Social Impact Assessment on the Equitable Climate Strategy and Action Plan

INDICATOR TOOL

INSTITUTE FOR SUSTAINABLE COMMUNITIES

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Executive Summary

The Institute for Sustainable Communities (ISC) conducted a study toward building a **Social Impact Assessment (SIA)** tool that is intended to become a crucial planning mechanism for strengthening and embedding social equity into cities' long-term climate strategies and action plans.

As cities develop climate strategies and roadmaps to achieve carbon neutrality, the SIA tool will assist stakeholders in the planning process by providing:

- A framework for cities to evaluate the status quo or baseline performance. It will guide them in developing strategies to redesign or redefine policies to produce more equitable outcomes based on four principles: inclusiveness, accessibility, affordability, and resilience.
- An indicator and score system. The system will enable them to efficiently assess the climate equity elements of carbon neutrality plans, against which to monitor and evaluate their performance.

The China Deep Decarbonization and Equitable Long-term Strategies Alliance (China DELTA) project, funded by the Swedish Postcode Foundation, is helping three mega-cities in China—Tianjin, Changsha, and Guangzhou—to rethink the societal and economic practices needed to meet ambitious climate change goals. By applying the SIA tool, these cities are ensuring that their climate strategies and roadmaps incorporate social metrics while achieving carbon neutrality transformation. In this process, China DELTA will ensure that marginalized groups participate in and are engaged at every step of planning, so their voices and unique needs are considered.

To promote urban growth with equity, the SIA tool refers to four equity principles defined by Asian Development Bank's GrEEEn Cities Operational Framework to ground our work in well-developed practice. The principles are fundamental rules of equity that apply to all nations. The indicator system, however, must take into account the unique social, political, and cultural environment of each country. It is not intended to provide a one-size-fits-all solution. Here ISC presents the SIA tool taking China as a case to demonstrate how the methodology can be applied in practice. The six elements chosen for the indicator system address the critical aspects of climate equity, which many countries should find applicable to their context. The indicators can be used as is or tailored to each country's specific needs.

▶ Why Focus on Social Equity in Climate Action?

- Globally, women tend to be more vulnerable to the worst effects of climate disruption—United Nations (UN) figures indicate that 80 percent of people displaced by climate change are women.[1]
- Millions of workers depend on fossil fuel–driven industries and infrastructure. Phasing out those industries will benefit low-income communities the most.
- Systemic changes needed in Chinese society and its economy to achieve carbon peaking and carbon neutralization offer massive opportunities to reduce social inequities.
- Although increasing climate action efficiency is a priority, including historically marginalized groups will improve the long-term effectiveness and sustainability of climate policies and programs.
- Careful, purposeful, and proactive planning to provide support and training to those negatively affected by a transition to a carbon-neutral future will ensure that no one is left behind in the process of protecting the climate.

▶ SIA Tool: Framework and Data Source

Developed in collaboration with local partners, the SIA tool is in line with the Asian Development Bank's GrEEEn Cities Operational Framework on promoting social equity[2] and supports UN Sustainable Development Goal (SDG) 11, Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient, and sustainable.[3]

In China, the project team used publicly accessible data from China's Statistical Yearbook, Urban Statistical Yearbook, and other sources to collect information for the development of the SIA tool.

▶ SIA Tool: Indicator System

Integral to the SIA tool is a social impact indicator system that helps cities build an accountability mechanism to ensure the fairness and inclusiveness of carbon-neutral strategies during the planning process. The SIA indicator system consists of six elements that represent important issues that, taken together, address climate equity: green jobs, public service, green transportation, healthy environment, energy affordability, and good governance (See Table 1). By monitoring and evaluating their climate action plans against these key social areas, cities ensure that the implementation of their carbon-neutral plans will achieve more equitable outcomes.

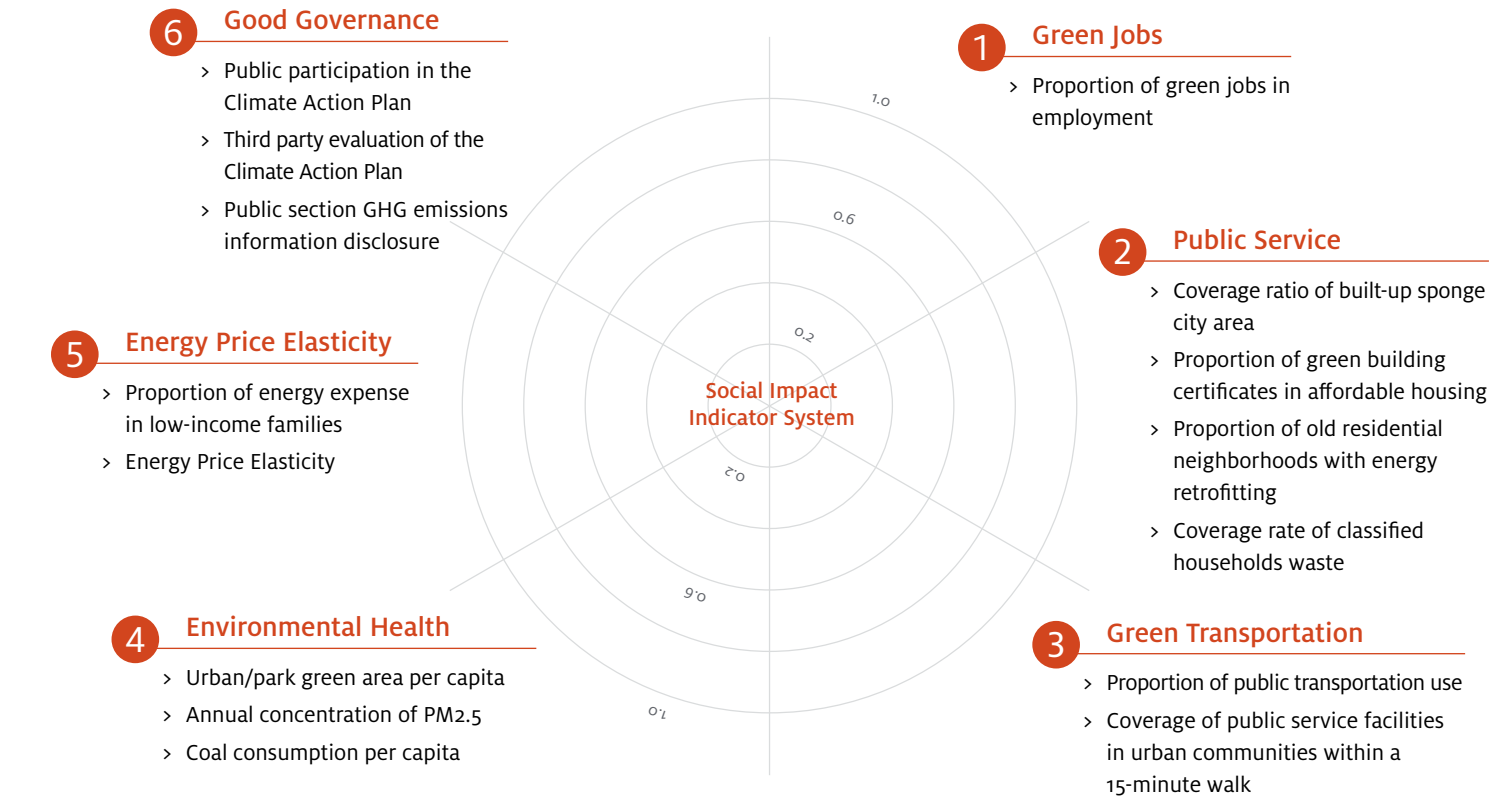
Table 1. Elements of the SIA Indicator System

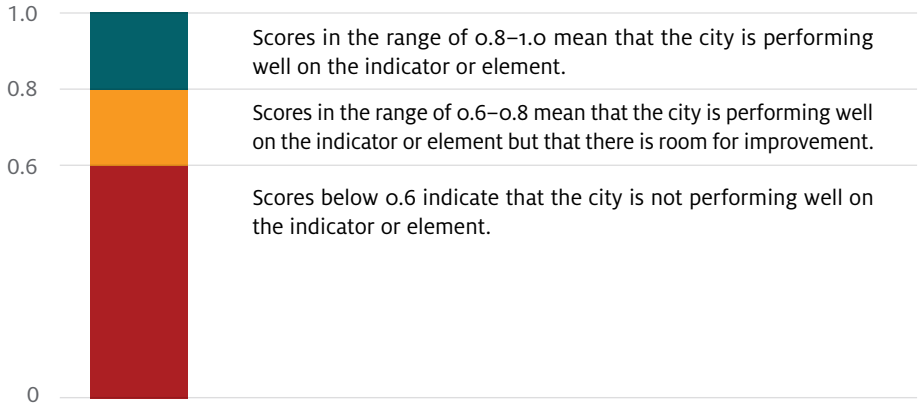
Elements of the SIA Indicator System	Element Description
1 Green Jobs	Addressing the climate crisis has led to the growth of an emerging green economy. The indicators for this element will help cities assess how many new green jobs are replacing job loss in energy-intensive industries that are phased out. It will also examine the gender dimension in the new labor force.
2 Public Service	Climate action enables governments to invest in and improve services to their citizens. The indicators for this element will help cities assess the inclusiveness and accessibility of public services by examining the availability of affordable housing, energy retrofitting of older homes, access to waste facilities, and Sponge City development, a Chinese initiative for building up water resilient cities with abundant natural areas such as trees, lakes and parks or other good design intended to absorb rain and prevent flooding.[4]
3 Green Transportation	Supporting green transportation is essential to building sustainable communities and achieving carbon neutrality. The indicators for this element will help cities assess the proportional use of public transportation and the number of service facilities, such as schools, hospitals, and others that are accessible within a 15-minute walk.

