



Background Report (draft)

Low Carbon Development Strategies, Policies and Practices in Guangzhou, China



Prepared by innovative Green Development Program

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PROJECT BACKGROUND

Inter-regional low carbon development in Northeast Asia is an important part of the global effort to address climate change. Cities throughout Northeast Asia are promoting low carbon development as a core component of their urban development efforts, with policies that are tailored to local social, economic and political conditions. As a result, the municipal governments of these cities have amassed a great deal of local experience regarding carbon-reducing strategies, measures, and policies. What has been missing is a mechanism for these cities to share experiences and learn from regional best practices.

In 2014, the North-East Asian Sub-Regional Program for Environmental Cooperation (NEASPEC), under the United Nations Economic and Social Commission for Asia and the Pacific, launched the North-East Asia Low Carbon City Platform (NEA-LCCP). NEA-LCCP is designed to support regional low carbon urban development through technical assistance, capacity building, information sharing, and analytical studies. In 2017, at NEASPEC's 21st Senior Officials' Meeting, NEA-LCCP was tasked with two activities – peer reviews and comparative studies – to strengthen knowledge, capacity and networking of experts, agencies and cities in North-East Asia.



Figure 1: North-East Asia Low Carbon City Platform objectives

Peer reviews identify case-study cities, assess their low carbon urban development policies, and promote the sharing of insights among peers. This is done by organizing technical reviews, workshops and field visits by issue-area experts. Comparative studies provide a comprehensive and systematic overview of national approaches to low carbon city development. They identify good practices in specific sectors for information-sharing and promote cooperation on future policy efforts.

Guangzhou is one of the case study cities selected by NEA-LCCP to undergo a peer review study. This background report introduces the key features of the city of Guangzhou that are relevant to low carbon development policy, as well as the city's key carbon reduction policies. It is designed to provide general information in support of an upcoming peer-review workshop and report.

Guangzhou has been steadily ramping up the ambition of its low carbon policymaking. In September 2010, the Guangzhou municipal government issued

Guidelines on Boosting the Low Carbon Economy; in February 2011, the Municipal Party Committee and the municipal government held a working meeting on transforming Guangzhou into a low carbon city; and in 2012, Guangzhou was selected for inclusion in the second batch of NDRC's low carbon pilot cities. Since then, it has pursued work on GHG emissions inventories, basic research on emission peaking, carbon reduction roadmaps, and the development of new policies and mechanisms for green and low carbon development. With these efforts, Guangzhou is aligning its local strategic planning and policymaking with the GHG reduction goals of China's national government.

In September 2015, at the first US-China Climate Leaders' Summit, Guangzhou announced that it would strive to peak its carbon emissions by 2020, 10 years ahead of the national CO₂ emission peaking target. As a member of China's Alliance of Pioneer Peaking Cities¹, Guangzhou has collected valuable experiences that can be shared with other NEA-LCCP cities. At the same time, against the backdrop of the "new normal" of China's economy, Guangzhou researchers and policymakers would benefit from the insights of the NEA-LCCP network to refine its strategies in key areas.

This background report provides information about Guangzhou's low carbon strategic measures, policies, and practices. It is not a rigorous evaluation of the city's low carbon performance. Instead, it summarizes the city's social and economic characteristics, urban development strategies and directions, and low carbon policy development. It gives a comprehensive account of policy measures within key areas. The focus is on Guangzhou's urban characteristics, drivers of urban growth, and the strategic measures and policy instruments used by the local government in key areas.

The first part of the report describes Guangzhou's overall characteristics. It identifies the unique features of the city that are relevant to low carbon efforts. The second part of the report describes the city's low carbon development strategies, policies, and practices. It includes discussions of actions in the energy, industry, transportation, buildings and land use sectors, as well as public consumption behavior. Guangzhou's low carbon development management system, strategic measures, and policy instruments, as well as the city's performance against key indicators are also reviewed. The third part provides a brief summary of the main areas of focus of Guangzhou's low carbon development strategy.

¹ Alliance of Pioneer Peaking Cities <https://www.wri.org/blog/2016/06/23-chinese-cities-commit-peak-carbon-emissions-2030>

1. OVERVIEW OF GUANGZHOU

1.1 Overall Characteristics and Geography

Guangzhou has a long history and a rich cultural heritage. The capital of Guangdong province, Guangzhou is located in the south of mainland China and the middle of Guangdong province, at the northern edge of the Pearl River Delta, adjacent to Hong Kong and Macau. With a history of over 2000 years, it was the starting point of the silkroad and is now the center of Cantonese culture. For thousands of years, it has been the gateway for China's global engagement and trade activity.



Figure 2: Location of Guangzhou in China

Guangzhou is the third largest city in China after Beijing and Shanghai, covering an area of 7434 km². After growing at an average annual rate of 2% for the last three decades, its permanent resident population is now over 14,043,500. Guangzhou's urban population ratio has been steadily increasing, from 72.6% in 2000 to 86.06% in 2016. Guangzhou's municipal government has jurisdiction over 11 districts.

Guangzhou's geographic location and weather conditions provide a favorable environment for urban development and ecosystem preservation. Located in China and Guangdong's southern edge, it possesses abundant water resources. Guangzhou's subtropical monsoon climate brings it warm weather, heavy rainfall, ample sunlight, only slight temperature differences between night and day, long summers, and short frost seasons. The average temperature across Guangzhou hovers between 21.5°C ~ 22.2°C, with average annual precipitation of over 1800mm and 150 days of precipitation per year.

Guangzhou is expected to be an important hub along the Belt and Road and play a central role in the Guangdong-Hong Kong-Macao Greater Bay Area, gradually building itself into an international city on the vanguard of urban development. Guangzhou's municipal party committee and government have proposed to strengthen six city functions and features by 2035 as a part of a city master plan: city leaders are working to develop Guangzhou as National Central City², a city with major historical and cultural significance, an international transport hub, and a major trade, communications, and technological and industrial innovation center.

² <http://politics.people.com.cn/n1/2017/0221/c1001-29095124.html>

1.2 Demographic Conditions and Trends

The size of Guangzhou's population has been continuously growing, accompanied by a steady rise in the urbanization rate and an increasing median age. Guangzhou's permanent resident population is one of the fastest growing in China. In 2017, Guangzhou's population saw a year-on-year increase of 454.9 thousand residents, taking up 63.22% of the total permanent resident population increase in Guangdong province and the Pearl River Delta. Its urbanization ratio among permanent residents in 2017 was 86.14%, far exceeding the national average of 58.52%. As the integration of the Pearl River Delta accelerates, Guangzhou's population will continue to grow. It is estimated that by 2020, its permanent resident population will reach 15.50 million; by 2035, that number will be as high as 20 million.

