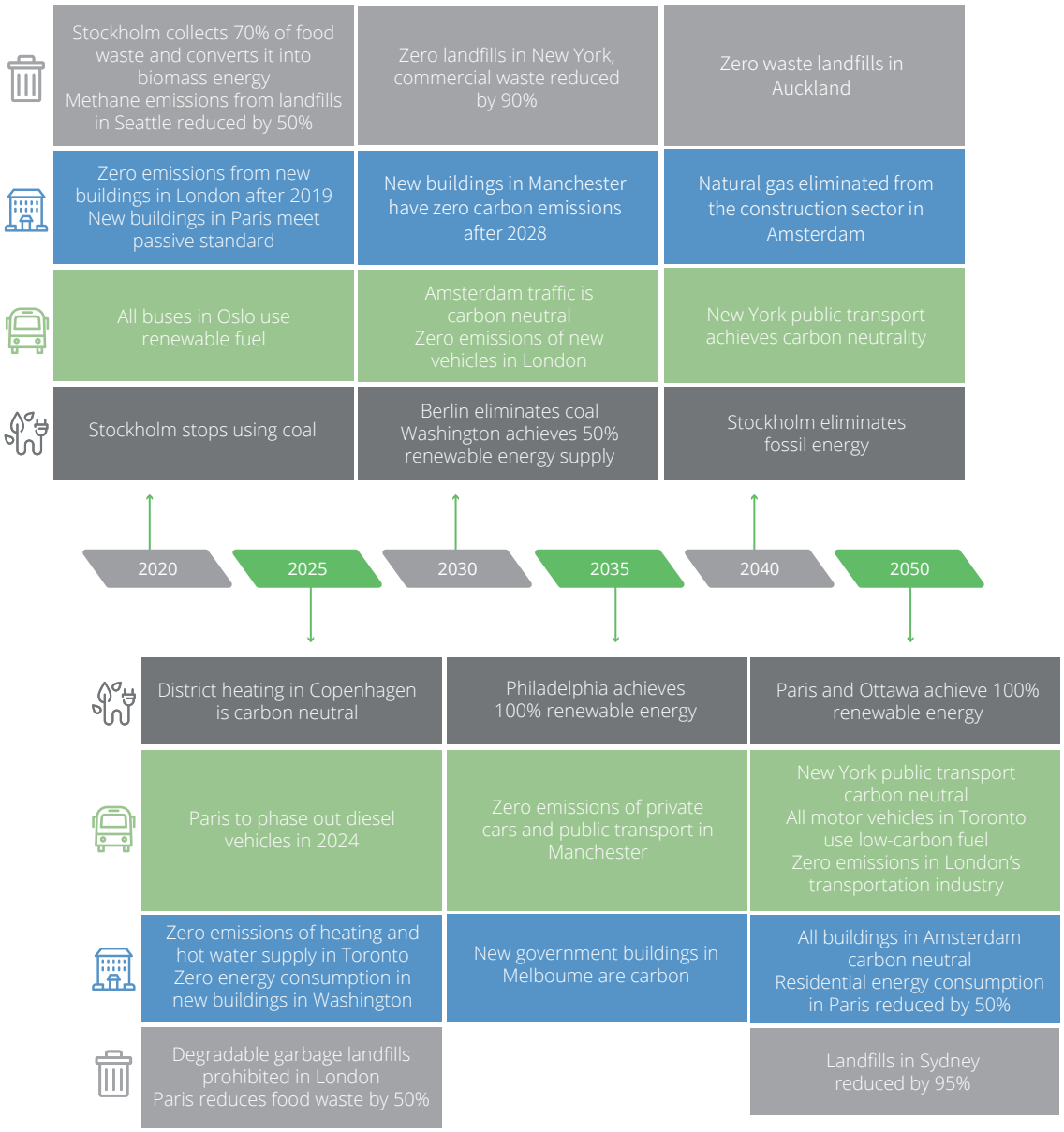


Figure 7. Setting of Medium- and Long-Term Targets for "Committed Cities"

On this basis, cities usually further break down the phased targets into different industries to support the realization of carbon targets. As shown in figure 9, the target mainly covers emission areas such as transportation, buildings, energy, and waste. Considering that carbon neutrality is the ultimate goal, industries also need to achieve carbon neutrality at different stages. The specific timeframe for each industry to achieve carbon neutrality needs to take into account the current emission situation and emission reduction potential of the city.



Source: iGDP, based on public information and data collection

Figure 8. Overview of Phased Industry Goals in Some Cities

7. Actions of the Planning Cities

Among the 88 Committed Cities, 34 cities have made climate action plans, and are referred to as Planning Cities in this report. From publicly available information we can identify climate policies and actions in different fields. These policies and actions to address climate change mainly include understanding local emissions by compiling greenhouse gas emission inventories, making plans to cope with climate change, setting up professional teams to carry out academic and policy research, setting targets and specific policy measures for major emission areas, and carrying out communications with the general public. This section introduces the main actions and policies put forward by the 34 Planning Cities.

7.1 Compiling a Climate Action Plan

The climate action plan is at the heart of urban climate policies and actions. The planning contents of the climate action plans of Planning Cities all reflect the complexity of climate policy. The challenge of dealing with climate change is closely linked to macro-scale factors such as society, economy, culture, spatiality, resources, and environment. The response to climate change by Planning Cities is therefore integrated into the overall design of urban development in order to ensure coordination and consistency among various domains. During the planning process, all stakeholders have channels to express their views or ask questions on issues of concern, so as to ensure that the planning has a wide base of support.

The contents of the planning documents include the current status of urban emissions (historical emission trends), a long-term development vision, medium- and long-term emission reduction targets, major policies and measures, assessments, and room for updates, etc. Most Planning Cities cities have put forward roadmaps and phased targets, impacts on different interest groups, adaptive measures, and increased coordination of urban green space or biodiversity conservation.

The Climate Action Plan of New York City

In 2007, New York City released the first edition of its climate plan, the "PlaNYC – a Greener, Greater New York", that set reducing greenhouse gas emissions as its commitment target for the first time. After that, the climate action plan of New York was updated every four years – in 2011, 2015, and 2019, respectively. At present, New York's climate action plan is "One NYC 2050 – Building a Strong and Fair City", which was issued in 2019. Its goal is to achieve carbon neutrality by 2050. Its main policies include reducing greenhouse gas emissions from buildings, adopting 100% clean electricity, creating green jobs, and assigning accountability to polluters.

The emission reduction target has been upgraded from the first version of the plan of at least 30% greenhouse gas emission reduction by 2030 to 80% emission reduction by 2050 (based on 2005-levels). In the latest edition of the plan, the target is further raised as achieving carbon neutrality by 2050 is proposed.

In addition to the climate action plan, New York has also issued numerous supporting documents, including special urban plans, technical support research reports, annual assessment reports on progress in emission reduction, sectoral emission reduction plans, and greenhouse gas inventories. In 2013, New York released a supporting document, called "PlaNYC: A Stronger, More Resilient New York", which incorporated the lessons of Hurricane Sandy and contained a series of policies to support urban post-disaster reconstruction. The city also put forward strategies that cities should adopt to adapt to the impacts of climate change, including sea-level rise and extreme weather events.

In the same year, "PlaNYC2013: New York City's Pathways to Deep Carbon Reduction" was released, which assessed the possibility of an 80% deep emission reduction in New York in 2050.

In 2014 and 2016, a series of "One City: Built to Last" plans – i.e. 80*50 plans for deep emission reduction in buildings, energy, industry, transportation, and waste treatment – were released.

In 2016, the "New York City's Roadmap to 80*50" was released, which put forward a road map for deep emission reduction. The supporting documents also included progress reports on the previous year's task completion, which are published every year to publicly quantify the completion of its emission reduction targets, such as those of the “One NYC 2016 Progress Report” and “One NYC 2019 Progress Report”.

Greenhouse gas inventories are also an important part of the supporting documents. Since 2007, New York has updated its inventory every year, thus taking the collection, collation, and analysis system of greenhouse gas emission data as the basis of all the efforts to deal with climate change. In addition to the above supporting documents, New York has also set up a special data analysis management organization to upload the data needed for urban operations (especially on emission reductions) to the government website and to develop various data analysis tools to analyze emission reductions or carry out relevant research.