Elements of the SIA Indicator System	Element Description
4 Healthy Environment	Climate action toward carbon neutrality provides significant opportunities to improve public health and advance social equity. The indicators for this element will help cities assess air quality and climate protection—for example, by measuring urban green/park areas per person, particulate matter (PM) 2.5 concentration, and coal consumption per capita.
5 Energy Affordability	Providing accessible and affordable energy is critical to uplifting low-income families. Indicators for this element will help cities assess the proportion of energy expenses for low-income families and its impact on rising consumption costs in society. Current studies include indicators on the rate of clean energy (biogas, biomass) use in rural communities.
6 Good Governance	Good governance is central to ensuring inclusiveness and fairness in the process of creating equitable climate strategies. Indicators for this element will assess the extent to which cities promote public participation, have independent monitoring and evaluation mechanisms, and disclose public-related carbon emission information. An upcoming study will include a cost-benefit analysis of public spending on carbon peaking and neutrality.

The six elements of the SIA Indicator System are assessed by 15 indicators (Figure 1) that evaluate climate planning and action. They reflect the context and practices of cities and were selected through a series of expert meetings and peer reviews that included community-based organiztaions.

Figure 1. SIA Indicators





SIA Tool: Scoring System

Each element in the SIA tool is assessed by a set of indicators. Each of those indicators is scored zero to one, where zero represents poor performance or no data provided, and 1.0 represents a perfect score. The score assigned to each element is the mean score for the set of indicators under that element.

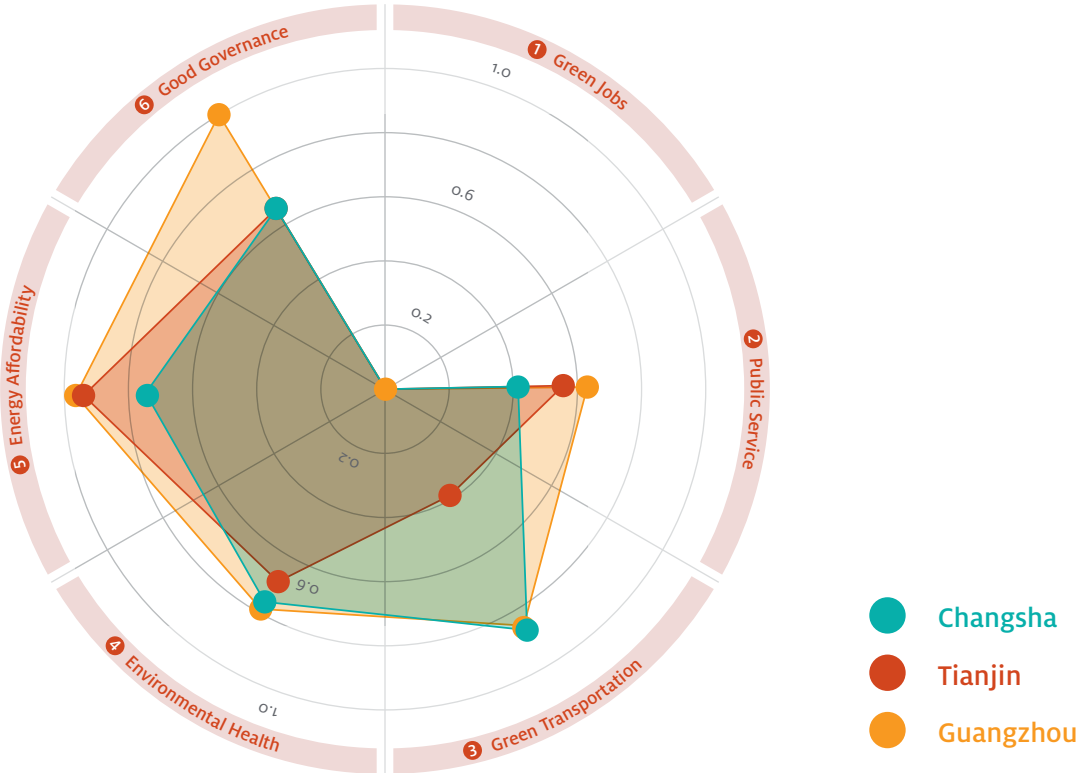
Benchmark data for each indicator is derived from applicable international standards or national standards of excellence. Each city's score for a particular indicator is calculated for defined intervals by comparing city data with the benchmark data.

Preliminary Findings for Application of the SIA Tool in the Pilot Cities

Working with stakeholders in the three pilot cities in China—Changsha, Tianjin, and Guangzhou—on their climate change action plans, the project team applied the SIA tool to ensure that the implementation of their carbon-neutral plans will produce more equitable outcomes.

Figure 2 shows the element scores for each pilot city. The main findings from the comparative analysis across the cities are discussed below.

Figure 2. Element Scores for the SIA Pilot Cities



The overall score is the average of the score for each element. For easy communication, the city score value is converted to a 100-point scale (see Table 2). This score can be calculated annually to monitor the equitable results of the climate action plan.

Table 2. SIA Scores for the Three Pilot Cities

City	Changsha	Tianjin	Guangzhou
Score	58	54	71

The following Table 3 describes the findings that correspond to the scores shown in Figure 2.

Table 3. Findings for Elements in Pilot Cities

Elements	Findings
1 Green Jobs	All three cities scored 0 because they lack data on green jobs.
2 Public Service	The three cities scored between 0.4 and 0.7 for public service. These scores reflect insufficient data on Indicator 3, the proportion of green building certificates in affordable housing, and Indicator 4, the percentage of energy-saving retrofitting in older residential communities.
3 Green Transportation	The three cities are performing well on the green transportation element, scoring between 0.6 and 1.
4 Environmental Health	The three cities are performing well on the environmental health element, scoring between 0.6 and 1.
5 Energy Affordability	Guangzhou and Tianjin each scored close to 1 for energy affordability while Changsha scored relatively low.
6 Good Governance	Guangzhou scored 1 for good governance. All three cities scored well on Indicator 15, Dual Carbon information disclosure. Changsha and Tianjin scored lower for Indicator 13, public participation in the Dual Carbon planning process, and Indicator 14, third-party evaluation mechanism for implementation of Dual Carbon goals.

▶ Next steps

ISC will continue to collect city-based, publicly available data in China and elsewhere for a benchmark study. Having evidence of the SIA tool's effectiveness in promoting climate equity, ISC intends to make an equitable climate action ranking for major Chinese cities and scale up the application of the tool to 30 additional cities in China and Southeast Asia.

1

Purpose and Significance of the Study

▶ 1.1 Necessity and Urgency of the Study

According to the Intergovernmental Panel on Climate Change (IPCC) 1.5°C Special Report (2018), stronger and deeper interventions are needed to limit the average global temperature increase to 1.5°C. This includes decreasing global net anthropogenic CO_2 emissions by approximately 45 percent from 2010 by 2030 so as to reach net zero emissions by around 2050. At the Paris Climate Conference in 2015, China pledged to peak its CO_2 emissions by 2030. In terms of quantitative targets for 2030, the country's CO_2 emissions per unit of GDP will reduce by 60 to 65 percent below 2005 levels, and increase the share of non-fossil fuels in primary energy consumption to around 20%.

On September 22, 2020, during the general debate of the 75th Session of the United Nations General Assembly, President Xi Jinping announced that China would strive to achieve a goal of carbon neutrality by 2060. At the 2021 Leaders' Summit on Climate, President Xi pointed out that the well-being of the people of all countries is closely related to the environment. It is essential to consider all people's aspirations for a good life, expectations of a positive environment, and responsibility for future generations; to explore the synergy of environmental protection with economic development, job creation, and poverty elimination; to strive to achieve social equality and justice during the green transformation; and to enhance the desire for prosperity, happiness, and security.

The goal of reaching a carbon emissions peak before 2030 and carbon neutrality before 2060 (Dual Carbon goals) is to bring China's green development path to a new level that will become a benchmark for socioeconomic development in China for decades to come. Meeting these goals will be challenging. Achieving them requires reshaping and transforming the country's energy mix, economic structure, infrastructure, public service, and even consumption patterns, which will have a profound impact on China's social structure and system. As highlighted by President Xi at the ninth meeting of the Central Economic and Economic Commission on March 15, 2021, the Dual Carbon goals will require broad and profound **economic and social systemic change**. How this change will balance efficiency and equity is both a long-term topic and an urgent task that must be fully considered and implemented in the current Dual Carbon design and implementation phases.

▶ 1.2 Significance and Value of the Study

Achieving the Dual Carbon goals will provide new opportunities for China to promote fair, and integrated development that can contribute to the UN SDGs. However, this may exacerbate or contribute to existing inequities that could adversely affect Chinese society. Foremost among these issues are the loss of jobs in energy heavy industries, rising energy prices, uneven development of urban and rural infrastructure to respond to climate disasters, and employment inequality.

From the perspective of concrete actions at the national and regional levels, climate actions will involve the redevelopment of all aspects of society, economy, and life in general. In particular, rapid technological transition and structural adjustment may disrupt economic systems, affect the labor market and social relationships, and cause other social and political impacts. Therefore, a just transition is inevitably intertwined with decarbonization. Figure 3 depicts the progress of the just transition in the context of the international climate agenda.