Table 1. Guangzhou's population and demographics from 2010 to 2017

	2010	2011	2012	2013	2014	2015	2016	2017
Permanent residents (10 thousand)	1270.96	1275.14	1283.89	1292.68	1308.05	1350.11	1404.35	1449.84
Urbanization ratio (%)	83.78	84.13	85.02	85.27	85.43	85.53	86.06	86.14
Percentage of population over 60 (%)	--	--	15.42	16.03	16.75	17.27	17.76	--

Source: Guangzhou Statistical Yearbook 2017

1.3 GDP and Industrial Structure

Guangzhou's economy has entered a "new normal" in which economic growth is slowing down while industrial reform deepens. In 2017, Guangzhou's GDP reached 2.2 trillion RMB (318.48 billion USD), a 7% increase from the previous year, boosting the city's competitiveness to a global level. However, there is still a considerable gap between Guangzhou's GDP per capita and that of the most developed cities in the world. In 2017, Guangzhou's GDP per capita was 150,678 RMB (22,317 USD), less than half of that of Singapore.

Guangzhou's industrial structure is undergoing a period of adjustment, transformation, and upgrade. In 2017, the growth ratio among the primary, secondary, and tertiary sectors of Guangzhou's economy was 1.09 : 27.97 : 70.94, with the tertiary sector contributing nearly 80% of the city's GDP.

Table 2. Guangzhou’s economic growth and industrial structure from 2010 to 2017

	2010	2011	2012	2013	2014	2015	2016	2017
GDP (hundred million)	10748	12423	13551	15679	16914	18334	19805	21503
GDP growth rate (%)	13	11.3	10.5	11.6	6.6	8.4	8.2	7.0
Structure of the three- sector model	1.75 : 37.24 : 60.85	1.65 : 36.84 : 61.51	1.58 : 34.84 : 63.58	1.47 : 34.01 : 64.52	1.31 : 33.47 : 65.22	1.25 : 31.64 : 67.11	1.22 : 29.42 : 69.42	1.09 : 27.97 : 70.94

Source: *Guangzhou Statistical Yearbook 2017*

The continuously increasing GDP and a more balanced economic structure indicates a relatively stable development trajectory for Guangzhou’s economy. Guangzhou is now adjusting its economic growth strategy and long-term trajectory to align itself with next-generation industrial and technological innovations, and China’s national strategy for development. During the 12th Five-Year Plan period (2011-2015), the focus of Guangzhou’s industrial structure shifted from the heavy chemical industry and service sector to the integrated development of advanced manufacturing and modern services - the so-called “two-wheel drive” phase (2013 - present). In 2015, the growth of emerging strategically-important industries took up more than 10% of the total GDP, with hi-tech contributing to 45% of the total industrial GDP. Strategically-important industries are leading the way forward. Information technology, artificial intelligence, and biomedicine have been speeding up their pace of development.

1.4 Electricity Consumption

As the total amount of energy consumption increases and consumption transitions from coal and petroleum towards electricity and natural gas, energy conservation and emission reduction efforts in the power sector will become a determinant factor in all end-use sectors’ CO₂ emissions.

In 2015, the GDP contributed by the electric and thermal power production and supply industry was 139.55 billion RMB, while the gas production and supply industry contributed 31.72 billion RMB, amounting to 171.27 billion RMB when combined, showing a year-on-year increase of 5.4%. Ranked the fourth largest industry of Guangzhou, next only to auto manufacturing, electronics manufacturing, and petrochemicals, the power industry has become a pillar of the city’s economy. In terms of emerging strategically-important industries, the new energy and energy conservation industry is the sixth largest, growing by 33.038 billion RMB in 2015.

Table 3. Coal consumption in electricity and thermal power production and supply percentage of industrial total (2010 - 2016)

	2010	2011	2012	2013	2014	2015	2016
Coal consumption in electricity and thermal power production and supply percentage of industrial total (%)	72.3	74.9	77.5	78.5	81.1	78.8	81.5

Source: *Guangzhou Statistical Yearbook 2017*

With an electricity self-sufficiency rate of 40%, Guangzhou’s local electric power supply cannot meet demand. Of the total electricity consumption, the percentage of electricity transmitted from elsewhere has been continuously increasing. In 2015, the percentage of locally generated electricity only accounted for about 30% of the total electricity consumption. There are 10 coal-fired power plants in Guangzhou. 80% of industrial coal consumption comes from electricity and thermal power plants. At the end of 2014, Guangzhou initiated and successfully implemented the “ultra-clean emission” program targeting coal-fired power plants. Currently, the coal consumption of in-service generator sets across Guangzhou are all over 310 kg/kwh, requiring greater efforts in coal usage and emission reduction as well as energy structure transformation and upgrading.

1.5 Industry

To date, the industrial sector is the only sector that has achieved CO₂ emission peaking in Guangzhou. In the future, as the work around energy conservation and emission reduction deepens and industrial development gradually slows down, Guangzhou’s CO₂ emission will see a steady decline.

In recent years, Guangzhou’s industrial development has been slowing down. The percentage of industrial growth in the region’s total GDP has dropped from 33.9% in 2010 to 28.6% in 2015. Automotive, electronics, and petrochemicals are the three pillars of Guangzhou’s industrial development, taking up 48.25% of total industrial growth. Guangzhou’s scarce land resources and diminishing environmental carrying capacity will increasingly constrain the manufacturing industry’s development. Guangzhou can no longer depend on an investment-driven, extensive development model.

Guangzhou’s manufacturing industry is shedding the old driving forces and taking on new ones. During this transition period, an industry with a clear advantage has yet to be seen, indicating a need to speed up transformation and upgrading. In 2015, the growth of Guangzhou’s advanced manufacturing industry took up 54.3% of the total industrial growth of enterprises above a designated size, a significant drop from 64.7% in 2010. Hi-tech manufacturing growth was 11.7%, 16.9% lower than the provincial average.

The optimization of industrial structure and improvement of energy efficiency is an important starting point for Guangzhou’s efforts in industrial energy conservation and emission reduction. Another focus of such efforts is to make the industrial energy consumption structure cleaner. Gradually raising the ratio of electricity and natural gas consumption to replace coal and petroleum usage will push forward clean industrial production.

1.6 Construction

The construction industry is the third largest CO₂ emitter in Guangzhou. Guangzhou has numerous large-scale construction projects. In 2015, existing construction projects exceeded 300 million square meters, 50% of which were residential projects. Energy consumption in construction projects accounts for one-third of total city energy use. The rapid development of Guangzhou's third largest industry and the increase of commercial areas will create sustained increases in future energy needs and CO₂ emissions. Going forward, the Public Construction Department will become an important actor in limiting emissions in Guangzhou.

