

STUDY ON CHENGDU LOW CARBON DEVELOPMENT BLUEPRINT



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SUMMARY

Cities are major contributors to greenhouse gas emissions; more than 70% of global greenhouse gas emissions come from cities. Furthermore, because urban areas are densely populated, cities themselves are also vulnerable to the effects of climate change; extreme weather events can exact incalculable losses on cities. Therefore, from the perspective of addressing climate change, there is an urgent need to change the mode of urban development. Furthermore, cities have the potential to play an important and unique role in helping to mitigate climate change because they have access to capital, manpower, and technology. Low-carbon development can also help to solve many “urban ills” and create new development opportunities.

Today, many big cities around the world are pursuing low-carbon development. This has also become an important component of their soft power. In July 2010, China launched its low-carbon development pilot program covering five provinces and eight cities. In December 2012, the program was expanded to cover another 29 cities and provinces including Beijing, Shanghai, Hainan, Qingdao etc. At the international level, there are many multi-national cooperation projects that are concerned with low-carbon and sustainable development of cities. With the support of the Caterpillar Foundation, the World Resources Institute has launched the Sustainable and Livable Cities Initiative, which has selected four sites in China, India, and Brazil to explore ways of building environmentally-sustainable and livable cities. In China, where Chengdu and Qingdao have been selected as the pilot cities, this project has been strongly supported by the National Development and Reform Commission’s Department of Climate Change. This five-year initiative is split into three phases: During the first phase, it will create low-carbon blueprints for environmentally-sustainable and livable cities for the pilot sites; in the second phase, it will progress to demonstration projects, moving from blueprints to action; and in the final phase, it will promote the successful experiences of the initiative to other cities.

As the “first important stage” of the Sustainable and Livable Cities Initiative, the Chengdu low-carbon development blueprint aimed to explore energy consumption and carbon emissions pathways along a variety of different development paths up until 2030 to provide advice and scientific support to policymakers on drawing up mid- to long-term development plans for the city.

RESEARCH & METHODOLOGY

This study focused on energy-related carbon dioxide emissions from the production and consumption sectors within the administrative boundaries of Chengdu. It largely focused on the energy demand and corresponding carbon dioxide emissions caused by the industrial sector¹, buildings sector, and transport sector with variable activities and energy efficiencies.

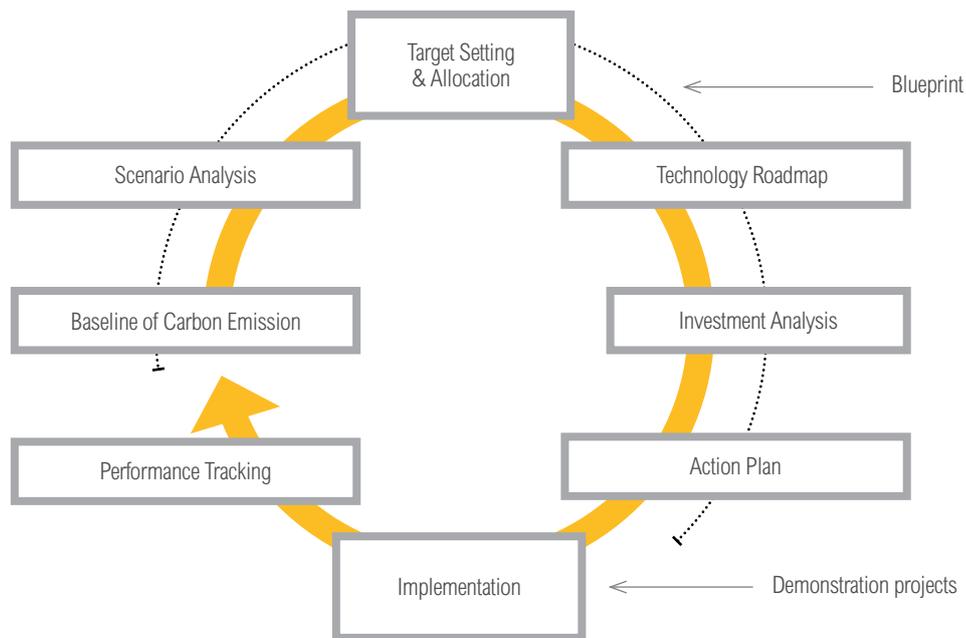
This study started with an analysis of the status quo in Chengdu, including how the city's macroeconomy, industrial structure, energy consumption and carbon emissions changed over the years. It defined the stages of the city's past and future development, and identified the key factors impacting carbon emissions.