2021

COP 26 Glasgow Climate Pact recognized the need to ensure a fair transition, promote sustainable development and end poverty, and create decent work and quality jobs

2019

COP 25 International Labor Organization launched the Climate Action for Jobs initiative and issued the Skills for a Greener Future report

2018

COP 24 Just transition in the Solidarity and Just Transition Silesia Declaration became one of three major themes of the conference

2016

The United Nations Framework Convention on Climate Change secretariat published the technical report Just Transition of the Workforce, and the Creation of Decent Work and Quality Jobs

2015

COP 21 The Paris Agreement incorporated the just transition, requiring the Convention secretariat to prepare a technical report on just transition

2011

COP 17 established a Forum on the Impact of the Implementation of Response Measures featuring the just transition as one of the themes

2010

COP 16 The preamble of the Cancun Agreements included the concept of just transition for the first time

1997

After conclusion of the Kyoto Protocol, many trade union organizations have requested just transition to be incorporated into the climate mechanism

1992

The United Nations Framework Convention on Climate Change proposed that climate strategies should take into account the economic, social and environmental impacts

Figure 3. Progress of the Just Transition Agenda

As early as 2013, at its 102nd meeting of Member States, the International Labor Organization (ILO) presented the concepts of sustainability, decent work, and green jobs as the foundation for a just transition. In 2015, the ILO published Guidelines for a Just Transition Towards Environmentally Sustainable Economies and Societies for All and clarified that the process of a just transition aims to properly manage the "transition to an environmentally sustainable economy and contribute to the goals of decent work for all, social inclusion and the eradication of poverty."[5]

Early in the discussion of environmental topics, the term "just transition" focused on job opportunities and labor rights. In the course of climate negotiations, the concept has expanded gradually to include families and communities—especially those vulnerable to poverty and climate change, such as those threatened by rising sea levels, extreme climate events, and loss of biodiversity.

In 2019, the ILO proposed green jobs as a core aspect of sustainability and resource productivity. The organization addressed global challenges such as environmental protection, economic development, and social inclusion. Green opportunities can also create decent jobs, improve resource efficiency, and build a sustainable low-carbon society. Green jobs must be high-quality, decent jobs that align with the four strategic goals at the core of the decent work agenda: 1) to develop and promote working standards and fundamental principles and rights; 2) create more opportunities for men and women to gain decent employment and income; 3) improve the coverage and effectiveness of social protection for all; and 4) strengthen dialogue among government, workers, employer organizations, and society as a whole.

The 2010 United Nations Climate Conference (known as the Cancun Agreements) stressed that the shift toward building a low-carbon society should ensure a just transition of the workforce in order to create decent work and quality jobs.

In 2015, the 21st session of the Conference of the Parties to the UN Framework Convention on Climate Change (UNFCCC) pledged to take into account the urgency of a just transition of the workforce and the creation of decent work and quality jobs in line with national development priorities. The UNFCCC formally included a just transition[6] in the preamble of the Paris Agreement, setting out that parties "take into account the imperatives of a just transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities."

At the 2021 United Nations Climate Change Conference (COP26 2021), just transition became a major topic of climate policy at the national level and was advanced to the decision-making stage. The Glasgow Climate Pact, signed by representatives of nearly 200 countries,[7] reaffirmed the importance of just transition, proposing that countries need to coordinate national domestic contributions (NDCs) and the long-term low-carbon development goals of each country, achieve just transition, promote sustainable development and eliminate poverty, create programs for decent work and quality jobs, and fund the developing parties by aligning the flow of funds with the path to realizing greenhouse gas emissions and development that is resilient to climate [change] through technology deployment and transfer. COP26 took a step forward in addressing the social impact of climate action. The Glasgow Climate Pact repeatedly mentions the rights of communities and Indigenous peoples, youth and gender equality, and the necessity for basic social and livelihood security.

In China, the core path of Dual Carbon goals begins with a shift where energy generation is decarbonized and economic systems are more climate-resilient. As a result, some regions, industries, and employment populations that traditionally rely on fossil fuels will be impacted. Among the results will be layoffs of workers in traditional high-carbon industries and widened income gaps. The transformation of the

coal industry is one example. With the implementation of supply-side structural reform and reduction of excess industrial capacity, the number of Chinese coal workers has been reduced from about 4.5 million in 2015 to about 2.6 million in 2020, according to domestic research and evaluation. It is likely that these numbers will be halved again by 2030.[8] In the short term, advancing the Dual Carbon process will inevitably increase pressure on traditional high-carbon industries to transfer workers to other posts. In the long term, implementation of Dual Carbon goals will create more jobs in industries such as the service and renewable energy sectors (and their upstream and downstream sectors), offsetting the negative impact of the withdrawal of high-carbon industries. Therefore, planning for carbon neutrality pathways must consider the negative impact on some populations, but also ensure that the opportunities brought by the green transformation are fair and equitable, promote meaningful public participation—and balance the impact of both through effective policies and systems.

Often, the impact of and response to climate change are not equal. Those who benefit least from the fossil fuel economy, as well as those that produce the smallest amounts of greenhouse gas emissions, are likely to suffer the most serious consequences. Ignoring these impacts means that the benefits and burdens of climate action will not be distributed fairly. For example, people who are marginalized in social, economic, cultural, political, or other ways often benefit least from environmental subsidies, low-carbon transportation options, climate resilience measures, and energy efficiency savings. Realizing Dual Carbon goals requires an effort to seek a coordinated development path from the multidimensional perspectives of economy, society, and ecological environment, achieving social equity and sustainable and just transformation.

ISC implemented the DELTA Project, from March 2021 to September 2022. The DELTA Project worked with China's low-carbon pioneer cities of Guangzhou, Tianjin, and Changsha to study carbon-neutral roadmaps on the basis of their carbon-peaking schemes and to support the achievement of the 2060 carbon-neutral vision. DELTA utilizes economic analysis tools to support partner cities to deepen their urban carbon neutralization programs and consolidate the 14th Five-Year Plan for Low Carbon Action. It uses a multi-scenario data model and a participatory approach to support cross-sectoral collaboration in partner cities to create a 2060 carbon-neutral roadmap tailored to the urban carbon neutralization and long-term planning strategy. DELTA developed and applied the SIA tool to ensure that the carbon-neutral roadmaps are developed and implemented with full consideration for its social sustainability. It forms, summarizes, and promotes the sharing of project outcomes and experiences in cities in China and other countries; builds a network of "carbon peer" learning alliances; and tells stories of China's experience to the international community.

The purpose of this report is to begin to build a complete and objective SIA index system of carbon-neutral paths for cities to guide their planning and practice toward achieving Dual Carbon goals. This report takes into account climate equity in the achievement of the Dual Carbon goals and promotion of social-economic low-carbon transformation. It is intended to help cities achieve a fair and inclusive low-carbon future that will provide residents an equal share in the comprehensive benefits of the Dual Carbon process.

2

Social Impact Assessment Indicator System for Cities' Carbon Peaking and Carbon Neutrality Planning of Cities

2.1 Technical Route of Indicator System Development

The SIA project team spent more than a year developing the Social Impact Assessment tool for carbon peaking and carbon neutrality planning. The team based its work on the UN SDG 11 index system; the inclusion, accessibility, affordability, and resilience principles of the urban sustainability dimension; and international case studies to promote just transition and climate equity.

After several rounds of expert discussion and training workshop feedback, the team of local partners, trainees, and experts identified the principles and scope of the assessment's indicator dimensions and components based on international experience, along with measures and goals for high-quality development in Chinese cities. In selecting indicators, the team paid particular attention to the elements of current projects that local governments stressed. These included:

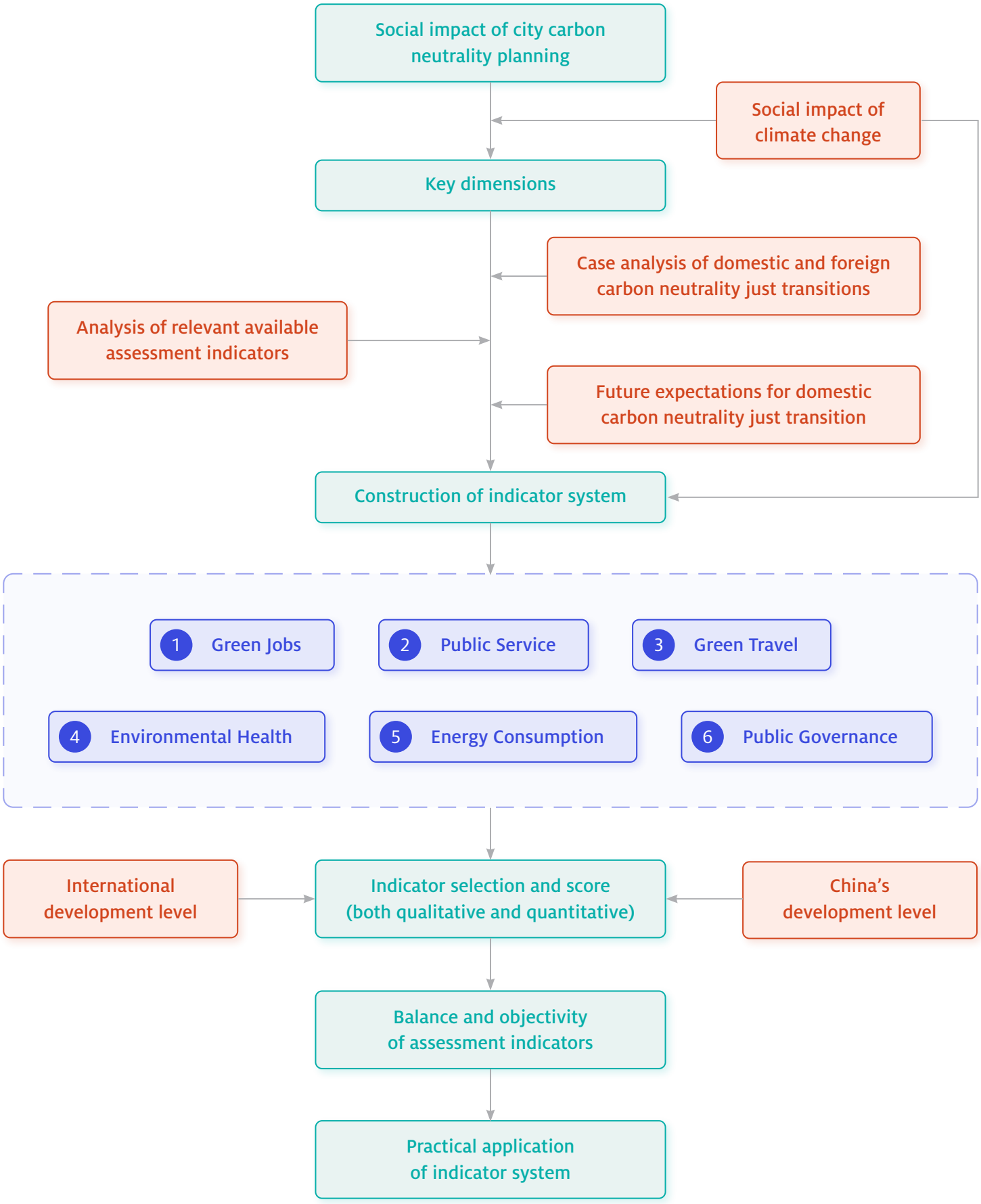
- Promoting employment
- Retrofitting older construction
- Constructing affordable housing
- Sorting waste
- Limiting the use of coal
- Engaging in Blue Sky projects
- Prioritizing public transit
- Encouraging 15-minute communities
- Developing city parks
- Constructing sponge cities

After considering the difficulty of collecting data, the availability of relevant data, the objectivity of indicator scores, and ability to implement technical and economic constructs, the team screened relevant preliminary inputs, and developed the SIA indicator system.

In identifying the criteria for scoring indicators, the team focused on understanding the benchmarking baseline for Chinese and international best practices. The team considered city data against a scale of advanced international standards to derive scores between 0 (no data, or the lowest score) and 1 (the highest score, equivalent to an advanced international standard). Adding and averaging inputs enabled the team to score each dimension. Then, the overall city scores were added and averaged.

Figure 4 depicts the technical routes and methods that the team used in developing the indicator system.

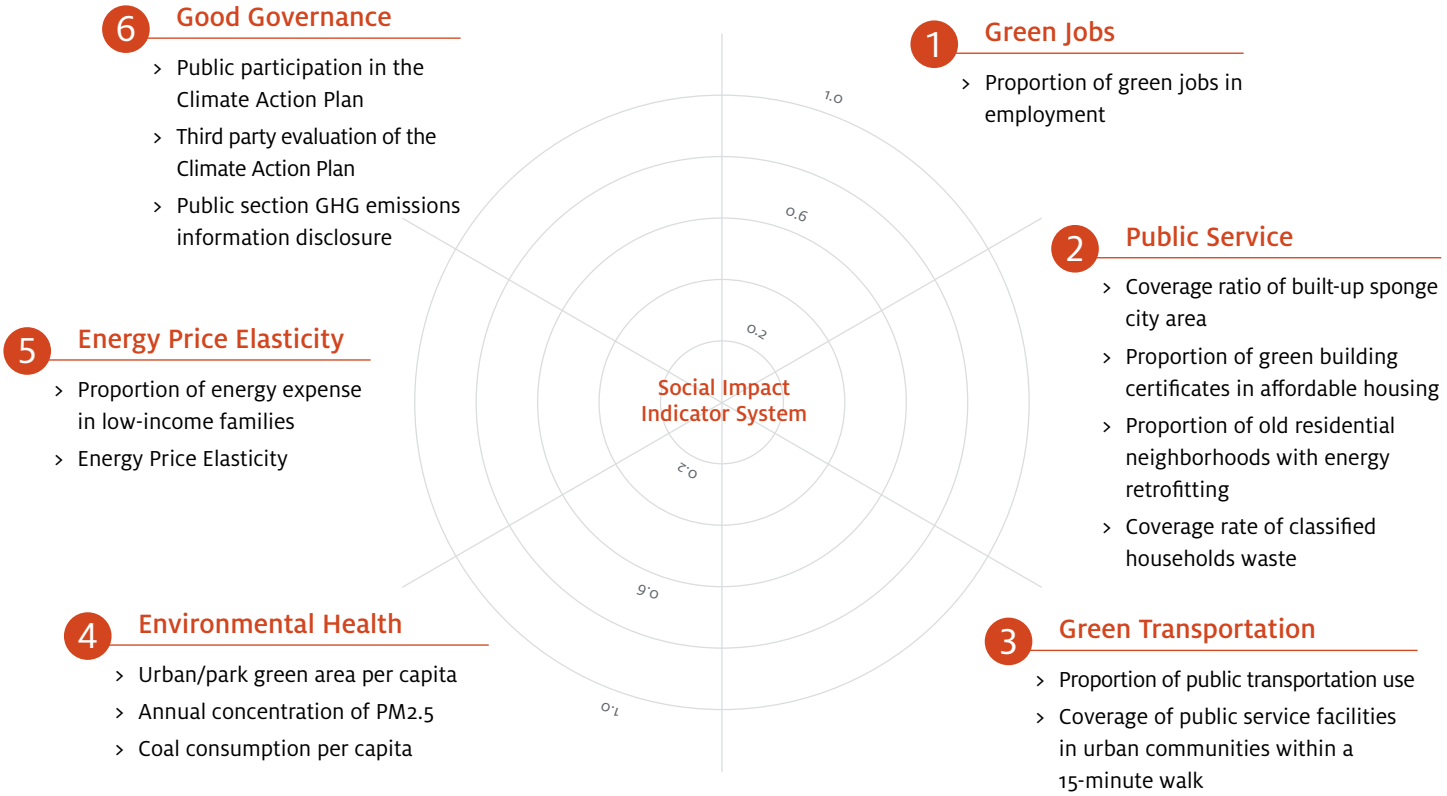
Figure 4. Technical Roadmap for Indicator System Development



▶ 2.2 Composition of the Indicator System

The social impact indicator system was developed through extensive discussion and reviews of Chinese and international references, expert opinions on urban sustainability, and feedback from trainees in the pilot cities' frontline departments. The system includes 15 indicators in six dimensions (see Figure 5). It reflects the characteristics of urban development in China and is generally applicable to cities in the country. For use in other developing and developed countries, the indicators can be selected according to relevant development characteristics.

Figure 5. Composition of Carbon Peaking and Carbon Neutrality Social Impact Indicator System



The six dimensions of the SIA indicator system discussed below are: green jobs, public service, green travel, environmental health, energy consumption, and good governance.

1 **Green jobs** are an important dimension of climate equity. Studying the proportion of green jobs in the overall workforce reveals whether the green economy is strong. During the process of economic transformation, many high-energy and high-pollution enterprises face shutdowns or transformation, and many jobs will be eliminated. However, the development of new industries and new economies also creates many jobs. Therefore, understanding the carbon neutrality transition involves recognizing the number of new green jobs that will replace jobs that are phased out of energy-intensive heavy industries. Financial arrangements will be needed to support the re-employment of workers laid off from high-pollution and high-emission industries that are eliminated. Gender equity considerations and demographic analysis in new jobs are also worth exploring.

2. The public service dimension considers whether, during carbon neutrality transition and development, cities' public infrastructure and urban renewal services cover the entire population equally, including vulnerable and low-income groups. In conducting high-quality development, Chinese cities are promoting urban upgrades; retrofitting older communities at scale; and engaging in large-scale construction of affordable apartments, trash sorting, sponge city construction, and other livelihood projects. In response to climate change, urban and rural infrastructure must be upgraded to maintain flood control and drainage, secure power grids and water supplies, protect farmland and wetlands, insulate buildings appropriately, and provide other safeguards. These dimensions can help determine whether high-quality development initiatives are green and low-carbon and whether they meet Dual Carbon goals. It is also necessary to evaluate whether these projects promote the desired development outcomes for low-income households to enable them to achieve prosperity as early as possible. Urban development safeguards residents' lives in numerous ways. These include reducing the risk of urban flooding through sponge city construction and covering built-up areas as fully as possible. These are all also important measures to cope with potential climate change disasters. To promote inclusion and affordability, cities should strive to make reliable, affordable housing available to low-income households and make energy-efficient and green improvements to older communities. In particular, residents in urban and rural communities should receive municipal services such as waste sorting.