1.7 Transportation

Guangzhou is currently undergoing large scale transportation development. In the future, the number of residents in transit will increase by a large margin. Local shipping is rapidly increasing, while the number of automobiles is also growing steadily. These factors create challenges for the city's transportation needs. The key to achieving Guangzhou's target peak CO₂ levels is managing the city's transit energy consumption and related CO₂ emissions.

Regarding international transportation, Guangzhou has sea, land, and geographic advantages. Baiyun International Airport is one of the three largest international air transit hubs in China; Guangzhou Port is a national coastal hub; Guangzhou railroad station is among the four biggest passenger transit hubs nationally and the largest in southern China. In short, Guangzhou plays an important role in China's national transport network and is the primary hub in southern China. In 2015, Guangzhou successfully applied to become a nationally recognized model city for transport service. Increasing Guangzhou's comprehensive transport hub's radius and strengthening its integrated capacity is a key component of the city's long-term goals. This is also an opportunity to establish a comprehensive, low carbon, and green transportation system.

The Guangzhou mass transit system includes four types: rapid transit, regular public transit, water buses and taxis. During the 12th Five-Year Plan, Guangzhou successfully applied to become a "national mass transit metropolis." The capacity of Guangzhou's rapid transit system continually increased. From 2010 to 2015 the rapid transit system's total passenger capacity increased from 27% of total mass transit to 43%³. The capacity of regular public transit also continually expanded and increased. In 2015, regular public transit accounted for 45% of total mass transit. In addition, the taxi quantity has steadily increased. In 2015, there were 17 cabs per 10,000 people, accounting for 12% of the total mass transit volume. Construction of water bus infrastructure has also improved, accounting for 0.3% of total mass transit volume in 2015.

Table 4. 2015 City Mass Transit System Structure

Category	Rapid Transit	Regular Public Transit	Taxis	Water busses
Proportion of total (%)	43	45	12	0.3

Source: Guangzhou Comprehensive Transportation Development 13th Five Year Plan

³ Guangzhou Transportation Development 13th Five Year Plan
<http://www.gzjt.gov.cn/gzjt/ghjh/201611/f49bd2182b0e43e1a666cb78bea332c4/files/a269c3e4284e4fc1b3ae81635f71b2fa.pdf>

Guangzhou continues to promote energy saving and the use of new energy vehicles (NEV). In 2012, Guangzhou was designated a national energy saving and NEV pilot zone. In 2015, Guangzhou produced 14,600 NEVs, with pure electric vehicles accounting for 60% and mixed electric cars (with extended usage) 40%. According to the New Energy Vehicles Work Plan (2017-2020)⁴, by the end of 2018, Guangzhou will see the use of more than 100,000 NEVs. By the end of 2020, the city will contain more than 200,000 NEVs. From the beginning of 2017, Guangzhou increased usage of fully electric vehicles by 100%.

1.8 Urban Structure and Ecological Environment

The Guangzhou city government has made adjustments to district administration and subdivisions to develop the city center. In 2015, Guangzhou's administrative area increased from 3,843.34 square kilometers to 7,434.4 square kilometers. Guangzhou's internal city space has developed continuously, expanding outside of original city limits, while construction of its city center reached saturation. According to the Guangzhou Municipal Comprehensive Plan (2011-2020) and the Guangzhou Municipal Comprehensive Plan (2017-2035) Draft Notice, Guangzhou's development of its city structure has shifted from expansion to optimizing and upgrading. It has transformed from a city based on a single center to a structure that uses the natural measures of "mountain, city, fields, and sea" as the basis for its organization. The Pearl River Delta drainage system's multicenter approach supports the city's network structure, and is divided into a "main city, sub-center, outer city, new town, countryside" layout. Guangzhou is strengthening its land use management system and resource exploitation management, defining ecological standards, setting permanent farmland protections, creating boundaries for urban and rural areas, and promoting compact urban spaces.

1.9 Energy Consumption

Guangzhou has scarce traditional fossil fuel energy resources and therefore low energy self-reliance. The city relies on outside sources and imports of coal, oil, natural gas and other fossil fuels. Local energy resources available for use primarily include renewable energy such as water, solar, wind and biomass.

Guangzhou's energy consumption is continually increasing, though its rate of increase is lower than its rate of GDP growth. During the 12th Five-Year Plan period, energy consumption increased from 47,756,000 tons to 56,888,900 tons of standard coal, an annual average increase of 3.56%. In the same period, GDP increased by 10.1%. According to the "Guangzhou Energy Development 13th Five-Year Plan", energy consumption will be capped by 2020 at no more than 62,840,000 tons, and is forecast to peak before 2050.

Guangzhou's energy consumption structure has undergone some optimization, but the proportion of high-carbon fossil energy consumption represented by oil is still high. Coal consumption, on the hand, has already reached its peak. During the 12th Five-Year Plan period, coal consumption decreased by 4,250,000 tons. Coal as a proportion of energy consumption decreased from 32.4% in 2010 to 19.8% in 2015. Natural gas consumption is steadily increasing, however, from 3% in 2010 to 6% in 2015. By 2020 it will reach 10% of

⁴ Guangzhou New Energy Vehicles Work Plan (2017-2020)
<http://www.gz.gov.cn/gzgov/s2812/201711/3b174f8a3bc543e9ada325e79509b08a.shtml>

overall consumption. Oil product consumption as a proportion of total energy usage currently exceeds 40%.

Table 5. Guangzhou's Energy Consumption from 2010-2015

	2010	2011	2012	2013	2014	2015
Resource Consumption Amount (10,000 TCE)	4775.60	5013.40	5163.45	5333.57	5496.46	5688.89
Resource Consumption Increase (%)	-	5.0	3.0	3.3	3.1	3.5
Rate of Energy Consumption Decline per 10,000 yuan of GDP	-	4.91	4.94	5.14	3.52	4.52
Total Social Electricity Usage (100 million kw)	625.9	663.5	694.1	710.7	765.9	779.3
Rate of Increase of Electricity Usage (%)	-	6.0	4.6	2.4	7.8	1.76
Coal as a Proportion of Energy Consumption (%)	32.4%	31%	27.7%	26.3%	22.7%	19.8%
Natural Gas as a Proportion of Energy Consumption (%)	3	4	4	5	6	5.8

Source: Guangzhou Resource Development 13th Five Year Plan (2016-2020)

1.10 Carbon Emissions

With the continuous growth of energy consumption, the challenge of greenhouse gas emission reduction faced by Guangzhou is becoming increasingly severe. In 2015, citywide energy consumption reached 56.89 million tons of standard coal, while carbon emissions per 10,000 yuan of GDP were approximately 0.67 tons, a decrease of 30.7% from 2010. The city's GDP in 2015 was 1736.68 billion yuan (in 2010 constant prices) while total CO₂ emissions reached 116 million tons, making per capita CO₂ emissions 8.62 tons.