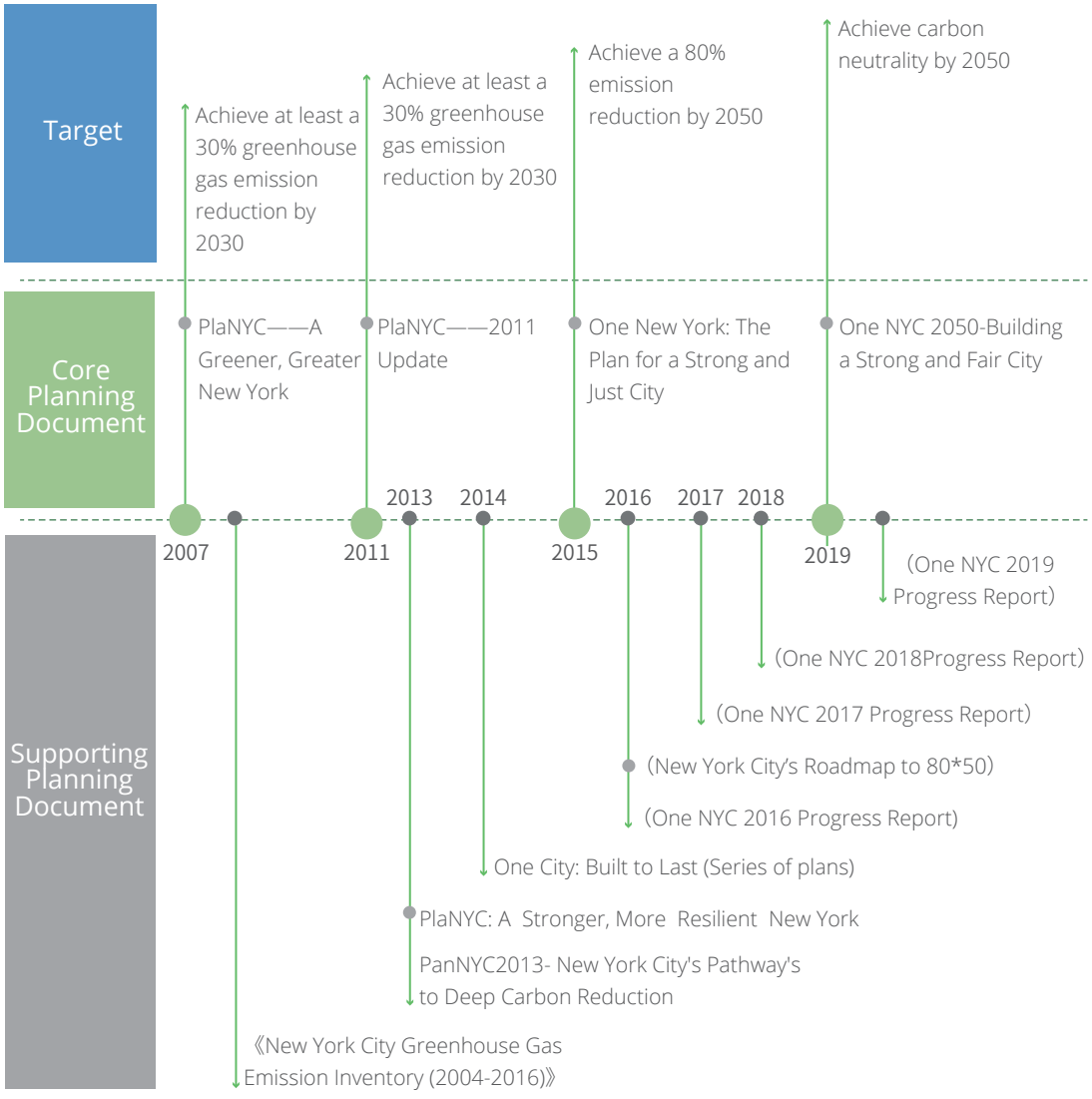


Figure 9. New York Climate Change Planning System

7.2 Policies and Actions

As a city government has only limited influence over industry, [27] the policy actions proposed by Planning Cities are mostly focused on the four sectors of buildings, transportation, electricity, and solid waste. Promoting emission reduction targets in these sectors is a top priority, which is matched by an increase in economic incentives and support policies. Policies and actions in different cities have some common sectoral characteristics, e.g. the power sector focuses mainly on reducing fossil fuels and increasing renewable energy, and the transportation sector mainly adopts electric or low-carbon fuel substitution and invests heavily to develop public transportation systems. The core of emission reductions in the buildings sector is to improve energy efficiency and increase the electrification rate. The focus of waste management is to improve the recycling rate, increase the classification rate, and reduce the amount of landfill waste.

This section introduces the policies and measures adopted by Planning Cities in the four sectors of buildings, transportation, electricity, and solid waste. The measures are based on summarizing and sorting out the measures proposed in the planning documents of the Planning Cities. Cities that propose "deep emission reductions" or "carbon neutral" targets have corresponding improvements in the setting of standards and policy targets. In the table below, we distinguish between "existing policies" and "deep emission reduction or near-zero-emission measures". While economic incentives and supporting policies are applicable in both scenarios, there is no obvious difference in the contents of the planning documents. Further understanding of the details of policy implementation will be needed to explain differences in execution.

City policies are supplements and enhancements to national and regional policies. To understand the overall climate authority of cities, national and regional actions should be considered as a whole, and cities should be included in the larger policy systems. Taking the EU region as an example, the "Green New Deal" released by the EU in 2019 proposed that the EU as a whole should achieve carbon neutrality by 2050 and set clear targets through legislation. It proposed to formulate a series of policies to ensure the realization of this goal, including expanding the industries covered by carbon markets, eliminating fossil energy, drafting a zero-carbon industry strategy, a circular economy action plan, an energy-saving renovation plan for existing buildings, a zero-emission transportation plan, and actions to encourage low-carbon technological innovation, etc. This is a powerful supplement and support to the areas beyond the city's control (such as industry and technological innovation) and can therefore enhance the overall latitude that EU cities have in climate policymaking.

7.2.1 Buildings Sector

According to the International Energy Agency, in 2018 the global buildings industry (including general and infrastructure construction) and energy consumption in the operation stage accounted for 36% of global energy consumption and 39% of global emissions. Among these, energy consumption for buildings and infrastructure construction accounted for about 6% (accounting for 11% of emissions), and energy consumption for operations accounted for 30% (accounting for 28% of emissions). [28] Cooling and

[27] Bronski, P., Calhoun, K., Corvidae, J., Creyts, J., Jungclaus, M., Mandel, J., & O'Grady, E. (2017). The Carbon-Free City Handbook. RMI. https://rmi.org/insight/the-carbon-free-city-handbook/

[28] IEA (2019), "Global Status Report for Buildings and Construction 2019", IEA, Paris https://www.iea.org/reports/global-status-report-for-buildings-and-construction-2019

heating Cooling and heating in buildings are the main sources of energy consumption, accounting for 35%-40% of total building energy consumption, generating nearly 40% of emissions.[29] Energy consumption varies in different climatic regions, for example, the northern region has winter heating demand while the southern region has more cooling demand for buildings.

Planning Cities have already carried out many measures in the buildings industry to control greenhouse gas emissions. Practice has proved that the existing technologies and measures can effectively reduce emissions, such as improving the energy efficiency standard of new buildings, carrying-out energy-saving renovation of existing buildings, and upgrading the energy efficiency of cooling, lighting, and appliances. However, cities need to make more efforts if they want to further reduce emissions from the buildings industry until they reach the level of "zero emissions".

In terms of building energy-saving design standards, in addition to setting stricter standards according to local conditions, cities should conduct pilot demonstrations which include passive housing, integrated design solutions and building integrated renewable energy, and expand the scope of pilots so as to achieve near-zero energy consumption in buildings.

In terms of building heating, some Planning Cities reduce the emissions of heating systems by eliminating fossil fuels and accelerating electrification. In addition, low-carbon energy sources such as solar thermal, heat pump systems, and biomass energy can also be used as alternatives to fossil fuel heating.

Buildings' cooling energy consumption has increased rapidly in recent years. In 2018, global cooling energy consumption was close to 2000TWh, and related emissions amounted to 1.13 billion tons, three times that of 1990.[30] Improving the energy efficiency of air conditioning, especially setting minimum energy performance standards, can rapidly reduce the cooling energy consumption of buildings. In addition, renewable energy cooling systems (such as photovoltaic refrigeration) are also in the pilot process. However, the popularization of energy-efficient technologies faces challenges in cost and price. A corresponding financing mechanism can promote the application of high-efficiency technologies.