Using an analysis of current conditions, in combination with Chengdu's near- and medium-term strategy plans, and consulting researches on China's mid- and long-term development by mainstream research institutions, we drew up a preliminary assessment on the city's socio-economic development between 2010 and 2030. Employing a combination of forecast and backcast methodologies, we designed three scenarios and

explored how Chengdu's socio-economic structure, technological development, and consumption patterns would change in the future. Of these three scenarios, the Baseline Scenario and Policy Scenario employed forecast methodology. The Blueprint Scenario applied backcast methodology, exploring which development paths for different sectors and industries would allow Chengdu to reach peak carbon emissions as soon as possible before 2030.

We built a combined top-down and bottom-up model to evaluate the scenarios. Starting with socio-economic development goals, we identified key factors, such as GDP growth, industrial structure, population, urbanization rate, and the availability of energy resources and quantified these key parameters. We then estimated the energy demand and CO₂ emissions from different sectors/industries, carried out a comparative analysis among these scenarios and evaluated the emissions reduction potential. We explored the path able to achieve the Blueprint Scenario by analysis of the macroeconomy, industry, consumption etc. Based on these results we developed policy recommendations for drawing up action plans.

Figure 1 | **Blueprint preparation and implementation process**



¹ Including both the industrial and the construction sectors.

Figure 2 | GDP and 3 Sectors Growth

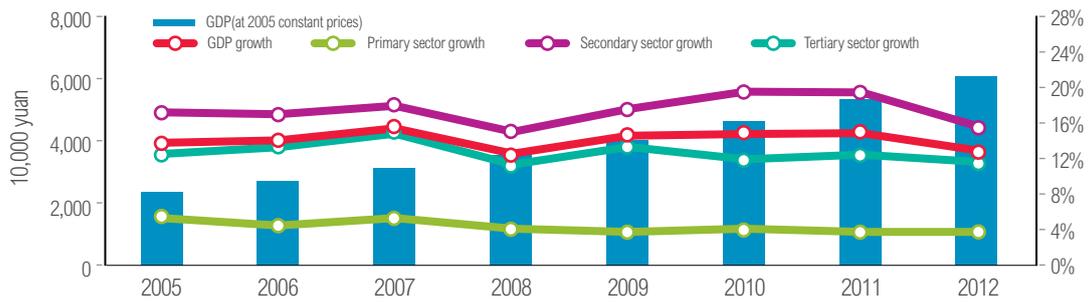
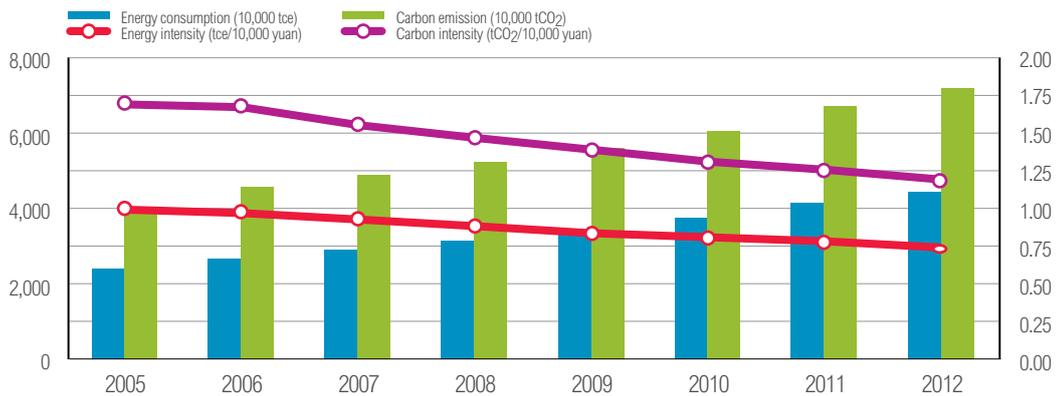


Figure 3 | Energy Consumption and Carbon Emission



CHENGDU'S ECONOMY, ENERGY CONSUMPTION AND CARBON EMISSIONS

Chengdu has sustained rapid economic growth for the past few years. Between 2005 and 2012, the city's GDP grew by an annual average of 14.3%, about 3 percentage points higher than the national average. In 2012, Chengdu's GDP reached 605.9 billion yuan (at 2005 constant prices), 2.55 times the value of its economy in 2005. It ranked top of all the prefecture-level cities in Sichuan province, and second only to Chongqing among the 11 cities in China's Mid-West. However, growth slipped from 2012. (see Figure 2)

Secondary sector growth has been higher than growth in the other two sectors, being 2.4 to 4.8 percentage points higher than overall GDP growth; while growth of the tertiary sector has been slightly lower than overall GDP growth. As a result, the secondary sector has gradually been taking an increasingly bigger share. Its share has risen from 41.4% in 2005 to 46.6% by 2012, whilst the tertiary sector's share has slipped from 51.1% to 49.2% during the same period.