During the 12th Five-Year Plan period, the main driving force in the decline in carbon intensity was an increase in energy efficiency and a sharp decline in the proportion of coal consumption. Guangzhou is striving to cap coal emissions by 2020 and decrease carbon emissions per unit of GDP by 23% as compared to 2015. While the reduction of energy consumption in secondary industry has driven a decline in emissions, the industry sector remains the most important contributor of Guangzhou's emissions. With the rapid development of the tertiary industry, its CO₂ emissions have also increased year by year.

2. GUANGZHOU LOW CARBON DEVELOPMENT STRATEGY AND POLICY PRACTICE

Guangzhou has carried out rigorous planning for low carbon development, taking into account both central and provincial government low carbon pilot requirements and local economic conditions. It has developed a low carbon management system, a comprehensive low carbon strategy, and specific sectoral low carbon measures.

2.1 Low Carbon Development Planning Structure

This planning is based on two national pilot policy directives issued by China's National Development and Reform Commission: "Notice on the Pilot Work on Low Carbon and Low Carbon Provinces and Cities (2010)"⁵ and "Notice on Launching the Second Batch of National Low Carbon Provinces Cities Pilot Projects (2012)".⁶ It takes into account other relevant urban plans and policies, and factors in social, economic and environmental impacts. The following image displays six steps in Guangzhou's low carbon development planning workflow:



Figure 3. Guangzhou Green Energy Development Method Research⁷

2.2 Low Carbon Management System Structure

Starting in the 12th Five-Year Plan period, Guangzhou has continuously improved its low carbon management. In 2010, the city government established the Guangzhou Energy Saving, Emission Reduction and Low Carbon Economic Development Leading Small Group (initially named the "Low Carbon Economic Development Leading Small Group").

Located in the Municipal Development and Reform Commission, which serves as a coordinator, the leading group is headed by the Guangzhou mayor and deputy mayor. This body, which contains representatives from nineteen relevant local government bureaus⁸, is responsible the development of low carbon strategies, guidelines and policies, and overseeing low carbon pilot projects.

Guangzhou has formulated and released a series of policy guidance documents. These

⁵ http://www.ndrc.gov.cn/zcfb/zcfbtz/201008/t20100810_365264.html

⁶ http://www.ndrc.gov.cn/gzdt/201212/t20121205_517506.html

⁷ This illustration is drawn from the technical roadmap adopted by the Guangzhou Academy of Sciences in support of Guangzhou's low carbon city strategy research.

⁸ Its members include representatives from relevant local government bureaus: Municipal Party Committee, Municipal Development and Reform Commission, Economic and Trade Commission, Education Bureau, Science and Technology and Information Technology Bureau, Finance Bureau, State Land and Housing Administration, Environmental Protection Bureau, and Construction Committee. Representatives from the Traffic Committee, Agriculture Bureau, Foreign Trade and Economic Cooperation Bureau, Planning Bureau, Statistics Bureau, Price Bureau, Forestry and Landscape Bureau, Tourism Bureau, Municipal Research Office, and Municipal Finance Office are also a part of the group.

include:

- Guangzhou Energy Conservation and Environmental Protection Industry Development Plan (2014-2020)
- Guangzhou City Ecological Civilization Construction Planning Outline
- Guangzhou Municipal People's Government Guiding Opinions on Developing Low Carbon Economy
- Guangzhou Municipal Committee of the Communist Party of China Implementation Opinions on Promoting Low Carbon Development and Construction of Ecological Cities
- Implementation Plan for the Low Carbon Cities Pilot Project in Guangzhou

Guangzhou is also a participant in five national pilot schemes:

- National Low Carbon City Pilot
- National Renewable Resources Recovery System Construction Pilot City
- National Low Carbon Transportation System Pilot City
- National Kitchen Waste Pilot City for Resource utilization and No Harm treatment
- National Model City for Circular Economies

Guangzhou is gradually improving its low carbon development management and oversight capacity. It has established a greenhouse gas emissions statistics, accounting and assessment system, completed an inspection of the city's greenhouse gas emissions, and carried out verification of greenhouse gas emissions from key enterprises. Guangzhou has also established an energy management center. This management center is now capable of online monitoring of the energy use of key energy-using units and areas in the city, contributing to energy-saving assessments and projects in an integrated fashion.

At the same time, Guangzhou is creating new low carbon development management models. The Guangzhou Carbon Emissions Exchange is carrying out provincial carbon emission information verification, quota issuance and adjustment, and promoting the improvement of institutional mechanisms. Guangzhou is also encouraging public participation as part of Guangdong's first approved general carbon welfare system pilot city. As the first pilot in this program, Guangzhou has developed a plan for the construction and transportation sectors to reduce carbon emissions in public transit, buildings, and water and electricity use.

2.3 Key Areas of Low Carbon Development Strategy and Policy Practice

In line with Guangzhou's overall low carbon development strategy, relevant government bureaus have formulated low carbon measures and policies to reduce emissions. This section reviews Guangzhou's low carbon development status, goals and measures adopted in the areas of energy systems, industry, construction, transportation, urban environment and land use. Progress indicators were selected in consideration of the best available data.

2.3.1 Energy System

Current Situation

Guangzhou is almost completely reliant on imports of coal, oil and natural gas. However, Guangzhou has abundant, largely untapped renewable energy resources, including hydropower, wind, and solar. Hydropower is highly developed, while solar, wind and biomass all have excellent potential for further growth. In 2011, the proportion of net energy transfers with other provinces (including autonomous regions and municipalities) was 72%, and the proportion of net imports was 28%.⁹ During the 12th Five-Year Plan, Guangzhou's energy consumption increased at an annual average rate of 3.56%, a decrease from the 8.4% growth rate in the 11th Five-year Plan period.¹⁰ In terms of its energy consumption structure (including foreign energy transfers), coal consumption has gradually declined, while oil and natural gas consumption, as well as foreign energy transfers, have increased. Final stage energy consumption in Guangzhou is concentrated in three fields: transportation, industry and construction.

Table 6. Guangzhou Resource Consumption 2011-2015

	Guangzhou Yearly Energy Consumption	Rate of Increase (%)
2011	5013.4	5.0%
2012	5163.45	3.0%
2013	5333.57	3.3%
2014	5496.46	3.1%
2015	5688.89	3.5%

Source: Guangzhou Resource Development 13th Five-year Plan (2016-2020)

Low Carbon Indicators

Guangzhou's low carbon energy development can be tracked against four indicators: production value per unit of energy consumption, per capita energy consumption, non-fossil fuels as a proportion of primary energy consumption, and coal use as a proportion of total energy consumption.