In addition, in the past 10 years, the energy efficiency of lighting technology has increased rapidly, doubling its efficiency,[31] it is now on track of the global low-carbon transformation. The usage of high-performance LED will double energy efficiency again.[32]

[30] Cooling – Tracking Buildings – Analysis - IEA. (2020). IEA. Retrieved 5 April 2020, from https://www.iea.org/reports/tracking-buildings/cooling

[31] IEA (2019), "Tracking Buildings", IEA, Paris https://www.iea.org/reports/tracking-buildings

[32] CHINA 2050: A FULLY DEVELOPED RICH ZERO-CARBON ECONOMY. (2019). Energy Transition Commission, Rocky Mountain Institute. https://rmi.org/insight/china-2050-a-fully-developed-rich-zero-carbon-economy/

In terms of supporting policies, Planning Cities have addressed the reduction of energy consumption in the operation stage, which relates to behavioral changes among owners and real estate companies. Informatization of building energy consumption and demand-side management are key. Policy design is mainly aimed at the collecting and disclosing of energy consumption data. Capacity building of building operators can ensure that the same energy service can be provided with less energy consumption.

The following table summarizes the policies and measures that have been taken by Planning Cities. The measures are divided into five categories: standards, targets, economic incentives, supporting policies, and pilot demonstrations. They are also divided into "conventional" and "deep emission reduction or near-zero-emission measures" respectively.

	Conventional Measures	Deep Emission Reduction or Near Zero-Emission Measures
Standards	• Building energy efficiency standards • Operating standards of construction operators (property companies). • Passive or net-zero energy consumption building.	• Minimum Energy Performance Standard for cooling equipment. • Minimum Energy Performance Standard for lighting equipment.
Targets	• Medium-and long-term targets for energy-saving renovation of existing buildings. • Target of electrification rate in construction.	• Target of phasing out fossil fuel for heating. • Development target of high performance LED lighting.
Pilot Demonstrations	• Passive and near-zero energy consumption building.	• Heating technologies such as photothermal, heat pumps and biomass energy will replace fossil energy pilot projects. • Pilot project of applying a renewable energy refrigeration system.
Economic Incentives	• Financial support for a higher energy-efficient building standard. • Financial support for purchasing energy-efficient equipment. • Carbon Emission Trading Mechanism in the buildings industry. • Subsidy mechanism for energy-saving renovation of existing buildings. • Establish an energy-saving evaluation and mortgage mechanism to ensure investment in improving energy efficiency.	
Supporting Policies	• Installing intelligent control systems in buildings. • Energy efficiency label for equipment. • Building energy consumption reporting, auditing, and disclosure mechanisms. • Building energy consumption rating system. • Information exchange mechanism for building owners. • Help consumers get information on their energy consumption. • Provide training on energy efficiency improvements for construction operators (property companies).	

7.2.2 Electricity Sector

The improvement of energy efficiency and the rapid development of renewable energy has accelerated the decarbonization of the power system. In the past ten years, the installed capacity of renewable energy has increased from 414GW to 1650GW, and the amount of solar energy alone has increased twenty-fivefold.[33] In 2018, renewable energy accounted for 26% of electricity production[34] (mainly from hydropower), while non-large hydropower accounted for 12.9%, avoiding two billion tons of carbon dioxide emissions.[35] However, although renewable energy accounts for a relatively high proportion of the increase in power demand, and the power industry is still dominated by fossil energy.[36] The de-carbonization of the electricity industry is key to the global goal of tackling climate change, and cities, as major consumers of electricity, can accelerate this process.

In 2017, global industry consumed 42% of electricity. Residents and commercial buildings accounted for 48% of electricity consumption, while transportation accounted for only 2%.[37] With electrification becoming the main means of low-carbon transformation, the energy required for transportation and construction will gradually be met by electricity, and the demand for electricity will therefore show a fast-rising trend. Planning Cities' most important measures to promote carbon reductions in the power sector include setting a target of eliminating fossil fuels or a target to attain a high proportion of renewable energy, developing distributed renewable energy and formulating incentive policies to support its development, and improving energy efficiency and reducing the peak demand of power through demand-side management.

In recent years, the technical availability of renewable energy technologies has changed dramatically. Apart from hydropower, the technical availability of photovoltaic, wind power, and biomass energy technologies has shown a rapid upward trend. On the one hand, due to the rapid development of renewable energy technology, the power generation efficiency of wind power and photovoltaic is continuously improving. On the other hand, because the potential of some renewable resources is related to other cross-industry factors, the forecast data is updated faster. Taking photovoltaic power generation as an example, the factors that affect its technological development include the area of buildings and open land, and the duration of local electricity demand. Among these factors, the changes in the area of buildings has changed greatly, and the degree of open land will also increase after combining GIS and other tools. Thus, after is the data has been updated or the technical means to obtain information have made breakthroughs, this new and improved data will have a positive impact on the prediction accuracy of renewable energy development.

Therefore, the development of renewable energy in some cities has seen a much lower target setting than the actual situation in terms of installed capacity. Cities can reflect the development potential of renewable energy resources in their target setting and related measures in a timely manner through the regular updating of planning and performing related basic research.

[33] Global Trends in Renewable Energy Investment 2019. (2019). Frankfurt School-UNEP Centre/BNEF. https://wedocs.unep.org/bitstream/handle/20.500.11822/29752/GTR2019.pdf

[34] Renewables 209 Global Status Report. (2019). REN21.

[35] Global Trends in Renewable Energy Investment 2019. (2019). Frankfurt School-UNEP Centre/BNEF. https://wedocs.unep.org/bitstream/handle/20.500.11822/29752/GTR2019.pdf

[36] 20 Renewable Energy Policy Recommendations. (2018). IEA. https://webstore.iea.org/20-renewable-energy-policy-recommendations

[37] IRENA, IEA and REN21 (2018), 'Renewable Energy Policies in a Time of Transition'. IRENA, OECD/ IEA and REN21

In addition, the electrification process needs to complement the optimization of the power structure. If the power structure is not low-carbon enough, increasing the electrification rate quickly will increase overall emissions.

The following table summarizes the policies and measures taken by Planning Cities. The measures are divided into five categories: standards, targets, economic incentives, supporting policies, and pilot demonstrations. They are also divided into "conventional measures" and "deep emission reduction or near-zero-emission measures" respectively.

	Conventional Measures	Deep Emission Reduction or Near Zero-Emission Measures
Standards	• Energy efficiency standards and emission requirements for fossil fuel power plants.	• Emission standard of power generation consistent with 1.5℃ target.
Targets	• Medium- and long-term renewable energy installation or power generation targets.	• Fossil fuel phase-out target. • 100% renewable energy target.
Pilot Demonstrations	• Microgrid demonstration. • Smart grid pilot. • Demand-side management pilot. • Demonstration of multi-energy complementation. • Big Data energy demonstration.	• Renewable energy heating pilot. • Renewable energy refrigeration system pilot.
Economic Incentives	• Renewable energy quota system. • Tax relief for renewable energy power plants or individuals to install renewable energy equipment. • Carbon Emission Trading System in the power industry. • Electricity price benchmark mechanism of distributed generation.	
Supporting Policies	• Net metering of renewable energy generation. • Solar energy resource or heat density map. • Provide consulting services for developers or building owners on renewable energy development.	

7.2.3 Transportation Sector

Transportation is the third-largest source of CO_2 emissions after electricity and industry,[38] with direct emissions from transportation accounting for 24% of global emissions in 2017.[39] Compared with 2010, the emissions from passenger transport and freight increased by 36% and 75%, respectively, in 2015. Of these, emissions from freight increased faster, accounting for 41% of the CO_2 directly emitted by the transportation industry.[40]

[38] Transport and Climate Change Global Status Report 2018. (2018). Partnership on Sustainable, Low Carbon Transport. http://slocat.net/tcc-gsr

[39] IEA (2019), "Global Status Report for Buildings and Construction 2019", IEA, Paris https://www.iea.org/reports/global-status-report-for-buildings-and-construction-2019

[40] Energy Technology Perspectives 2016. (2016). IEA. https://webstore.iea.org/download/direct/1057

Due to the increase in urbanization rates, population, and income, the traffic demand of cities will continuously increase. Half of the world's passenger transport demand occurs in cities. Energy consumption due to passenger transport services accounts for 80% of the energy consumption in the urban transportation sector. Less than 1% of freight traffic takes place in the city,[41] but because the energy consumption intensity per unit of freight volume and per distance of the city's freight modes (mostly light commercial vehicles or medium trucks) is higher than that of long-distance freight (such as trains or shipping), its energy consumption accounts for 21% of all freight energy consumption.[42] The transportation policies formulated by Planning Cities mainly focus on reducing emissions from the transportation industry in eight areas: fuel economy standards, urban planning, electric transportation, transportation demand management, public transportation, slow transportation, intelligent transportation, and shared travel modes.