3. There is some overlap between the green travel and public service dimensions. However, as the carbon emissions from transportation are rapidly increasing and are a prominent issue in urban development, green travel is assessed as a separate dimension. Prioritizing public transit is integral to the development strategy for densely populated mid-sized and large cities. Increasing the share of public transportation in urban mobility—especially travel by motor vehicles—is an important measure to reduce carbon emissions. Doing so also is an inclusive measure that benefits the public. Since 2016, Shanghai has published China's Planning Guidance for 15-Minute Community Life Circles and built a network of urban community life circles where people can live and work within a 15-minute walk. The concept of the 15-minute community life circle is being promoted gradually to other cities for exploration and practice. In those communities, all service facilities, such as schools and hospitals, should be within a radius that can be reached on foot within 15 minutes. They should be promoted in line with the public transit priority strategy to minimize use of motor vehicles. Within the 15-minute community life circle, products and services are supplied by small and micro businesses, community social organizations, and others. The development and survival of those organizations affects all aspects of residents' lives, and they create many jobs. During the COVID-19 pandemic, service sites and medical institutions in neighborhoods played important roles. These are the "active cells" of society and the catalysts of carbon reduction in the lives of residents.

4. The healthy environment dimension emphasizes the synergy of eco-service, air quality, and climate protection. Indicators such as the area of urban greenfields, parks per capita, and PM 2.5 concentration reflect urban green public spaces, ecological environments, and air quality; data reflecting this information are publicly available. China is a major coal consumer. However, coal-fired boilers are being eliminated, bulk coal heating is being reduced, and in recent years, the share of coal in energy consumption has declined. Nonetheless, that share was 56 percent in 2021, much higher than the average of Organization for Economic Co-operation and Development countries (20 percent)—and total coal consumption is still increasing. Coal consumption is significantly associated with SO_2, NOx, PM2.5, and volatile organic compound (VOC) emissions, directly affecting air quality and respiratory health. Controlling total coal consumption is the only way to reduce pollutants from coal burning and carbon emissions, which is related to protecting the health of the public. Meeting this goal is of utmost urgency.

5 The energy consumption dimension mainly considers the impact of rising energy prices on low-income households, and on the rising consumption costs of society as a whole. This dimension aims to reduce households' energy cost burden. In the conversion from fossil to non-fossil energy, the fluctuation of energy prices is the rigid social cost of coping with climate change. Both state and local governments must adopt subsidy policies that target the energy costs of low-income households to avoid affecting the quality of life and social stability due to rising energy prices and increased costs of living. A modest increase in energy prices is acceptable. Ideally, income growth will outperform price increases. Thus, the cost of living and production will not exceed the means of most people and most industrial and commercial units, so strong economic development can compensate for addressing climate change and increased social costs. Indicators to select the energy price elasticity factor can reflect the impact of rising energy prices on the cost and quality of social life and production. An ongoing concern is how to reduce energy costs. Local governments should further study how to improve the use of clean energy resources (biogas and biomass) in rural communities to replace bulk coal, increase the supply of cheap clean natural gas, and avoid installing expensive natural gas pipelines.

6 The good governance dimension considers whether the public is included in Dual Carbon work and planning; whether implementation is conducted, supervised, and evaluated by a third party; and whether cities regularly disclose carbon information to the public. Fulfilling the vision for carbon neutrality is possible only through the involvement of the whole of society. The improvement of climate public governance means more bottom-up integration into the communities, harmonizing the interests of all parties, and promoting the development of the climate governance model of market-led government regulation.

To facilitate the quantitative assessment of indicators, measures may be scored 0 or 1, representing "no" or "yes." The project team recommends strengthening cost-benefit analyses of public expenditures related to Dual Carbon goals.

Based on the considerations for the six assessment dimensions, the project team selected 15 indicators as quantitative assessment criteria. Each indicator takes into account three aspects:

1. Whether the indicator accurately represents the quality of the assessment.
2. Whether data is available and, if so, whether they are available in the statistical yearbook
3. Whether any research support is available for domestic and foreign benchmark data

Table 4 defines each indicator and lists its data source. Indicator 1, the percentage of the population with green jobs, is not included in city statistical yearbooks, and cities generally lack data support. The National Development and Reform Commission issued the Green Industry Guidance Catalog. In the future, data for Indicator 1 will be obtainable from public government documents. Not all of the pilot cities have announced their current situations or goals for Indicator 3, the proportion of green building certificates in affordable housing; Indicator 4, the percentage of energy-saving retrofitting in older residential communities; and Indicator 7, public service facilities in urban communities accessible within a 15-minute walk. As cities develop, the values of these three indicators will likely be discussed in future government documents.

Indicator 12, the energy price elasticity coefficient, reflects the comparison between increases in energy prices and household income. Indicator 1, the percentage of the population with green jobs, generally lacks data; and data for Indicator 3, the proportion of green building certificates in affordable housing, Indicator 4, percentage of energy-saving retrofitting in older communities, and Indicator 7, public

service facilities in urban communities accessible within a 15-minute walk, are lacking in some cities. All data needs close attention and strengthening in the urban Dual Carbon practice.

Table 4. SIA Indicator System for Carbon Peaking and Carbon Neutrality Planning

Dimension	Indicators	Indicator definition and calculation formula	Data source
Green Jobs	1. Percentage of population with green jobs	Working population under Green Industry Guidance Directory / Total working population	
Public Service	2. Coverage ratio of built-up sponge city areas	Area that met the sponge city construction target / Proportion of built-up areas in the city	City statistical yearbook
	3. Proportion of green building certificates in affordable housing	Area of newly constructed affordable apartments with green building labels certified by the Ministry of Housing and Urban-Rural Development / Area of newly constructed affordable apartments	Industrial sector statistics
	4. Percentage of energy-saving retrofitting in older communities	Building area of energy-saving retrofitting of older residential communities / Total building area of older communities	Industrial sector planning, statistics
	5. Proportion of domestic waste sorting practices	Number of communities with urban and rural domestic waste sorting practices / Total number of communities of the city	City statistical yearbook
Green Travel	6. Proportion of public transportation use	Public transportation traffic / Total motorized traffic	City statistical yearbook; statistical communiqué on National Economic and Social Development
	7. Public service facilities in urban communities accessible within a 15-minute walk	Number of communities with public service facilities accessible within a 15-minute walk (1 to 2 kilometers) / Total number of communities in the city Community public service facilities include medical care, education, culture, sports, public transit, social welfare, community management, basic business services, etc.	Industrial sector statistics

Dimension	Indicators	Indicator definition and calculation formula	Data source
Environmental Health	8. Urban/park green areas per capita	Green areas of city parks / Square meters per person	City statistical yearbook, statistical yearbook of urban and rural buildings
	9. Average annual concentration of PM 2.5	Annual average concentration of fine particulate matter (PM 2.5) (μg/m^3)	City statistical yearbook
	10. Coal consumption per capita	Coal consumption of industrial enterprises above a designated size / Size of permanent population (tons/person)	City statistical yearbook
Energy Consumption	11. Percentage of energy expenditures by low-income households	Households with annual incomes below the local average wage; Annual spending on energy consumption/ Household disposable income Energy consumption products include electricity, coal, liquefied petroleum gas, natural gas, coal gas, firewood, straw, and fuel oils Low-income households are defined according to the criteria of each province or city or are based on household members living together who have a per capita income less than 1.5 times the local minimum living standard	Statistical yearbook/survey
	12. Energy price elasticity coefficient	Annual average increase in energy price/ Residents per capita disposable income Energy types: water, electricity, natural gas Urban and rural residents within the city's jurisdiction	National economy statistical data
Public Governance	13. Public participation in the Dual Carbon planning process	Publicly available on the government affairs information network, established hearing system, policy announcements, solicitation of complaints and opinions, policy consulting institution intervention, etc.	Public channels such as government affairs information network and official WeChat government account.
	14. Third-party evaluation mechanism for implementation of Dual Carbon goals	Whether a third party agency was included in the implementation and evaluation process	Public channels such as government affairs information network and official WeChat public account of government
	15. Dual Carbon information disclosure	Publicly available on the government affairs information network, WeChat public account, and other channels	Public channels such as government affairs information network and official WeChat public account of government

▶ 2.3 Scoring Criteria for Each Indicator

To quantitatively analyze total evaluation results, the project team compared city data with benchmark data (see Table 5) and calculated the score for each indicator based on the high score of 1 and the low score of 0. The team converted the value of each indicator to a score between 0 and 1; where no data were available, the indicator was scored as 0. The combined score for each dimension is the average of its indicators, and the total score for the city is the sum average of the scores for each dimension.

For example, an overall score of a dimension between 0.8 and 1 indicates that the city is performing well on this indicator and needs to continue to maintain its advantage. A score of 0.6 to 0.8 indicates that the city is performing well on the indicator, but there is room for improvement. A score below 0.6 indicates that the city is not performing well on the indicator and should strengthen its measures to achieve a breakthrough as soon as possible.