Table 7. Changes in energy and low carbon development indicators

Target	2010	2015
Production value per unit of energy consumption (TCE/10,000 yuan - current year prices)	0.44	0.31
Yearly per capita resource consumption (TCE per capita)	3.76	4.21
Non-fossil fuels as a proportion of resource consumption (%)	--	--
Coal as a proportion of resource consumption	45%	27.5%

Source: Guangzhou Annual Statistics Report

⁹ Guangzhou National Circular Economy Demonstration City Implementation Plan
<http://www.gzii.gov.cn/sjmw/9.2/201606/cb9a65f7da2841e0b46915a20d7224b1.shtml>

¹⁰ Guangzhou 13th Five-Year Plan for Energy Development 2016-2020
<http://www.gz.gov.cn/gzgov/s2812/201711/76eb233dd2a141e9840962c35c2a79ca.shtml>

Strategic Measures and Policies

Guangzhou has issued four key energy-related policy documents:

- Guangzhou Municipal People's Government Notice on Renovating High-Pollution Fuel Boilers
- Ultra-Clean Emissions Reconstruction Work Plan
- Guangzhou City Accelerated Natural Gas Promotion and Utilization Work Plan
- Guangzhou Distributed Photovoltaic Power Generation Development Plan

These policies are focused on decreasing reliance on fossil fuels and improving energy efficiency. Guangzhou is promoting decarbonization of its energy consumption through decreasing coal use, as well as pushing rapid development of natural gas and renewable energy. Renewable energy development is focused on solar energy use, as well as promoting the development and use of biomass. With regard to energy efficiency, Guangzhou is focused on development of high-efficiency hot-spot cogeneration units and high-efficiency coal-fired power generation technologies; working to quickly eliminate use of outdated technology.

Table 8. Key industries in Guangzhou’s energy decarbonization efforts, their primary objectives and related policy measures

Field	Optimization of Energy Resource Structure	Improvements in Energy Efficiency
Primary objectives	Lowering the proportion of coal consumption and transforming power plants from coal to electric; extend and increase use of natural gas and solar energy.	Extend cooperative production on key projects; increase focus on management of high energy demand firms; eliminate and renovate primary resource use facilities.
Policy Measures	<p>Administrative measures</p> <ul style="list-style-type: none"> • “Clean Power Emissions”: program to transform coal plants to electric power • By 2020, the city will limit coal consumption in coal-fired power technology to less than 310 g / kWh • “Gas Turbine Air Pollution Special Emissions Restrictions” a standard for gas turbines • Decreasing high polluting fuel boiler use • Expanding the reach of “no coal districts” <p>Economic Incentives</p> <ul style="list-style-type: none"> • Financial subsidies (Photovoltaic power generation project construction, elimination of high energy consumption) • Carbon emissions trading <p>Voluntary Measures</p> <ul style="list-style-type: none"> • Pilot Demonstration Program <ul style="list-style-type: none"> ○ National Circular Economy Model City ○ New Energy Comprehensive Use Demonstration Zone <p>News Model</p> <ul style="list-style-type: none"> • Energy Saving and Green Public 	

2.3.2 Industry

Current Situation

Guangzhou is promoting decarbonization in the industry sector (Guangzhou's biggest energy consumer) through industrial upgrading and energy saving measures. In the 12th Five-Year Plan period, Guangzhou increased its focus on removing industrial facilities with outdated modes of production, closing or relocating many high consumption and high polluting industrial firms.

At the same time, it has worked to improve its industrial structure. Guangzhou has developed six key industries: petrochemicals, major equipment, automobile manufacturing, electronic products, textiles and clothing, and food and beverage. These six industries account for 77.7% of industrial value added.¹¹ In addition, the advanced manufacturing industry developed rapidly. In 2015, the value added of strategic emerging industries accounted for more than 10% of GDP, while the output value of high-tech products accounted for 45% of total industrial output.¹² Production of advanced manufacturing of industrial robots, rail transit equipment, and major equipment has also grown.

Low Carbon Indicators

Progress in Guangzhou's industrial low carbon development can be tracked against three indicators: heavy industry output value as a proportion of industrial output value, total energy consumption per 10,000 yuan of industrial output value, and advanced manufacturing value-added as a proportion of industrial value-added. The following table shows Guangzhou's performance in these three indicators.

Table 9. Graph Changes in industrial low carbon development indicators

Indicator	2010	2015
Heavy Industry Output Value as a Proportion of Total Industry Output	64.63%	63.4%
Energy consumption / 10,000 yuan Industrial Output (TCE/10,000 yuan)	3.02	3.5
Advanced Manufacturing Value Added as a Proportion of Industrial Value Added ¹³	64.7%	54.3%

Source: Guangzhou Statistical Yearbook, Guangzhou's 13th Five-Year Plan Advanced Manufacturing Development and Composition (2016-2020)

Strategic Measures and Policies

Guangzhou has adopted many strategies and initiatives to promote low carbon industrial development, with a focus on industrial decarbonization and transformation. Guangzhou is deepening energy-saving in high-energy consuming enterprises. At the same time, it is building a circular economy supply chain, extending industrial production chains, and

¹¹ Guangzhou National Circular Economy Demonstration City Implementation Plan, <http://www.gzii.gov.cn/sjmw/9.2/201606/cb9a65f7da2841e0b46915a20d7224b1.shtml>

¹² Guangzhou 13th Five-Year Plan for Energy Conservation and Carbon Reduction 2016-2020, <http://www.cnemission.com/article/news/ssdt/201705/20170500001278.shtml>

¹³ Calculation includes five major industries: manufacturing, automobiles, shipping, petrochemicals and steel production

creating a closed loop between projects, businesses and industries. In addition, Guangzhou is focused on promoting industrial transformation and upgrading through the recently released “Guangzhou Industrial Transformation and Upgrading Three-Year Action Implementation Plan 2015-2017.” Guangzhou is implementing initiatives to make industrial manufacturing high-end and high-tech; while promoting innovation and upgrades in traditional industries such as food and beverage, furniture and home appliances, and electronic products; vigorously developing high-end manufacturing industries such as industrial robots and intelligent equipment, and developing service-oriented manufacturing industries. “Intelligent service” upgrades are drawing on the Internet technologies, big data and other new technologies.