In the United States, California enacted its light vehicle fuel economy standards through legislation, leading 15 states to immediately adopt California's standards, showing that fuel economy standards can be one of the important policy measures promoted by non-state entities. Research by the Global Fuel Economy Initiative shows that existing technologies can double the economic efficiency of fuel of new light vehicles by 2030 and double it for all light vehicles by 2050.[43] Cities' transportation policy can encourage consumers to buy more energy-efficient motor vehicles by means of energy-saving signs for motor vehicles or tax incentives.

In the past 10 years, the output and penetration of EVs have increased rapidly. In 2018, the global stock of EVs reached 5 million, up 63% from 2017. The main measures to increase the number of EVs in Planning Cities include setting a timetable for the electrification of public transportation, subsidies or tax concessions for private EVs, building charging facilities, and models for sharing EVs. The promotion of EVs and the elimination of fossil fuel vehicles are carried out at the same time. Cities like Amsterdam, Paris, New York, London have all set targets for phasing out fossil fuel vehicles.

Traffic demand management includes a series of measures to control or shift traffic demand and reward efficient travel modes. Its purpose is to reduce the motorized travel volume of passengers or freight. The control policies include the control of private car ownership, travel control, congestion charges, and the designation of car-free areas. Transfer policies include subsidies or concessions for low-carbon commuting, reform of parking fees, designation of low-emission areas, off-peak delivery, etc. In addition, traffic demand control cannot be separated from corresponding traffic planning and urban design. The design concepts of (TOD) and "complete streets" make traffic demand management possible.

Public transportation is a multi-purpose measure that not only reduces carbon emissions, but also reduces congestion, air pollution, and noise while meeting travel demand. Planning Cities increase the supply of public transport services through the construction of rail transit and Bus Rapid Transit (BRT) systems, and motivate the public to use public transport through appropriate cost incentives.

Non-motorized traffic, such as walking or cycling, can not only meet travel needs but also bring safety, health, and economic benefits to a city. To realize these benefits, Planning Cities often strive to improve the construction of non-motorized infrastructure.

[41] IEA (2016), Mobility Model, 2016, database and simulation model, www.iea.org/etp/etpmodel/transport/.

[42] Energy Technology Perspectives 2016. (2016). IEA. https://webstore.iea.org/download/direct/1057

[43] Eads, G. (2011). 50by50-Prospects and Progress. Global Fuel Economy Initiative. https://www.globalfueleconomy.org/media/46113/50by50-prospects-and-progress-2011-lr.pdf

Shared travel is a traffic service mode that has emerged in recent years, covering different modes of transportation such as passenger transportation, freight transportation, and electric bicycles. The impact of shared travel on traffic emissions is currently not well understood, but considering the continuous expansion of its scale, policies should consider regulating the carbon emissions of these vehicles.

The following table summarizes the policies and measures that have been taken by Planning Cities. The measures are divided into five categories: standards, targets, economic incentives, supporting policies, and pilot demonstrations. They are also divided into "conventional" and "deep emission reduction or near-zero-emission measures", respectively.

	Conventional Measures	Deep Emission Reduction or Near Zero-Emission Measures
Standards	• Economic fuel standard.	• Formulate fuel economy standards higher than national standards.
Targets	• Medium-and long-term targets for public transportation development. Development target for low-carbon vehicles (electric, fuel vehicles, or bio-fuel vehicles). • Private car possession and travel demand control.	• Zero-emission targets in the transportation industry. • Target for eliminating fossil fuel vehicles. • Target for electric public transport. • Target for electric freight transportation. • High proportion of non-motorized travel and bus travel targets. • All-electric targets for new cars.
Pilot Demonstrations	• Electric truck demonstration. • Pilot demonstration of renewable diesel and aviation fuel. • Pilot drone express service.	
Economic Incentives	• Implement congestion/climate tax mechanism for fuel vehicles in designated areas. • Parking pricing model (roadside parking, dynamic pricing, etc.). • Regional road pricing (toll roads, dynamic pricing). • Lower the premium for vehicles with less mileage. • Provide incentives for property or owners, install charging piles, and other infrastructure. • Subsidize low-carbon commuting modes.	
Supporting Policies	• Replace ordinary buses with BRT systems. • Set up BRT lines in densely populated areas. • Transit-Oriented Development (TOD) urban design. • Off-peak delivery service. • Building friendly infrastructure for non-motorized travel. • Redesign parking infrastructure. • Application of intelligent transportation system to provide real-time public transportation, parking, and travel information for citizens. • Change freight transportation to railway or water transportation. • Design policies for sharing trips (bicycles, passenger transport, freight transport, etc.). • Set up bus or carpool lanes.	

7.2.4 Waste Management

Compared with emissions from the electricity, transportation, and buildings industries, CO_2 emissions from waste are much lower. In 2016, the emissions from waste were about 1.6 billion tons of CO_2, accounting for 5% of global emissions,[44] most of which are due to methane emissions from open landfills. With the improvement of living standards and the increase of urbanization rate and urban population, cities will produce more waste, which increases risks to health and the ecological system.

Planning Cities usually adopt product life-cycle management to reduce the generation of waste. By reducing, reusing, classification, recycling, organic compost fermentation, and so on, the volume of waste landfills can be reduced, thus bringing down emissions.[45] In addition, one-third of the world's food is lost or wasted, resulting in emissions. Urban policies also include measures to reduce food waste. Some leading cities regard the circular economy as a long-term goal and are exploring ways to better recycle resources.

The following table summarizes the policies and measures already taken by Planning Cities. The measures are divided into three categories: targets, economic incentives, and supporting policies, and are listed as "existing measures" and "deep emission reduction or near-zero-emission measures".

	Conventional Measures	Deep Emission Reduction or Near Zero-Emission Measures
Targets	• Landfill reduction target. • Requirements for recycling ratio of recycled concrete.	• Zero-waste target. • Zero-landfill target.
Economic Incentives	• Impose disposal fees on non-recyclable waste. • Raise the cost of landfill disposal. • Charge for plastic or paper bags. • Penalties for failure to classify and recycle according to requirements. • Reward residents or enterprises for garbage recycling (e.g. discounts, gifts or points, etc.). • Encourage sustainable consumption through government procurement rules.	
Supporting Policies	• Infrastructure construction for garbage collection, recycling, and composting. • Improve garbage power generation capacity. • Strengthen the sorting and processing capacity of organic waste. • Improving methane collection and reuse capacity of landfill sites. • Set up a fixed garbage collection space in new buildings. • Encourage producers to reduce excessive packaging of products through government procurement and other methods. • Provide training for residents and enterprises on garbage sorting and recycling. • Provide technical support for waste classification for property owners and property companies.	

In addition to the above four industry policies, Planning Cities cities have also taken corresponding action in the two cross-sectoral areas of technological innovation and consumer behavioral change. In the area of consumer behavioral change, emissions reductions are pursued by changing the diet structure, purchasing local goods, and encouraging telecommuting. In contrast, policies on technological

[44] BKaza, Silpa, Lisa Yao, Perinaz Bhada-Tata, and Frank Van Woerden. 2018. "What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050." Overview booklet. World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO

[45] Land is a Critical Resource, IPCC report says — IPCC. (2020). Ipcc.ch. Retrieved 6 April 2020, from https://www.ipcc.ch/2019/08/08/land-is-a-critical-resource_srccl/

8. Case Studies

This section presents case studies on industry and city-wide actions. Industry cases are from cities that have outstanding performance in the four major emission areas of buildings, transportation, energy, and waste. The city cases are divided into three groups: level of economic development, emission reduction commitments, and city size. From each group the report homes in on one city, focusing on its target setting and highlighting policy measures to provide reference for Chinese cities.

8.1 Industry Cases

Case 1: Architecture - New York's Green New Deal

Located on the Atlantic coast in southeastern New York state, New York is the largest city and port in the United States. The New York metropolitan area is one of the largest metropolitan areas in the world. In 2018, New York had a population of 8.4 million and a median household income of US$ 63,799.[46] As of 2017, New York has a total area of 1214.4 km^2. According to the data of the "New York 2016 Greenhouse Gas Emission Inventory", the buildings sector is the largest greenhouse gas emission sector in New York and is also one of the areas with the best emission reduction impacts.[47] In terms of building emission reduction, New York City has enacted laws targeting emission reduction programs for different types of buildings.