Table 5. Scoring Criteria for SIA Indicators for Carbon Peaking and Carbon Neutrality Planning

Dimension	Indicators	Scoring Criteria	Sources of materials related to benchmarking data
Green Jobs	1. Percentage of population with green jobs	0: 0 1: 8 percent	Green City Freiburg: The number of green jobs is 8 percent.[9]
Public Service	2. Coverage ratio of built-up sponge city areas	0: 0 1: 80 percent	Guidance of the General Office of the State Council State Office on Promoting Sponge City Construction, Guo Ban Fa (2015). No. 75: By 2030, more than 80 percent of urban built-up areas will reach the target.[10]
	3. Proportion of green building certificates in affordable housing	0: 0 1: 100 percent	The State Council of the People's Republic of China. China's New Green Buildings Accounted for More Than 90% as of the First Half of 2022.[11]
	4. Percentage of energy-saving retrofitting in older communities	0: 0 1: 100 percent	Guiding Opinions of the General Office of the State Council on Comprehensively Promoting the Renovation of Old Urban Communities, Guo Ban Fa (2020). No. 23: By the end of the 14th Five-Year Plan period, based on the actual situation of all regions, we strive to complete the task of renovating old urban communities that were built before 2000. The refinement category in the renovation task includes energy-saving renovations of buildings in the community.[12]
	5. Proportion of domestic waste sorting practices	0: 0 1: 100 percent	The Ministry of Housing and Urban-Rural Development and other departments issued the Notice of Certain Opinions on Further Promotion of Domestic Waste Sorting (Jian Cheng [2020]. No. 93). By around 2025, cities at the prefecture level and above will establish classified placement, collection, transportation, and treatment systems for domestic waste appropriate to local conditions.[13]

Dimension	Indicators	Scoring Criteria	Sources of materials related to benchmarking data
Green Travel	6. Proportion of public transportation use	0: 0 1: 75 percent	The criteria for the Action Plan for Creating Green Travel: China's large and super-large cities shall have a motorized mobility share rate of not less than 50 percent, large cities not less than 40 percent, and small and medium-sized cities not less than 30 percent.[14] For comparison, the public transport share rate in Curitiba, Brazil, is about 75 percent.[15]
	7. Public service facilities in urban communities accessible within a 15-minute walk	0: 0 1: 100 percent	Technical Guide for Community Life Circle Planning TD/T 1062-2021, issued by the Ministry of Natural Resources.[16]
Environmental Health	8. Urban/park green areas per capita	0: ≤6.5m^2 1: ≥11m^2	Evaluation Criteria for Landscaping in Urban Parks (GB/T 50563-2010): Level I criteria (9.5 m2–11 m2 or more per capita); Level II criteria (7.5 m2–9.0 m2 or more per capita); Level III and Level IV (6.5 m2–7.5 m2 or more per capita).[17]
	9. Average annual concentration of PM 2.5	0: 75 μg/m^3 1: 5 μg/m^3	World Health Organization Global Air Quality Guidelines (2011 Edition) recommended criteria.[18] Annual average concentration of PM 2.5 is 5 μg/m^3. Technical Regulation on Air Quality Index (AQI) (Trial) (HJ633-2012): An AQI exceeding 100 indicates pollution, and the corresponding AQI for PM2.5 concentration of 75 μg/m^3 is 100.
	10. Coal consumption per capita	0: 2.85 tons 1: 0 tons	Per capita coal consumption in the United States in 2019 was 1.49 tons.[19, 20] Per capita coal consumption in China in 2019 was 2.85 tons.[21]
Energy Consumption	11. Percentage of energy expenditures by low-income households	0: ≥10 percent 1: ≤4 percent	Household energy consumption accounts for 4 percent to 8 percent of disposable income, with a long-term average of about 5 percent.[22] For low-income households, energy consumption of more than 10 percent will become a significant burden.[23]
	12. Energy price elasticity coefficient	0: 0 1: 1	Increasing energy prices greater than increasing income will add burden to household spending and affect quality of life.[24]
Public Governance	13. Public participation in the Dual Carbon planning process	0: No 1: Yes	To facilitate quantitative evaluation of indicators, scores of 0 and 1 correspond to "no" and "yes," respectively.
	14. Third-party evaluation mechanism for implementation of Dual Carbon goals	0: No 1: Yes	
	15. Dual Carbon information disclosure	0: No 1: Yes	

▶ Cases of Indicator System Application

The project team selected three cities based on the DELTA Project (Figure 6), Tianjin, Changsha, and Guangzhou, to study the application of the indicator system. Drawing on medium- and long-term strategic research on urban carbon neutrality and deep decarbonization, the research team used the SIA tool to assess the current situation and planning of urban Dual Carbon and put forward relevant policy recommendations.

The DELTA Project uses the LEAP model to design three scenarios for analysis: the benchmark, peaking, and neutrality. LEAP, shorthand for the Low Emissions Analysis Platform, is a powerful, versatile software system for integrated energy planning and climate change mitigation assessment that was developed by the Stockholm Environment Institute. For the resource endowment and policy measures of each city, the project proposes a carbon neutrality path. The main carbon economic development indicators for achieving carbon peaking between 2020 and 2030, and even achieving carbon neutrality by 2060, are broken down by assessment year. Figure 6 shows the model output status of each city's population, economy, and emissions. The SIA described in this study further expands the 2D carbon-economy model to a 3D carbon-economy-society model, which considers the interactions of climate action, economic development, and social development with a view to obtaining the greatest synergies between the three, providing guidance for the carbon peaking and carbon neutrality planning path.

Figure 6. Overview of the Cities Studied in the Project (2020 level)

Tianjin
Population: 13.7 million
GDP: CNY 1.6 trillion
GHG Emissions: 170 Mt

Changsha
Population: 10 million
GDP: CNY 1.3 trillion
GHG Emissions: 63 Mt

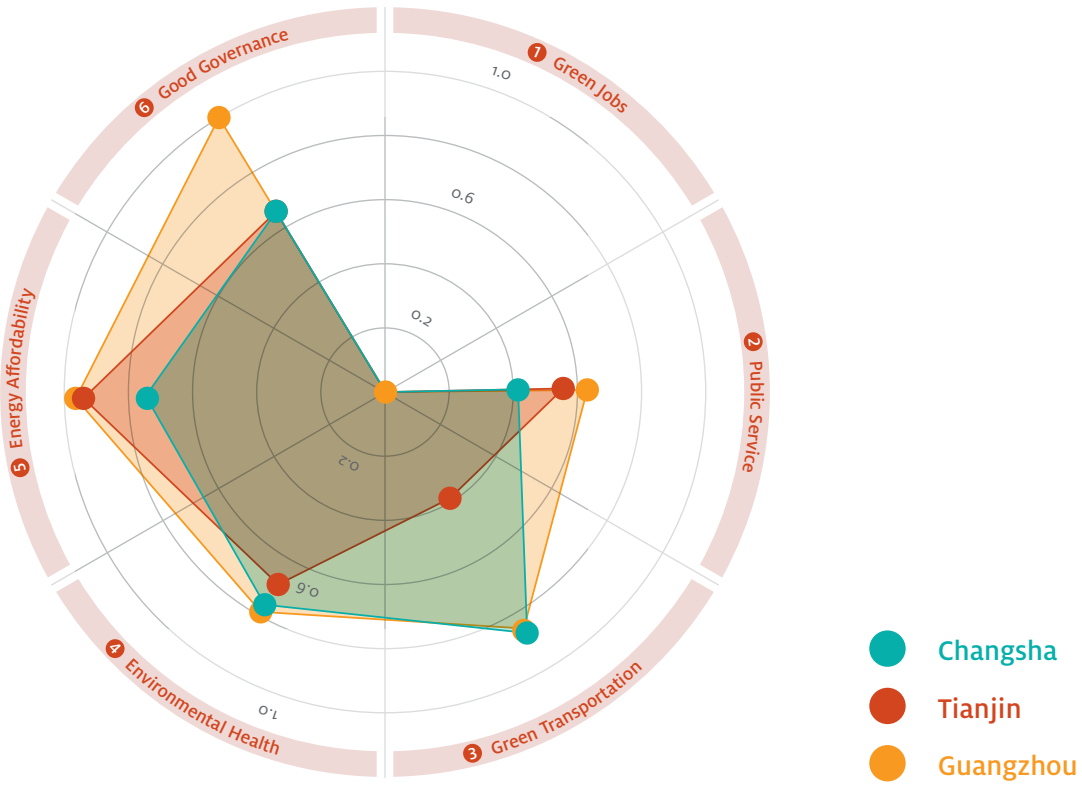
Guangzhou
Population: 18.8 million
GDP: CNY 2.8 trillion
GHG Emissions: 110 Mt

From March to June 2022, with the assistance of ISC partner city Tianjin's Academy of Eco-Environmental Sciences Low Carbon Center, Hunan Innovative Low Carbon Center, and Guangzhou Institute of Energy Conversion, and the Chinese Academy of Sciences, the project team collected and analyzed carbon-society-economy data released by Tianjin, Changsha, and Guangzhou based on the previous carbon-economy analysis. The team evaluated the quality, availability, and applicability of SIA indicators, calculated scores, and compared the data for the three cities. They reported the findings to relevant departments as policy recommendations, enabling them to consider weaknesses they identified, along with weaknesses in the Dual Carbon path planning and work plan, and to formulate medium- and long-term strategies for the coordinated development of Dual Carbon and livelihoods. In the process, the team optimized the descriptions of indicators and benchmark data to better match each city's circumstances. Finally, the team prepared this project report from July to August 2022.

Through the application and comparative analysis of the SIA tool for three cities (Figure 7), the team arrived at five main findings, and a preliminary conclusion.