Table 10. Primary objectives and related policy measures in Guangzhou’s Industrial Emissions Reductions

Field	Industrial decarbonization		Industrial Model
	Improving Carbon Emissions Efficiency	Improving High Resource Use Efficiency	Improving Product Quality
Primary Objectives	Eliminate outdated production capacity, improve enterprise management for heavy polluting industries	Energy transformation for high energy consumption firms; strengthening key energy-using enterprises (industrial enterprises with annual energy consumption above 5,000 TCE); Creating a circular economy industrial chain	Developing advanced manufacturing; implementing a new round of: technological upgrades, making industrial manufacturing higher end and high tech, industrial innovation activities, green development activities, and six major initiatives from the "four hundred" largest firms
Policy measures	Models of administrative control <ul style="list-style-type: none"> ● Industrial Transformation and Upgrading Three-year Action Plan ● Clean production audit Economic incentives <ul style="list-style-type: none"> ● Water, electric, and gas price differentiation policy ● Strategic emerging industry fund ● Financial support (industrial technology transformation and industrial manufacturing upgrading) ● Carbon emissions trading exchange ● Scientific and technological achievements trading subsidies ● Guiding equity investment (for key industrial projects) ● Intellectual property rights law financing service 		
	Information Measures <ul style="list-style-type: none"> ● Product energy efficiency record for heavy consumption industries ● Establishing an expanding firm training program directory ● Multi-firm development center ● High-growth SME (privately run) business directory ● Database of the basic industries Voluntary Measures <ul style="list-style-type: none"> ● Energy efficiency targets for key industries ● Pilot zone program (circular economy industrial park) 		

2.3.3 Buildings

Current Situation

The buildings sector is Guangzhou's most rapidly growing carbon emitter. During the 12th Five-Year Plan period, Guangzhou upgraded existing facilities, implementing 176 green building evaluation projects, with a construction area of approximately 17.46 million square meters.¹⁴ Urban housing areas have gradually increased, making a decrease in emissions from the buildings industry more vital.

Low Carbon Indicators

Guangzhou's buildings industry uses two primary standards to evaluate progress on energy emissions. The first is green buildings as a proportion of annual construction, the other is the rate of implementation for urban buildings energy saving standards. The chart below displays low carbon emission targets in the construction industry for 2010 and 2015.

Table 11. Guangzhou Construction Industry low carbon development, 2010 and 2015

Indicator	2010	2015
Green Construction as a Proportion of Annual Construction (%)	--	20%
Rate of Implementation for Urban Construction Energy Saving Standards	--	100%

Source: Guangzhou Ecological Civilization Construction Plan Outline (2016-2020)

Strategic Measures and Policies

To promote low carbon buildings, Guangzhou has issued:

- Guangzhou Green Building and Building Energy Conservation Management Regulations
- Guangzhou Green Building Action Implementation Plan
- Guangzhou City Construction Waste Recycling Building Materials Products Promotion and Use Measures

These regulations focus on low carbon policy implementation and formulation. They promote action regarding the management of green and energy efficient buildings. The key goals of this development strategy include:

- Improving Carbon Emission Efficiency: Strengthening efficiency of new buildings, as well as upgrading and managing existing buildings. Upgrading the energy efficiency of high consumption components (lighting equipment, air systems, elevators, etc.), as well as expanding the scope of renewable energy use. This includes the installation and use of renewable energy equipment such as solar powered air conditioners, wind (or hydro) source heat pumps, and solar photovoltaic panels. This plan will monitor, limit, and manage buildings energy consumption.
- Improving energy efficiency: By increasing green buildings as a proportion of new construction and combining green building practices characteristic of Guangzhou, Guangdong, and Guangxi, this strategy will develop and expand the use of energy-

¹⁴ Guangzhou Energy Emissions Reduction 13th Five Year Plan (2016-2020)
<http://www.cnemission.com/article/news/ssdt/201705/20170500001278.shtml>

saving and environmentally-friendly building materials. At the same time, it will promote carbon-reducing management practices throughout the entire building life cycle. This includes conserving energy and water, saving materials, and protecting the environment.

Table 12. Guangzhou Construction Emission Reduction Key Industries, Primary Goals and Policy Measures

Industry	Improve Carbon Efficiency	Improve Efficiency of Energy Use
Primary Goals	New and Existing Buildings Energy Upgrades and Management	Promote Green Buildings, Materials and Facilities
Policy Measures	Administrative Control <ul style="list-style-type: none"> ● New Buildings Energy Standards ● Green Buildings Standards and Evaluation Metrics Economic Incentives <ul style="list-style-type: none"> ● Contract-based energy use management ● Management of energy consumption limits for large public buildings ● Penalties for exceeding energy use limits ● Industry and Commerce Energy Special Saving Fund Information <ul style="list-style-type: none"> ● Green Buildings Signage System ● Record keeping system for building consumption ● Labeling system for products made of recycled construction waste ● Energy consumption monitoring platform for public buildings Voluntary Measures <ul style="list-style-type: none"> ● Encouraging model “green ecology” districts ● Creating a demonstration zone for Southern China green building technology research and integration 	

2.3.4 Transportation

Current Situation

Making transportation low carbon is a focus of Guangzhou’s low carbon development goals. Due to infrastructure growth, energy consumption in the transportation sector has rapidly increased. As a national pilot city for improved transit hub systems, Guangzhou has been actively promoting mass public transit. During the 12th Five-year Plan period, public transit increased by 2,685 vehicles and new public transit lines increased by 462. These changes increased public transit passenger capacity by 45%.¹⁵ Citywide public transit as a proportion of motorized transportation has reached 60%.¹⁶ In addition, as a national pilot city for energy saving and NEVs, by 2015 Guangzhou promoted usage of more than 14,600 NEVs.¹⁷ At the same time, Guangzhou has implemented controls over medium and small scale vehicles to limit the increase of private vehicles.

¹⁵ Guangzhou 13th Five-Year Plan for Comprehensive Transportation Development
<http://www.gzjt.gov.cn/gzjt/ghjh/201611/f49bd2182b0e43e1a666cb78bea332c4/files/a269c3e4284e4fc1b3ae81635f71b2fa.pdf>

¹⁶ Guangzhou 13th Five-Year Plan for Energy Conservation and Carbon Reduction 2016-2020
<http://www.cnemission.com/article/news/ssdt/201705/20170500001278.shtml>

¹⁷ Guangzhou 13th Five-Year Plan for Energy Conservation and Carbon Reduction
<http://www.cnemission.com/article/news/ssdt/201705/20170500001278.shtml>

Low Carbon Indicators

Progress in decarbonizing the transportation sector can be tracked against five indicators:

Table 13. Changes to Guangzhou transportation low carbon development targets (2010 and 2015)

Indicator	2010	2015
City Center Public Transit as a Proportion of Motorized Transit	--	60%
City Wide Public Transit Rate (%)	--	--
Public transportation vehicle quantity per 10,000 residents (standard)	--	--
Rail transit as a proportion of total public transit (%)	--	--
NEVs quantity	--	14600

Source: Guangzhou Energy Saving and Carbon Reduction 13th Five Year Plan, 2016-2020

Strategic Measures and Policies

Among other policy measures, Guangzhou City has compiled and implemented:

- Pilot Implementation Plan for the Construction of Low Carbon Transportation System in Guangzhou (2012-2014)
- Medium and Long-Term Planning for the Construction of Low Carbon Transportation Systems in Guangzhou (2012-2020)

These regulations provide guidance and support for developing citywide low carbon transport. Low carbon transportation development centers on the three following elements:

- Optimizing City Transit: Constructing a green transportation system, combining all transit methods. Developing modern logistical systems, improving logistics networks and promoting construction of a logistics information platform.
- Promote Environmental Protection and Energy Saving Transit Tools: Actively promote NEVs, focus on public transit, taxis, and official/VIP vehicles; while simultaneously increasing usage of NEVs in city logistics and by private citizens. Establish a suitable NEV service system, and improve the network of battery charging stations.
- Decarbonization of basic transportation infrastructure: Upgrade public transit stations, freight transit stations, and other high consumption facilities. Establish walkway systems, improve the shared bicycle system and improve the bike transit environment. Invest in green upgrades for ports and maritime shipping. Speed up construction of electric port facilities and improve port machinery. Promote the development of smart transit technology and develop a smart transit service and management platform.