In April 2019, the New York City government announced New York's "Green New Deal" to ensure that the city will reduce its greenhouse gas emissions by nearly 30% by 2030 (based on 2005-levels). The "Green New Deal" requires New York City to carry out energy efficiency renovations of existing large buildings of 25,000 square feet or more, to reduce the emissions of these large buildings by 40% by 2030, and by 80% by 2050. There are 50,000 of these large buildings in the whole city, accounting for 2% of New York's real estate stock, while the emissions account for half of all the buildings in New York. In order to achieve this goal, the Green New Deal requires these large buildings to install new windows, insulation materials, and other renovation equipment to improve energy efficiency. If building owners fail to meet the above targets, they can be fined up to 40 million dollars per year. It is estimated that this policy will bring about a 10% reduction in greenhouse gas emissions in New York (compared to 2005 baseline).[48]

The Green New Deal also stipulates that the roofs of new and some small buildings should be covered with plants, solar panels, small wind turbines, or some combination of the three.[49]

Apart from exempting some special use and small residential buildings, the "Green New Deal" also formulated economic incentive policies to stimulate citizens to participate. The "Green New Deal" creates a low-interest loan program to help building owners obtain funds to carry out green reforms. These loans enable most borrowers to see a net gain from cost savings brought about by improving energy efficiency.

Case summary:

New York City has formulated a targeted bill for the buildings sector, which has the greatest potential for emission reduction in the city, ensuring the consistency and stability of the target, and has designed detailed implementation rules and economic incentive rules to ensure the realization of the target.

For more information, please refer to: https://www.governor.ny.gov/

[46] Data USA.[on line] https://datausa.io/profile/geo/new-york-ny#economy

[47] New York City. INVENTORY OF NEW YORK CITY GREENHOUSE GAS EMISSIONS IN 2016.[R]. https://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/GHG%20Inventory%20Report%20Emission%20Year%202016.pdf

[48] New York City. Action on Global Warming: NYC's Green New Deal. https://www1.nyc.gov/office-of-the-mayor/news/209-19/action-global-warming-nyc-s-green-new-deal#/0

[49] Grist. New York City's newly passed Green New Deal, explained. https://grist.org/article/new-york-citys-newly-passed-green-new-deal-explained/

Case 2: Transportation - Madrid Low Emission Area

On November 30, 2018, Madrid kicked off a low-emission zone ("Madrid Central") in the historic area of Madrid – the city's core commercial, residential, and tourist hub, with an area of 4.72 km^2.[50] The purpose of designating a low-emission area is to ease traffic congestion and reduce air pollution, while also reducing greenhouse gas emissions. The main measures include restricting the entry of fuel-powered vehicles into the area. Only public transport vehicles, vehicles with no environmental protection signs owned by residents in the area (replaced by clean vehicles before 2025), some delivery vehicles, EVs, or vehicles conforming to the EU ECO signs (hybrid, natural gas, etc.) can enter. The low emission area requires vehicles entering the area to lower their speed. This measure can reduce air pollution caused by traffic and at the same time provide a sense of security for pedestrians, bicycles, skateboards, and other modes of transportation and promote walking and bike-riding. The low emission area also reduces the supply of fixed parking spaces in the area, thus reducing the utilization rate of vehicles. The city imposed a 90 euro fine on drivers who illegally drive high-emission cars by using surveillance cameras.

Case summary:

Madrid has promoted the application of the EU clean energy vehicles standard through the policy of establishing a low-emission area in the transportation sector, and has brought into play the synergistic effect air pollution control and greenhouse gas emission reduction by controlling traffic.

For more information, please refer to:

https://www.madrid.es/portales/munimadrid/es/Inicio/Movilidad-y-transportes/Madrid-Central-Zona-de-Bajas-Emisiones/?vgnextfmt=default&vgnextchannel=508d96d2742f6610VgnVCM1000001d4a900aRCRD&vgnextoid=508d96d2742f6610VgnVCM1000001d4a900aRCRD

Case 3: Energy - Copenhagen Green Energy Plan

The Copenhagen Municipal Government released the first edition of its "Climate Plan 2025" in August 2009. The plan aims to reduce the city's CO_2 emissions by 20% by 2015 and achieve carbon neutrality in Copenhagen by 2025 (based on 2005-levels).[51] In order to achieve this ambitious goal, the government will both improve the supply of renewable energy and the level of energy efficiency.

According to the municipal government's assessment, Copenhagen's CO_2 emissions decreased by 38% in 2015. The speed of emission reductions is accelerating with the development of technology and the efforts of various parties, and this achievement mainly comes from the use of renewable energy for district heating and cooling.[52] In 2025, Copenhagen's energy will be provided entirely by clean energy-wind, solar, geothermal, garbage, wood, and other biomass energy. 360 wind turbines will be set up by 2025 to supply most of the electricity demand in the city, and seawater will be introduced to cool buildings and households through the construction of new regional refrigeration systems. Compared with traditional air conditioning, district cooling systems will reduce energy consumption by 80%.

[50] Can your car drive into the center of Madrid? [on line]. http://www.studyes.com/content/13064.html

[51] Copenhagen City.[on line]. http://stateofgreen.cn/合作伙伴/哥本哈根市

[52] The Stone of Other Mountains | Copenhagen's Zero Carbon City in 2025.[on line]. http://www.sohu.com/a/124453206_383718

In addition to improving the application of clean energy, the municipal government also uses green financial means to encourage residents to participate in investment in clean energy production companies. For example, the Middelgrundens Wind Farm is Denmark's first offshore wind farm with a cooperative ownership structure. It has been in operation since 2000 with a total investment of about 48 million euros. It has nearly 10,000 shareholders and everybody is free to buy and sell its shares.[53]

To improve energy efficiency, the Copenhagen Municipal Government has integrated the three major energy consumption areas of power generation, transportation, and buildings into a comprehensive plan in order to achieve its green goal. Electricity is used for power generation and heating by implementing regional heating systems. In terms of architecture, Copenhagen has strict building standards and promotes the building of energy-saving buildings. In terms of transportation, in Copenhagen's 2025 carbon neutral plan, the Copenhagen Municipal Government hopes to increase the proportion of people who ride bicycles to work or go to school from more than 30% to 50% by 2025.

Case summary:

Copenhagen's medium-term and long-term emission reduction plans focus on promoting clean energy production, technological innovation, and green finance, actively improving energy efficiency, carrying out linkages over different industries, and formulating specific action measures.

For more information, please refer to:

https://urbandevelopmentcph.kk.dk/artikel/cph-2025-climate-plan

Case 4: Waste Disposal - Tokyo

According to the “Creating a Sustainable City Tokyo's Environmental Policy”, the latest policy document released by Tokyo in 2019, Tokyo is 2,194 km2, with a resident population of 13.85 million. The city's GDP amounts to 960.3 billion U.S. dollars and had a total of 930,000 tons in final waste disposal in 2016, and 56.7 million tons in energy-related CO_2 emission in 2017.

Tokyo announced that it will achieve zero emissions by 2050. To achieve this goal, the Tokyo Municipal Government has formulated a comprehensive emission reduction plan, of which waste management is an important part. According to its “Sustainable Materials and Waste Management Plan” (March 2016), the Tokyo Municipal Government strives to complete two tasks before 2030: transform the sustainable utilization of resources and reduce resource loss, promote the use of ecological materials, and further recycle and reuse waste.

In order to reduce food waste, implement waste reduction measures, and halve food waste in Tokyo by 2030, the Tokyo Municipal Government implemented the Tokyo Food Waste Avoidance Plan, which will investigate the current situation of food waste, discuss solutions, and encourage consumers to take actions. The municipal government will unite the food manufacturing and packaging industry with consumers to reduce disposable food packaging and encourage large packaging consumption.