1. Based on the benchmarking analysis of publicly available data, a quantitative assessment of the current situation and planned social impact of urban Dual Carbon development can be made quickly.
2. The three evaluated cities scored similarly in the three dimensions of energy consumption, environmental health, and green travel, all in the excellent and good ranges of 0.6 to 1. In particular, the scores in the energy consumption dimensions for Guangzhou and Tianjin cities are near 100 percent, indicating that the urban energy consumption burden is not high relative to the cost burden of low-income households, the energy consumption rise does not exceed the overall level of social income growth, and the overall range is relatively reasonable.
3. For the Dual Carbon information disclosure indicator, Guangzhou scored 100 percent (1 point) on public governance, but Tianjin and Changsha failed to score 100 percent for public participation in planning or third-party evaluation. This indicates that it is necessary to introduce public participation in Dual Carbon planning and a third-party evaluation mechanism into the performance evaluation.
4. All three cities have vigorously developed green industries and attracted residents to employment in green jobs. However, due to a lack of data from the cities' yearbooks or the sector data for Indicator 1, percentage of population with green jobs, the score for that indicator in all three cities is 0, and the score for the green jobs dimension is also 0. This shows that the prioritization of green employment in Dual Carbon work needs to advance, and that Dual Carbon for employment is a weakness to be remedied.
5. The three cities scored between 0.4 and 0.7 on the public service dimension, with much room for improvement. The low score or lack of data on Indicator 3, proportion of green building certificates in affordable housing, and Indicator 4, percentage of energy-saving retrofitting in older residential communities, affects the city's overall score. The cities can increase their scores for public service by increasing the scores for those two indicators, striving for 0.6 to 0.8 (good or excellent) during the 14th Five-Year Plan and 15th Five-Year Plan periods.

Figure 7. Radar Diagram of Results of Social Impact Assessment by Dimension



To facilitate quantitative analysis, the three public governance indicators consider only whether the work was done, and the quality concept was not introduced. In other words, the technical details and breadth of Dual Carbon information disclosure, the steps for and diversity of public participation, the scope of third-party evaluation, and the closed-loop mechanism of rewards and punishments were not introduced. Both the share of green buildings in affordable housing (Indicator 3) and the percentage of energy-saving retrofitting of older buildings (Indicator 4) need to be supported by technical standards, which require green two-star or higher certification energy savings of 50 percent to 75 percent. Due to the lack of data, the project team's rapid assessment tools have not yet performed an in-depth analysis of the technical standards for each indicator. The team anticipates improving the tools' application depth in the next phase of research.

Figures 8, 9, and 10 show the score distribution for the 15 indicators in Changsha, Tianjin, and Guangzhou, respectively. The 15 SIA indicators (listed below each figure) are scored excellent, good, or poor. The red area of each figure indicates poor scores. City departments should plan programs and measures to improve these rankings as soon as possible.

Figure 8. Score Distribution of Indicators in Changsha

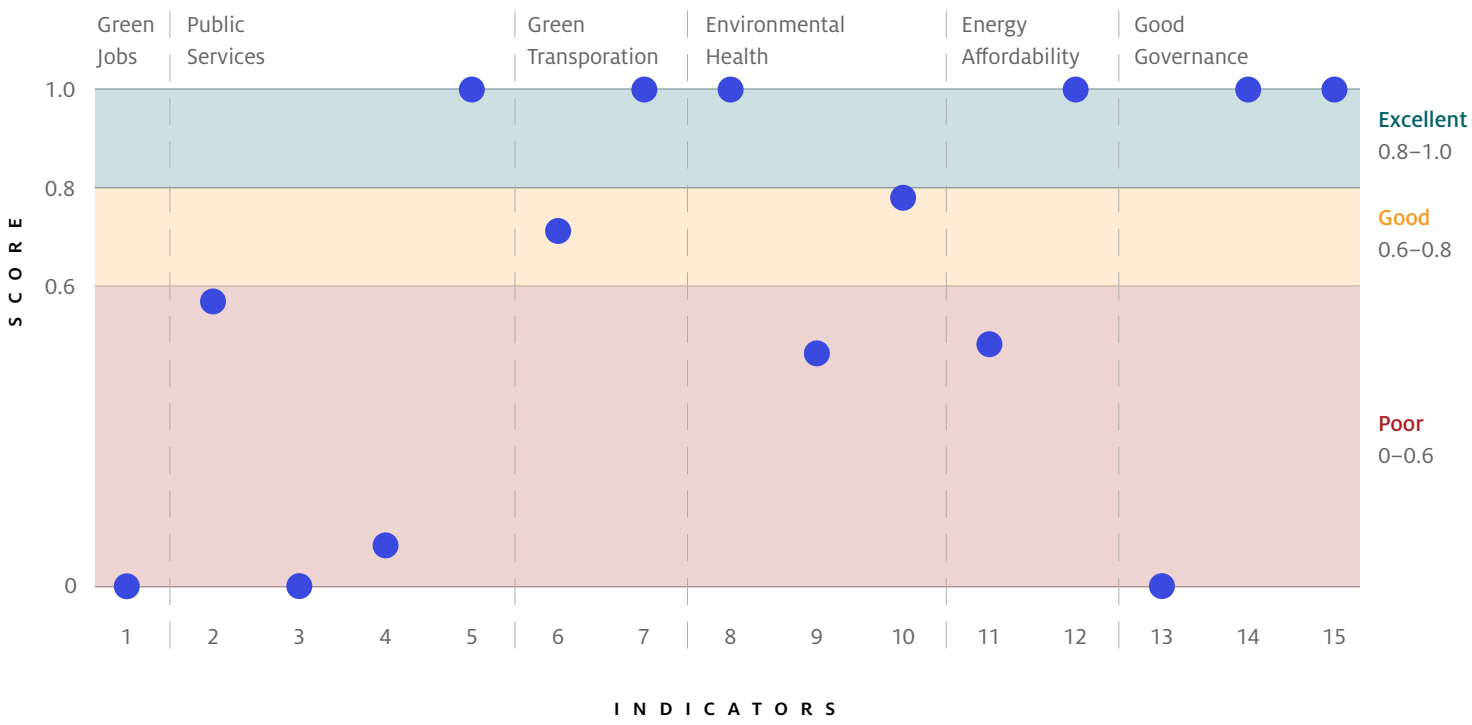


Figure 9. Score Distribution of Indicators in Tianjin

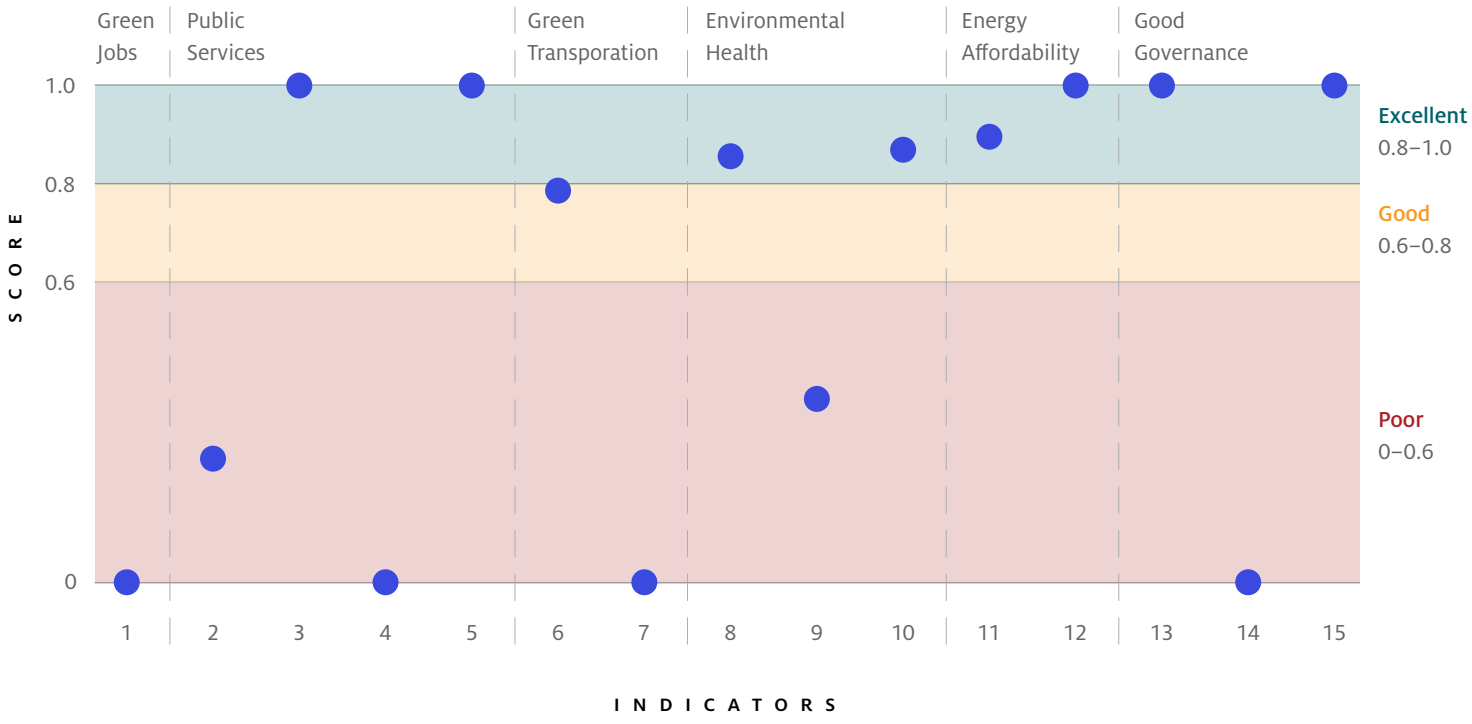
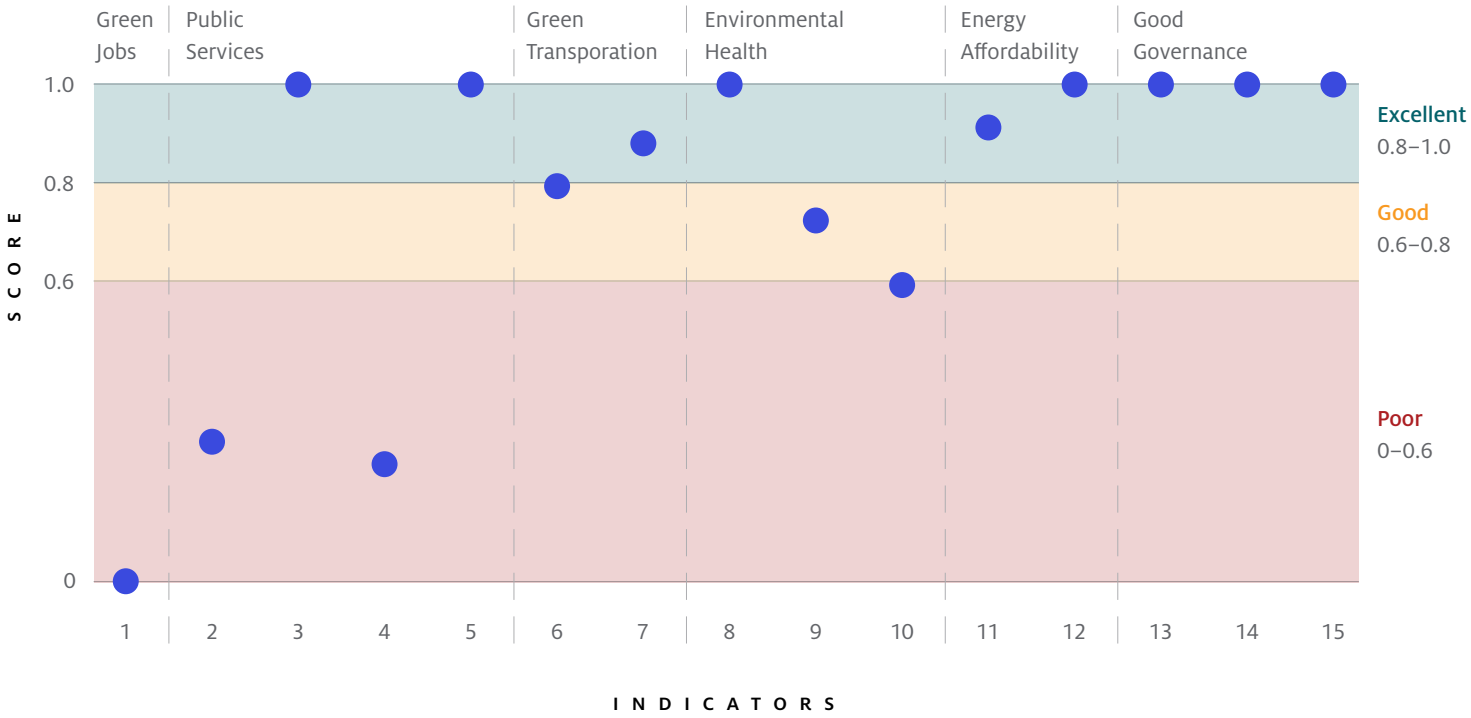