Table 14. Key Areas of Focus, Primary Responsibilities and Policy Measures in Reducing Guangzhou Transit Emissions

Field	City Transit	Energy Saving, Environmental Protection and Transportation Tools	Basic Transportation Facilities
Primary Goals	Integrated Public Transit system	Promote NEVs and Construct Accompanying Service Facilities	Develop walkway systems; develop smart transit; complete low carbon upgrades to high consumption facilities.
Policy Measures	<p>Administrative Measures</p> <ul style="list-style-type: none"> ● Bus Rapid Transit (BRT) ● Promote use of national V standard vehicle fuel ● Adopt national standard IV oil and diesel fuel, as well as national V standard vehicle fuel ● Institute compact car purchasing limits ● LNC public transit replacement plan <p>Economic Incentives</p> <ul style="list-style-type: none"> ● Create a subsidy fund (for new energy vehicles) ● Create a traffic energy special fund <p>Information</p> <ul style="list-style-type: none"> ● Traffic Information Service Software: an “Industry Hotline” <p>Voluntary Measures</p> <ul style="list-style-type: none"> ● Public Welfare Incentive City ● Pilot Demonstrations <ul style="list-style-type: none"> ■ National Low Carbon Transit Hub System Pilot City ■ National Energy Saving and NEV Model Promotion Pilot City 		

Box 1. Guangzhou Low Carbon Transportation Model Cases

Guangzhou Low Carbon Transportation Model Cases

Case 1: Underground spaces in the central core area of Zhujiang New City
Zhujiang New City is Guangzhou’s central business district (CBD) for finance, trade, housing, administration and recreation. In this area, Huachenghui, a comprehensive development project for underground spaces, is one of the largest and most complex projects of its kind in the country. Its most distinctive feature is how it combines land, a compact spatial layout and transportation structures to create a three-dimensional transportation system. To support high-density development of the central business district and establish a three-dimensional transportation system integrating above-ground and underground spaces, Huachengji has proposed a multi-level public transportation system with rail transit as the main structure and conventional ground public transit as an auxiliary measure. This system works to build underground, ground and raised systems simultaneously. The central square three-dimensional walking system offers a model for planning and construction modern CBDs in other cities.

Case 2: Guangzhou BRT Express Bus
The Guangzhou BRT system was opened in early 2010. Its innovative operation model of a “dedicated corridor + flexible line” was used to integrate the main BRT line with more than 80 bus lines. Nine-hundred and eighty nice buses have integrated into the BRT system, and the average bus speed has increased from 15km to 18km. The Guangzhou BRT system is the first “Gold Standard” rated BRT system in China. Research indicates that the BRT system reduces emissions by 86,000 tons of carbon dioxide per year in Guangzhou.

Case 3: LPG Clean Energy Vehicle
Since 2003, Guangzhou has promoted the use of LPG (liquefied petroleum gas) clean fuel for taxis and buses throughout the city. As of 2014, Guangzhou has more than 20,000 LPG taxis and more than 10,000 LPG buses. In Guangzhou, use of clean energy vehicles contributes an annual CO₂ reduction of 180,000 tons.

2.3.5 City Environment and Land Use

Current Situation

Following increased consumption of urban land, water, energy and other resources, adjusting Guangzhou's urban environment and land strategy will have an important impact on the city's low carbon development. During the 12th Five-Year Plan period, Guangzhou improved environmental quality by accelerating the construction of urban environmental facilities, strengthening comprehensive environmental improvement efforts, and improving its urban ecological space. In 2015, annual air quality was rated as "excellent" for 312 days in Guangzhou, accounting for 85.5% of the year. The city's forest coverage rate has increased from 36% to 42.3%. By 2015, the rate of green area construction was 36%, and the green coverage rate was 41.5%.¹⁸

Low Carbon Indicators

Progress in lowering emissions in this sector can be tracked against ten indicators:

Table 15. Changes in Guangzhou City Environment and Soil Use Indicators

Indicator	2010	2015
Per Capita Public Park Area (square meter)	15.01	16.5
Urban Area Green Space Coverage (%)	35.5%	36%
Forest Coverage (%)	41.4%	42.03%
Per Capita Daily Water Usage (liter)	366.41	253.23
Per Capita Waste Production (ton)	0.28 ¹⁹	0.34
Citywide Waste Water Treatment Rate (%)	85.65% ²⁰	93.22%
Citywide Lifestyle Waste No-Harm Treatment Rate	91.96% ²¹	95.24%
Annual Concentration of PM10 (ug/m ³)	-	59
Annual Concentration of PM 2.5	-	39
Proportion of Good Air Quality Days	-	85.5%

Source: Guangzhou Statistical Annual Report, Guangzhou Ecological Civilization Construction Plan Outline (2016-2020)

Strategic Measures and Policies

Guangzhou has successively issued the "Opinions on Comprehensively Promoting Domestic Waste Treatment," the "Guangzhou Huacheng Greentown Water City Construction Plan," the "Guangzhou City Interim Measures for Restricting the Management of Excessive Packaging of Goods," and the "Guangzhou City Construction Waste Recycling Building Materials Promotion and Use" as measures to improve the urban environment. These low carbon action plans focus primary on waste management, forestry carbon sinks and air quality, as detailed below:

- Waste management: Strengthen recycling systems for "urban minerals" such as discarded auto parts, electronic products, and plastic packaging; improve resource utilization of urban daily waste. Promote the establishment of specialized sorting centers, renewable resource recycling networks and domestic waste treatment facilities.

¹⁸ Guangzhou Ecological Civilization Construction Planning Outline 2016-2020
<http://www.gz.gov.cn/gzgov/s2884/201611/6d8da0f68ba14ee6b75d279061dcf24a.shtml>

¹⁹ 2010 data.