[53] Copenhagen will become the world's first zero-carbon emission city in 2025.[on line]. http://www.weather.com.cn/climate/qhbhyw/07/1667775.shtml

In terms of waste recycling, the Tokyo Municipal Government encourages enterprises, organizations, and individuals to carry out various recycling projects by formulating relevant policies. The city also requires that the dust generated from burning non-recyclable wastes be recycled and used as a raw material to manufacture environmentally-friendly products. In the buildings sector, the building recycling law requires construction companies to separate materials and recycle special building materials (such as concrete, asphalt concrete, wood, etc.) when demolishing buildings. The Tokyo Municipal Government, together with companies with technical expertise in waste treatment, has jointly established a number of ecological town projects to help the region extend the lifespan of landfills. In addition, the Tokyo Municipal Government has legislated to reduce the use of disposable plastic products.[54]

Case summary:

In terms of waste treatment, the Tokyo Municipal Government set long-term reduction and recycling goals for the whole society primarily through legislation. Through cooperation with enterprises and individuals, it has issued detailed technical guidance, and launched multiple projects or initiatives on waste reduction and recycling.

For more information, please refer to:

https://www.kankyo.metro.tokyo.lg.jp/en/about_us/videos_documents/documents_1.files/creating_a_sustainable_city_2019_e.pdf

Case 5: Nature-based Solutions - Medellin Green Corridor Project

Medellin is the second-largest city in Colombia, with a population of 24,200 in 2018,[55] and an area of 380.64 square kilometers under the jurisdiction of the municipal government.[56] The capital of Antioquia, it is located at the western foot of the Central Cordillera Mountains in the Abra Valley, on the Boulder River, at 1541 meters above sea level. The average annual temperature is 21.5℃ and the average annual precipitation is 1309 mm. The city has spring-like seasons and a pleasant climate.

Medellin faces a severe urban heat island effect threat, which is aggravated by climate change. Its response has been to build a green corridor and create a better living environment. Medellin has focused on the areas lacking the most green space, planted 30 green corridors along 18 roads and 12 waterways, in total planting 8,300 trees and 350,000 bushes. In this project, green corridors and street gardens were built on the main roads of the city to improve the commuting environment for millions of citizens, and green corridors were built beside abandoned subway lines to collect rainwater and build sponge green walls to supply water to plants. The project successfully reduced the local temperature by more than 2°C, promoted biodiversity conservation in the region, reduced the urban heat island effect, cleaned up the air, and provided comfortable shade for urban cyclists and pedestrians.

[54] Tokyo City Government: "Creating a Sustainable City Tokyo's Environmental Policy" [Policy]. https://www.kankyo.metro.tokyo.lg.jp/en/about_us/videos_documents/documents_1.files/creating_a_sustainable_city_2019_e.pdf

[55] "Information" (PDF). www.dane.gov.co. 2019. Retrieved 2020-03-26.

[56] "Estimates and projections of the total national, departmental and municipal population by area 1985-2020" (XLS). NADS. Retrieved 1 September 2014.

Plants were selected with the support of local plant research institutions and provide food and travel corridors for local wild animals. The mixed planting of arbor, shrub, and grass provides a habitat for local animals, birds, and insects.

A comfortable and green environment provides relief and promotes gardening skills. The project has also trained 75 gardeners to help vulnerable city residents.

Medellin was awarded the Ashden Award for Natural Cooling in 2019 for this green corridor project.

Case summary:

Based on the analysis of the hazards of climate change faced by cities, Medellin chose a solution based on nature. By building urban green corridors, it created a cool city, increased urban carbon sinks, and gained multiple benefits, including reducing the urban heat island effect, improving biodiversity, facilitating travel, and cleaning the air.

For more information, please refer to:

https://www.ashden.org/winners/alcald%C3%ADa-de-medell%C3%ADn

8.2 Developed Economy City Case – Paris

The population in the administrative area of the Paris Municipal Government (Paris city) [57] reached 2.22 million in 2019, covering an area of 105 square kilometers.[58]

Paris' CO_2 emissions reached 25.6 million tons in 2014. The emissions in Scope 1 are 6 million tons of CO_2 and are mainly the direct emissions from Paris and the energy consumption of residential, tertiary/service and industrial sectors, the transportation in the city center, and the emissions related to the waste generated in the city. The emissions in Scope 2 and Scope 3 amounted to 19.6 million tons of CO_2 and mainly come from energy consumption, food, building-related sectors, and transportation.[59]

The medium- and long-term commitment of Paris to reduce greenhouse gas emissions has been broken down according to the greenhouse gas emissions identified in the Paris Climate Plan 2050: by 2020, local emissions will be reduced by 30% (based on 2004-levels), and the carbon footprint of outer Paris will be reduced by 20%; by 2030，local emissions will be reduced by 50% and the carbon footprint of outer Paris by 40%.[60] In 2050, local emissions will achieve zero emission of greenhouse gases and carbon neutrality, and the carbon footprint of outer Paris will decline by 80%, with a goal to offset the remaining

[57] The administrative scope of Paris this research refers to is the same as that in the Paris Climate Action Plan Towards a Carbon Neutral City and 100% Renewable Energies.

[58] City of Paris. Notre grande enquête : qui sont les Parisien·ne·s ?[Press]. https://www.paris.fr/pages/notre-grande-enquete-qui-sont-les-parisien-ne-s-5185

[59] City of Paris. PARIS CLIMATE ACTION PLAN TOWARDS A CARBON NEUTRAL CITY AND 100% RENEWABLE ENERGIES.[R]. https://cdn.paris.fr/paris/2019/07/24/1a706797eac9982aec6b767c56449240.pdf

[60] In the Paris Climate Action Plan ("PARIS CLIMATE ACTION PLAN TOWARDS A CARBON NEUTRAL CITY AND 100% RENEWABLE ENERGIES", carbon footprint is defined as local emissions plus upstream emissions generated before energy consumption (upstream: transmission and distribution loss, amortization of energy facilities (production and transmission)), emissions related to the food, buildings industry, and transportation outside Paris (including air transportation).

emissions to net-zero carbon emissions of 48%. Paris has created an implementation roadmap, detailing specific targets in seven areas - energy, buildings, transportation, waste disposal, changes in residents' behavior, city form, and food - and has formulated corresponding policies and measures.

1. Energy consumption and production:

Energy Consumption Targets	Renewable Energy Production Targets	Measures
• Renewable energy consumption to reach 25% in 2020, 45% in 2030 and 100% in 2050. • An energy consumption decrease by 35% by 2030 and 50% by 2050. • A reduction in renewable energy consumption for heating by 75% by 2030 and 100% by 2050.	• Renewable energy production is to reach 10% by 2030 and 20% by 2050.	• Installation of solar photovoltaic devices/distributed renewable energy; • Decarbonization of heating and cooling networks; • Increase the purchase of renewable energy; • Optimize energy storage; • Eliminate coal energy; • Use renewable energy for heating; • Upgrade the smart grid.

2. Transportation

Targets	Measures
• By 2020, achieve a "100% bicycle-friendly" city, including having a speed limit of 30 kilometers on all roads except the main roads; • Phase-out diesel-powered cars by 2024; • Have a low-carbon public transportation system by 2025; • By 2030, gasoline-powered cars should be phased out.	• Implement an electric bus system on the right bank of the Seine; • Building electric vehicle infrastructure; • Develop public transportation; • Optimize parking policies; • Promote non-motorized travel; • Establish a zero-emission area; • Encourage shared travel; • Encourage clean logistics; • Encourage the development of EVs; • Build a system for managing the • Develop self-driving unmanned busses/minibusses.

3. Buildings

Targets	Measures
• From 2018 onwards, all new buildings in Paris must meet the statutory consumption target of 50 kW HPE/m construction area per year; • Starting from 2020, all new municipal buildings need to meet the passive building standards; • Reduce housing energy consumption by 1/3 by 2030 and 1/2 by 2050 (based on 2004-levels); • Reduce the energy consumption of all existing buildings by 40% by 2030; • By 2030, the energy efficiency of public institutions needs to be improved to the highest standard; • One million housing units have to be renovated by 2050.	• Create ecological communities that are carbon-neutral and flexible, such as Saint-Vincent-de-Paul, will become the first carbon-neutral community in the city. • By 2050, energy conservation has to be improved for 1 million houses and more than 50 million square meters of commercial space, offices, restaurants, and public institutions. • By 2030, the energy efficiency of 300 schools, 40 junior colleges, and 15 swimming pools in public buildings have to reach the highest standard, and energy consumption of urban parks has to be reduced by 40%. • The implementation of net-zero carbon construction projects. • Promote ground source heat pumps.