Figure 10. Score Distribution of Indicators in Guangzhou



1. Percentage of population with green jobs
2. Coverage ratio of built-up sponge city areas
3. Proportion of green building certificates in affordable housing
4. Percentage of energy-saving retrofitting in older residential communities
5. Proportion of domestic waste sorting practices
6. Proportion of public transportation use
7. Public service facilities in urban communities accessible within a 15-minute walk
8. Urban/park green areas per capita
9. Annual average concentration of PM 2.5
10. Coal consumption per capita
11. Percentage of energy expenditures by low-income households
12. Energy price elasticity coefficient
13. Public participation in the Dual Carbon planning process
14. Third-party evaluation mechanism for implementation of Dual Carbon goals
15. Dual Carbon information disclosure

The scores for each dimension of the three cities are combined to obtain the total score for each city, based on 100 points (see Table 6).

Table 6. SIA Total Scores for Pilot Cities

City	Changsha	Tianjin	Guangzhou
Score	58	54	71

3

Conclusion

Promoting social equity and inclusion in the achievement of carbon peaking and carbon neutrality planning goals can improve the effectiveness and sustainability of policies and projects, particularly in the four areas discussed below.

1. **Prevent the occurrence and worsening of social problems in the carbon peaking and carbon neutrality transition process** (high unemployment in many eliminated industries, rising living costs of poor and vulnerable groups, uneven development of urban and rural infrastructure, and others). Because a good policy vision may have unplanned negative effects (for example, construction of urban green infrastructure can improve urban quality while also pushing up housing prices), energy structure transition is not necessarily inclusive. For example, coal workers and the communities where they live are more directly affected by the transition process. And, as energy costs rise, the burden on the poor and small and micro enterprises is uneven. The energy costs of disadvantaged people are relatively large proportions of total household expenditures. A study by the International Energy Agency[25] found that women account for 39 percent of the global workforce but for only 26 percent of workers in the traditional energy sector—and this figure is even lower at the executive level. The issue of low employability and limited opportunity for decision-making roles that women face in the energy sector also exists in others.

2. Carbon neutrality transformation, as an intrinsic driver of high-quality economic and environmental development in society, can provide opportunities to promote the coordinated development of Dual Carbon and livelihoods. In the process of transformation, therefore, it is desirable **to promote the development of green industries and to focus on the populations most affected by climate change**, as well as industry populations directly affected by the green transformation, low-income populations, and others in green employment. Efforts should be made to advance opportunities to increase employment for women, promote long-term sustainable social development, and address social justice issues that may arise from transformation. Improving climate resilience infrastructure is also an increasingly important factor for economic development, especially for vulnerable populations.

3. **Ensure differentiated and targeted policies and measures, thereby addressing the risks from climate inequality and imbalanced socio-economic development.** In developed countries, energy consumption patterns are linked to gender roles, responsibilities, and identities. For example, a study on men's and women's energy consumption in Germany, Greece, Norway, and Sweden[26] found that the energy consumption of a single-member male household is generally higher than that of a single-member female household. Transportation accounts for the largest share of energy consumption, and men consume 70 percent to 80 percent more energy than women in Germany and Norway; the figure is 100 percent and 350 percent higher in Sweden and Greece, respectively. The main reasons for the difference are the size and frequency of the use of cars, driving habits, and other factors. The study suggested that European countries should focus on those differences and develop targeted policies to meet their climate and gender equity goals.

4. **Integrate the SIA principles, frameworks, and indicator system for just transition into the development, policy formulation, and implementation process for carbon neutrality to achieve Dual Carbon goals and improve livelihoods.** Overall planning should focus on equity and inclusion so as to consider socio-economic impact while reducing carbon emissions. Offer relevant stakeholders a channel for participation to ensure that adverse social impact is avoided or mitigated in policy design, formulation, and implementation, and to expand the positive social energy of inclusion.

The project team developed a social impact assessment tool that it used in this study. Its 15 indicators in six dimensions make it possible to conduct a rapid quantitative assessment of the current circumstances and planned social impacts of a city's carbon peaking and carbon neutrality development. Taking into account the interrelatedness of climate action, economic development, and social development from the carbon-to-economy-society dimension, the team provides recommendations for the carbon peaking and carbon neutrality planning paths. Accordingly, this study encourages local governments to address weaknesses in some indicators, develop policies, and promote prosperity, carbon reduction, equity, and inclusion in a high-quality manner.

In using the SIA tool to analyze the Changsha, Tianjin, and Guangzhou cases, the project team scored each of the 15 indicators based on the benchmarking analysis of publicly available data. The preliminary conclusion is that, for the dimensions of energy consumption, environmental health, and green travel, the scores of the three cities were relatively close—ranging from 0.6 to 1, or good to excellent. This indicates that the overall household energy consumption burden for each city is relatively reasonable and that environmental health and green travel have both improved greatly in recent years. In the field of public service, it is also necessary to accelerate the protection of green affordable apartments and energy-saving renovation of older buildings. Data collection and analysis for the three cities revealed a general lack of data for green jobs, indicating that, in Dual Carbon work, promoting green employment is a weakness that requires improvement.

In the next stage, in addition to expanding urban assessment and urban benchmarking, the tool's depth of application needs to be improved. Due to the lack of urban data, the rapid assessment tools that the project team developed have not yet been used for in-depth analysis of each indicator's technical standards. Specifically, the assessment of the three good governance indicators has not yet addressed the concept of quality—technical standards for and breadth of Dual Carbon information disclosure, procedures and diversity representation of public involvement, the scope of third-party assessment, and the closed-loop mechanism of rewards and punishments. Both the share of green buildings in affordable housing (Indicator 3) and the percentage of energy-saving retrofitting of older buildings (Indicator 4) need supporting technical standards, which require the award of green two-star or higher certification and meet the standard of 50 percent to 75 percent of the energy savings of the building design. In the future, the project team anticipates developing a regionally applicable SIA indicator system based on the country characteristics of India and countries in Southeast Asia, Europe, and the Americas to advance the progress of the global climate equity agenda.

Carbon peaking and carbon neutrality is a historical process of transformation and development of industrial and commercial civilization. It will involve two or three generations over a 40-year span. This process must focus on efficient prioritization (minimizing the cost to achieve the greatest reduction in carbon) and equality (emitters pay, inclusiveness). Efficient prioritization depends on industrial innovation and government guidance; equality considerations depend on social innovation and government leadership. The SIA was designed to support Dual Carbon planning and decision advocating climate equity, seeking the maximum common divisor of carbon, economy, and society.

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