²⁰ 2010 data.

²¹ 2010 data.

- Forestry carbon credits: Increase the forest carbon credit system, establish a carbon credit calculation and monitoring system and promote development of carbon exchanges; strengthen greenification and beautification of city construction.
- Air quality: control the quantity of air pollution while strengthening control of air pollution emissions in fields including industry, transit, food service, etc.

Table 16. Key Elements of Guangzhou’s Environment and Soil Use Low Carbon Development

Field	Forestry Carbon Credits	Waste Management	Air Quality
Primary Goals	Improve the carbon sequestration capacity of forestry green space; carbon credit evaluation, supervision and exchange.	Waste recycling and resource management	Controlling air pollution emission levels; pollution governance.
Policy Measures	<p>Administrative Measures</p> <ul style="list-style-type: none"> ● Construction Waste Recycling Target System ● Production Responsibility Extension System ● Kitchen waste emission registration, supervision and penalty system ● Automobile air pollution emission standard <p>Economic Incentives</p> <ul style="list-style-type: none"> ● Sustainable Building Materials Financial Subsidy ● Disposal Permits (air pollution, water pollution, etc.) ● Volatile Organic Carbons (VOCs) Disposal Fee ● Carbon Credit Exchanges <p>Information</p> <ul style="list-style-type: none"> ● Industrial Resource VOCs Comprehensive Emissions Information Management System ● Forestry Carbon Credit Assessment Monitoring System ● Guangzhou Digital Forestry Platform ● Dust Particle Pollution Information Sharing Platform <p>Voluntary Measures</p> <ul style="list-style-type: none"> ● Carbon Public Welfare System ● Pilot Zones <ul style="list-style-type: none"> ■ Car Component Remanufacturing Pilot ■ Recycling System Construction Pilot ■ Household Waste Classification Model City ■ National Kitchen Refuse Utilization and No Waste Management Pilot City ■ Green Low Carbon Community 		

3. CONCLUSION

Guangzhou is the political, economic, cultural center of southern China. It is also one of China’s most economic vibrant cities. In over thirty years of rapid economic development, Guangzhou’s per capita GDP has already exceeded 20,000 USD, setting the stage for a new phase of social and economic development. Following rapid increases in total economic

output, increases in Guangzhou's energy consumption and carbon emissions pose a tremendous challenge to the city's sustainable development. Guangzhou's transition into a green, low carbon city is facilitating the city's economic and social development, as well as protecting its ecological environment. Guangzhou is China's second nationally approved low carbon pilot city. It has continuously explored paths to achieve a low carbon model, including actively pursuing a greenhouse gas reduction agenda, researching green, low carbon development policies, as well as performing basic research on how to promote low carbon lifestyles.

Guangzhou serves as a national center and pilot city, striving to take the lead in capping total carbon emissions, while also facilitating economic and social development. It is exploring all means of decreasing total carbon emissions. Although Guangzhou's work to promote energy saving and carbon reduction is showing positive results, sustaining such progress presents numerous challenges. Guangzhou has established related systems and comprehensive low carbon management structures, with provisions for measures and policies in all relevant industries. These measures combine traditional administrative command-type policies with market economy incentives, and actively explore information-based policies that utilize data analytics.

Guangzhou's rapid economic development and accompanying increases in energy consumption have created significant pressure on the city's energy structure, as well as its industrial energy saving and low carbon efforts. The rapid increase in transit related emissions also require considerable focus and attention. How to effectively craft policies to support Guangzhou's energy conservation and emission reduction in this sector will become one of the key questions for the city's low carbon development going forward. Effectively coordinating its low carbon efforts, establishing rigorous medium and long term goals, and strengthening market-based mechanisms will also be central challenges. The Ministry of Transportation will soon become the most important department in Guangzhou's future energy consumption and management of CO₂ emissions. Future research on reducing carbon emissions in Guangzhou will likely focus heavily on transportation emissions.

4. REFERENCES

1. Guangzhou municipal Government. The outline on thirteenth Five-Year Plan for Guangzhou National Economic and Social Development (2016-2020).
<http://www.hrsgz.gov.cn/zwxxgk/jhzj/zxgh/201607/P020160701347733755621.pdf>
2. Guangzhou municipal government. The Thirteenth Five Year Plan for Energy Saving and Carbon Reduction in Guangzhou (2016-2020) .
<http://www.cnemission.com/article/news/ssdt/201705/20170500001278.shtml>. 2017-04-17
3. Guangzhou municipal government. The Thirteenth Five-Year Plan for Energy Development in Guangzhou (2016-2020).
<http://www.gz.gov.cn/gzgov/s2812/201711/76eb233dd2a141e9840962c35c2a79ca.shtml>
4. The Guangzhou municipal government. The Thirteenth Five-Year Plan for Guangzhou's Urban Construction.
<http://www.gz.gov.cn/gzgov/s2812/201707/48ab63e1b02745cdb0d3cc27be242cc0.shtml>
5. Guangzhou Municipal Government. The thirteenth Five Year Plan for Comprehensive Transportation Development in Guangzhou, P58 Green Transportation: Building a High Quality Green Transportation System.
<http://www.gzjt.gov.cn/gzjt/ghjh/201611/f49bd2182b0e43e1a666cb78bea332c4/files/a269c3e4284e4fc1b3ae81635f71b2fa.pdf>
6. Guangzhou municipal government. Outline on Guangzhou's Ecological Civilization Construction Plan (2016-2020) .
<http://www.gz.gov.cn/gzgov/s2884/201611/6d8da0f68ba14ee6b75d279061dcf24a.shtml>
7. The Overall Urban Planning in Guangzhou (2017-2035)
<http://www.gzlpc.gov.cn/hdjl/zjyj/201802/W020180225000925672953.pdf>
8. Guangzhou Municipal Commission of Industry and Information Technology. The Implementation Plan for establishing the national recycling economy demonstration city in Guangzhou.
<http://www.gzii.gov.cn/sjmw/9.2/201606/cb9a65f7da2841e0b46915a20d7224b1.shtml>
9. Sun Wei, Yu Zhuojun, Liao Cuiping. Analysis of the Peak Value of Carbon Emission in Guangzhou. *New Energy Development*, 2016(06): p 246-252
10. Wang Bo, Zhang Haixia, Zheng Wei. Transportation Carbon Emission Inventory and Emission Reduction Strategies in Guangzhou. *Proceedings of China's Urban Transport Planning Annual Conference in 2017*. 2017.
11. Guangzhou Institute of energy research, Chinese Academy of Sciences. *Research on Green Low Carbon Development Path in Guangzhou*. Project Report. 2018.
12. Edited by Green Low Carbon Think Tank Partners. *China Urban Low Carbon Development Planning, Peak Values and Case Studies*. Science Press. 2018.