4. Waste

Targets	Measures
• By 2020, 20 recycling centers and related repair workshops (recycling stations) should be established. • Set up 1,000 composting sites by 2020; • Reduce food waste by 50% by 2025; • By 2030, every 100,000 residents should have a "100% recycling store"; • Achieve "zero unrecycled waste" by 2050.	• Organic waste collection; • Recycling services; • Promote the circular economy; • Garbage classification; • Reduce packaging initiatives; • Collect and donate unused and surplus food; • Low-carbon lifestyle initiative.

Paris has not set specific targets in terms of changes in residents' behavior and urban morphology but has formulated policies to promote the realization of the city's medium and long-term goals. For example, it plans to encourage sustainable behavior change by promoting energy-saving appliances, implementing repair and reuse methods and a circular economy, promoting teleconferencing and reducing commuting, encouraging a sustainable diet and eating local food, increasing training on carbon-reducing driving methods, and by upgrading green financial services.

8.3 Middle- and High-Income Economy City Case – Hong Kong

Hong Kong's population reached 7.429 million in 2018. According to the classification standard of the UN's "Global Economic Situation and Prospects 2019",[61] its economic development level belongs to the middle and high-income level of developing economies.

At present, Hong Kong ranks seventh in the global trading economy, and its main trading partner is Mainland China. Hong Kong's economy is dominated by the service industry, with especially close ties with the Mainland and other parts of the Asia-Pacific region. In 2018, Hong Kong's GDP reached 256.04 billion RMB, per capita GDP reached 343,630 RMB, the average annual GDP growth rate was 3.0%, and the labor force reached 3.979 million. Hong Kong's industrial structure is dominated by the tertiary industry, which

[61] World Economic Situation & Prospects for 2019. (2019). Economic Analysis & Policy Division | Dept of Economic & Social Affairs | United Nations. Retrieved 9 May 2020, from https://www.un.org/development/desa/dpad/publication/world-economic-situation-and-prospects-2019/

contributed 92% to GDP in 2017. Manufacturing in Hong Kong accounts for only 1% of GDP, while the buildings and water, and electricity and gas industries account for 5% and 1%, respectively. Primary industry (including agriculture and fishery, mining and quarrying) does not contribute significantly to the added value of Hong Kong's GDP, and its proportion of total employment is also low.[62]

According to Hong Kong's greenhouse gas inventory in 2017, Hong Kong's carbon emissions peaked in 2014. In 2017, Hong Kong's total carbon emissions were about 40.7 million tons, and per capita carbon emissions were 5.5 tons. The carbon intensity decreased by about 34% compared with 2005.[63]

In 2017, the Hong Kong Government issued the "Hong Kong Climate Action Blueprint 2030+", which aims to reduce the carbon intensity by 65%-70% from the level in 2005 by 2030, equivalent to 26%-36% absolute emission reduction, while the per capita carbon emissions will be reduced from about 5.7 tons in 2015 to 3.3-3.8 tons in 2030.

In terms of energy, through energy demand management, Hong Kong will reduce its energy intensity by 40% in 2025 (based on 2005 levels). It also aims to increase the proportion of renewable energy and use current renewable energy technologies to generate electricity, including wind power, solar energy, and waste incineration. Its development potential is estimated to be about 3-4% by 2030. As of the completion of this report, Hong Kong has not defined its climate vision for 2050.

According to the emission reduction targets of the Paris Agreement, Hong Kong has to formulate long-term and long-term emission reduction targets and timetables, update plans, and review the effect of its actions every five years. At the same time, it will strengthen the work related to climate adaptation, and put forward specific measures in infrastructure, urban planning, water security, nature conservation and biodiversity, emergency mechanism construction, green finance, community participation, and encourage people to adopt low-carbon behavior.

Hong Kong's energy sector plans to gradually reduce coal-fired power generation by 2030 and replace it with natural gas; coal consumption in Hong Kong accounted for 48% of power generation fuel in 2015 and will decline by 25% in 2020, and continue to decrease by 2030. In 2015, natural gas accounted for 27% of power generation, rose to 50% in 2020, and will continue to increase until 2030. Non-fossil fuels will be flat from 25% in 2015 to 2020 and will continue to increase until 2030. With regard to renewable as solar energy, the government is taking the leading role and giving priority to the use of renewable energy, such energy, in government infrastructure projects. It has also increased efforts to support the development of wind power and hydropower.

In terms of construction, buildings in Hong Kong account for 90% of electricity consumption in Hong Kong. More than 60% of carbon emissions come from electricity production related to building energy consumption. Therefore, in addition to continuously improving the energy-saving performance of newly-built buildings, existing buildings and public infrastructure will be focused on, as shown in Table 2. In terms of transportation, Hong Kong has adopted measures such as optimizing traffic road planning to increase the proportion of public transportation trips, encourage walking, reduce congestion, save energy, and encourage social cooperation to increase public participation.

[62] Hong Kong Municipal Government. Hong Kong Annual Report of the Hong Kong Special Administrative Region.R].2018. https://www.yearbook.gov.hk/2018/sc/

[63] Hong Kong City Government. Hong Kong's carbon reduction peaks to meet the climate challenge.[Press].2019. https://www.cso.gov.hk/sc/blog/blog20191222.htm

In terms of adaptation, Hong Kong plans to strengthen the urban structure and slope safety, integrate drainage and flood management plans, and construct high-quality gardens to enhance biodiversity. In addition, reclaiming water, reusing reclaimed water and rainwater recovery, coupled with seawater desalination, can increase Hong Kong's water resources and can serve as a catalyst for deeper thinking on the challenge of sea-level rise. Hong Kong also plans to expand country and marine parks and has drawn up a long-term plan to promote urban forestry and ecology. These plans will help cool down the city as climate change causes temperatures to rise.

Table 2. Hong Kong's Feasibility Scheme for Monitoring Large Existing Buildings[64]

	Existing	2030 Policy
Energy Audit	According to the energy audit code, four kinds of building equipment and devices of buildings are audited every 10 years.	More frequent audits are required for cooling systems with high energy consumption.
Tools	Building energy efficiency regulations require disclosure of energy consumption indicators.	From voluntary to mandatory data sharing.
Reexamine	There are no specific requirements and they are not widely used.	Promote the best-operating methods in public buildings and interact with businesses and professionals to enhance awareness.
Current Building Retrofitting	Energy audits provide recommendations but do not require implementation.	Encourage the implementation of relevant recommendations.
Green Building Standard	In addition to serving as a comprehensive evaluation, the "Green Building Environmental Assessment" system can be used as an alternative standard for the selection of existing buildings.	Encourage owners to consider using the new "Green Building Environmental Assessment" together with the existing building rating standards when renovating buildings.
Beyond Legal Requirements	Establishing a dialogue platform between the public and private sectors.	Continue to promote energy conservation in existing buildings.

[64] (2020). Climateready.gov.hk. Retrieved 11 May 2020, from https://www.climateready.gov.hk/files/report/tc/HK_Climate_Action_Plan_2030+_booklet_Chin.pdf

Appendix

Table 3. List of Willing Citiess, Committed Cities, and Planning Cities

Willing Cities	OECD Country City	Committed City	Planning City	Does it have a list?	Scope 1	Scope 2	Scope 3	List Year	Source	Notes
Abidjan		✓								
Adelaide	✓	✓	✓	✓	✓	✓		2016	https://d31atr86jnqrq2.cloudfront.net/docs/foundation-report-carbon-neutral-adelaide.pdf?mtime=20190620170245	
Addis Ababa		✓								
Accra		✓		✓	✓	✓	✓	2015	C40	
Amsterdam	✓	✓	✓	✓	✓	✓		2015	https://www.amsterdam.nl/en/news/co2-emissions/	
Edinburgh	✓	✓	✓							
Amman		✓	✓	✓	✓	✓	✓	2014	C40	
Auckland	✓		✓	✓	✓	✓	✓	2014	https://www.aucklandcouncil.govt.nz/environment/state-of-auckland-research-report-cards/Pages/greenhouse-gas-emissions-report-card-auckland-reporting-area-2016.aspx	
Oslo	✓	✓	✓	✓	✓	✓	✓	2017	https://www.oslo.kommune.no/getfile.php/13326721-1559029071/Tjenester%20og%20tilbud/Politikk%20og%20administrasjon/Statistikk/Milj%C3%B8status/Klima-og%20energistatistikk/Milj%C3%B8direktoratets%20kommunefordelte%20utslipp_EN.pdf	
Austin	✓	✓	✓	✓	✓	✓		2016	C40	
Paris	✓	✓	✓	✓	✓	✓	✓	2014	C40	

Willing Cities	OECD Country City	Committed City	Planning City	Does it have a list?	Scope 1	Scope 2	Scope 3	List Year	Source	Notes
Barcelona	✓	✓	✓[65]	✓	✓	✓	✓	2016	C40	
Berlin	✓									
Boston	✓	✓	✓	✓	✓	✓		2017	https://www.boston.gov/sites/default/files/embed/file/2019-07/boston_ghg_inventory_2005-2017.pdf	
Portland	✓	✓	✓	✓	✓	✓	✓	2017	https://beta.portland.gov/sites/default/files/2020-02/climate-data-report-final-31janupdate.pdf	
Boulder	✓	✓	✓	✓	✓	✓	✓	2016	https://assets.bouldercounty.org/wp-content/uploads/2018/12/2016-ghg-inventory-and-strategies-report-october-2018-final.pdf	
Brussels	✓	✓		✓				2012	https://www.environment.brussels/state-environment/report-2011-2014/climat/emissions-de-gaz-effet-de-serre	The inventory report is in French and Dutch.
Buenos Aires		✓		✓	✓	✓		2016	C40	
Chengdu										
Tshwane		✓								
Dakar		✓								
Dhaka										
Dar es Salaam		✓								

[65] The planning content is Spanish

Willing Cities	OECD Country City	Committed City	Planning City	Does it have a list?	Scope 1	Scope 2	Scope 3	List Year	Source	Notes
Osaka	✓	✓								
Durban		✓		✓	✓	✓	✓	2017	http://www.durban.gov.za/City_Services/energyoffice/Documents/eThekwini_GHG_Inventory_2017_Summary_Report.pdf	
Dubai		✓		✓	✓	✓	✓	2016	C40	
Tokyo	✓	✓	✓	✓	✓	✓	✓	2014	https://www.kankyo.metro.tokyo.lg.jp/en/climate/index.files/b0548c2a69e7883f1945aca50f606a92.pdf	
Toronto	✓	✓	✓	✓	✓	✓	✓	2016	http://wx.toronto.ca/inter/it/newsrel.nsf/bydate/E29796278FB8C9A5852583990052EAF5	
Philadelphia	✓	✓	✓	✓	✓	✓	✓	2012	https://www.phila.gov/departments/office-of-sustainability/publications/	
Copenhagen	✓	✓	✓	✓	✓	✓	✓	2016	C40	
Glasgow	✓	✓		✓	✓	✓		2012	https://www.glasgow.gov.uk/CHttpHandler.ashx?id=32441&p=0	
Guadalajara										
Gwangju	✓	✓	✓	✓	✓	✓	✓	2015	http://www.neaspec.org/sites/default/files/Oh Byoung Chull_Assessment Modelling .pdf	
Heidelberg	✓	✓	✓	✓	✓	✓	✓	2015	C40	
The Hague	✓	✓	✓							
Hamburg	✓	✓	✓	✓	✓	✓	✓	2016	https://data.cdp.net/Emissions/2016-Citywide-Emissions-Map/iqbu-zjaj	Due to the statistical method used in Germany's energy balance table, the emissions of Hamburg City Area 12 do not contain greenhouse gases such as CH4 and NO2, which is different from other GPC standard lists.

Willing Cities	OECD Country City	Committed City	Planning City	Does it have a list?	Scope 1	Scope 2	Scope 3	List Year	Source	Notes
Hanoi		✓		✓	✓	✓	✓	2015	C40	
Helsinki	✓	✓	✓	✓				2018	https://www.hsy.fi/en/experts/climatechange/mitigation/Pages/Greenhouse-Gas-Emissions.aspx	Non-GPC method is used to compile the list, and the definition of the scope is different.
Yokohama	✓	✓	✓	✓	✓	✓	✓	2015	C40	
Ho Chi Minh City										
Warsaw	✓			✓	✓	✓	✓	2014	C40	
Washington	✓	✓	✓	✓	✓	✓	✓	2019	https://doee.dc.gov/service/greenhouse-gas-inventories	
Quito		✓		✓	✓	✓	✓	2015	C40	
Kuala Lumpur										
Caracas										
San Francisco	✓	✓	✓	✓	✓	✓	✓	2017	https://sfenvironment.org/sites/default/files/fliers/files/sfe_cc_2017_community_inventory_report.pdf	
Karachi										
Cape Town		✓		✓	✓	✓	✓	2016	C40	
Curitiba				✓	✓	✓	✓	2016	C40	
Quezon City				✓	✓	✓		2016	C40	

Willing Cities	OECD Country City	Committed City	Planning City	Does it have a list?	Scope 1	Scope 2	Scope 3	List Year	Source	Notes
Lagos		✓		✓	✓	✓	✓	2015	C40	
Lisbon	✓	✓	✓	✓						no inventory report found
Rio de Janeiro		✓		✓	✓	✓	✓	2019	Monitoring Greenhouse Gas Emissions in the City of Rio de Janeiro 2012 to 2017: Presentation of Results (July/2019) [19]	
Lima				✓	✓	✓	✓	2015	C40	
Rotterdam	✓	✓								
London	✓			✓	✓	✓	✓	2017	https://data.london.gov.uk/dataset/leggi	
Rome	✓	✓		✓	✓	✓	✓	2015	C40	
Los Angeles	✓	✓	✓	✓	✓	✓	✓	2016	https://data.lacity.org/A-Livable-and-Sustainable-City/2017-Community-Wide-Greenhouse-Gas-Emissions/kkrh-b4e3/data	
Madrid	✓	✓	✓	✓	✓	✓	✓	2017	https://www.madrid.es/UnidadesDescentralizadas/Sostenibilidad/EspeInf/EnergiayCC/04CambioClimatico/4aInventario/Ficheros/GHGemissions2016.pdf	
Medellin										
Manchester	✓	✓	✓	✓	✓	✓	✓	2017	http://www.manchesterclimate.com/sites/default/files/Manchester%20Climate%20Change%20Framework%202020-25.pdf	
Montreal	✓	✓								
Milan	✓	✓	✓ [66]	✓	✓	✓	✓	2015	C40	

[66] Content of the plan is in Italian.

Willing Cities	OECD Country City	Committed City	Planning City	Does it have a list?	Scope 1	Scope 2	Scope 3	List Year	Source	Notes
Minneapolis	✓	✓	✓							
Melbourne	✓	✓	✓	✓	✓	✓	✓	2014	C40	
Mexico City	✓	✓		✓	✓	✓	✓	2014	http://www.data.sedema.cdmx.gob.mx/cambioclimaticocdmx/climatechange/co2_cdmx.html	
Nanjing										
Nairobi		✓								
New York	✓	✓	✓	✓	✓	✓		2017	https://nyc-ghg-inventory.cusp.nyu.edu/#data	
Qingdao										
El Salvador		✓			✓	✓	✓		C40	
São Paulo		✓								
Santiago										
Seoul	✓	✓		✓	✓	✓	✓	2013	C40	
Stockholm	✓	✓	✓	✓	✓	✓	✓	2016	C40	
Tel Aviv	✓									
Venice	✓	✓	✓[67]	✓	✓	✓	✓	2016	C40	
Port Vila		✓								

[67] Plan is in Italian.

Willing Cities	OECD Country City	Committed City	Planning City	Does it have a list?	Scope 1	Scope 2	Scope 3	List Year	Source	Notes
Vancouver	✓	✓		✓	✓	✓	✓	2018	http://www.metrovancouver.org/services/air-quality/emissions-monitoring/emissions/emission-inventories/Pages/default.aspx	
Seattle	✓	✓	✓	✓	✓	✓	✓	2016	https://www.seattle.gov/Documents/Departments/OSE/ClimateDocs/2016_SEA_GHG_Inventory_FINAL.pdf	
Sydney	✓	✓	✓	✓	✓	✓	✓	2016	C40	
Hong Kong				✓				2017	https://www.climateready.gov.hk/files/pdf/2017_GHG_by_sector.pdf	There is no introduction to the inventory preparation method.
New Orleans	✓			✓	✓	✓	✓	2014	C40	
Houston	✓	✓		✓	✓	✓	✓	2014	C40	
Athens	✓	✓		✓	✓	✓	✓	2016	C40	
Jakarta		✓								
Johannesburg		✓		✓	✓	✓	✓	2014	C40	
Chicago	✓	✓	✓	✓	✓	✓	✓	2017	https://www.chicago.gov/content/dam/city/progs/env/GHG_Inventory/Chicago-2017-GHG-Report_Final.pdf	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