Rapid economic growth, especially fast industrial growth, requires huge amounts of energy. Between 2005 and 2012, **Chengdu's total energy consumption rose from 23.997 million tons of standard coal equivalent to 44.423 million tons of standard coal equivalent. Per capita energy consumption rose from 1.96**

tons of standard coal equivalent to 3.13 tons of standard coal equivalent, while the national level in 2012 was 2.67 tons of standard coal equivalent.

During the same period, the annual growth of energy consumption averaged 9.2%, much lower than GDP growth (14.3%). As a result, energy consumption per 10,000 yuan (GDP calculated at 2005 constant prices) fell from 1.01 tons of standard coal equivalent/10,000 yuan to 0.733 tons of standard coal equivalent /10,000 yuan, a drop of 27.4%. Over the period of the 11th Five-Year Plan energy intensity fell 20.2%.

The growth of carbon emissions followed a similar pattern to the growth in energy consumption over the same period. **CO₂ emissions rose from 40.283 million tons in 2005 to 71.67 million tons in 2012; meanwhile, emissions per capita rose from 3.3 tons of CO₂ to 5.06 tons of CO₂.** In 2011, emission per capita in Chengdu was 4.75 tons of CO₂, while the national average was 5.9 tons of CO₂.

Between 2005 and 2012, emissions per unit of GDP fell from 1.7 tons of CO₂/10,000 yuan to 1.18 tons of CO₂/10,000 yuan, a decline of 30%, and 23.3% during the period of the 11th Five-Year Plan. (see Figure 3)

SCENARIO ANALYSIS

This study uses scenario analysis to simulate Chengdu's energy demand and carbon emissions until 2030. The Baseline Scenario (S1) is based on existing policies on energy conservation and emissions reduction; the Policy Scenario (S2) assumes a variety of different measures are taken to reduce CO₂ emissions to tackle climate change; and the Blueprint Scenario (S3) is based on the assumption that the main goal is to peak carbon emissions as soon as possible and thus Chengdu's emissions reduction potential is exploited to the full.

From our analysis we can see that energy demand will rise under all three scenarios. **In 2030, energy demand in S1 will be 2 times higher than that in 2010; in S2, it will be 1.5 times higher, and in S3, it will be 0.9 times higher.** This rise in energy demand will drive up CO₂ emissions in both S1 and S2; in 2030, carbon emissions in S1 will be 1.9 times higher than in 2010, while they will be 1.3 times higher in S2. **Carbon emissions in S3 will enter a plateau stage from 2025 to 2030, stabilizing at about 100 million tons, 0.7 times higher than in 2010.**(see Figure 4)

Energy intensity and carbon intensity will both decline. **In 2015, in S1, energy intensity will fall 12.8% from 2010 levels; in S2, it will fall 16.9%; and in S3, it will fall 20.4%. Thus,** the 12th Five-Year Plan's

target to reduce energy intensity by 16% is achievable under S2. By 2030, under S1, carbon intensity will fall 37.9% from 2010 levels; in S2, it will fall 49.3%; and in S3, 61.4%. **By 2020, carbon intensity in S1 will fall 41.2% from 2005 levels; in S2, it will fall 47.3%; and in S3, 53.3%.** This means that S1 and S2 can be respectively used to realize national upper and lower limits on carbon intensity (40-45% drop by 2020 from 2005 levels). S3 has the biggest potential to help Chengdu achieve low-carbon development — under this scenario, the drop in Chengdu's carbon intensity from 2005 to 2020 will be 8 percentage points above the upper limit of the national target. By 2030, carbon intensity under S1 will fall 39.7% below the level of 2010; 51.8% in S2; and 64.8% in S3. (see Figure 5)

Energy consumption per capita will continue to rise in both S1 and S2. By 2030, it will have risen to 6.3 tons of standard coal equivalent in S1, and 5.1 tons of standard coal equivalent in S2. Under S3, after energy consumption per capita has risen to 4 tons of standard coal equivalent by 2025, it will start to drop. By 2030, it will have decreased to 3.9 tons of standard coal equivalent. Carbon emission per capita will rise to 9.8 tons of CO₂ by 2030 under S1 and 7.9 tons of CO₂ in S2. Under S3, after it has reached 6.1 tons of CO₂ in 2025, carbon emission per capita will begin to drop until by 2030 it will have fallen to 5.8 tons of CO₂. (see Figure 6)



Figure 4 | Comparison of Energy Demand and Carbon Emission

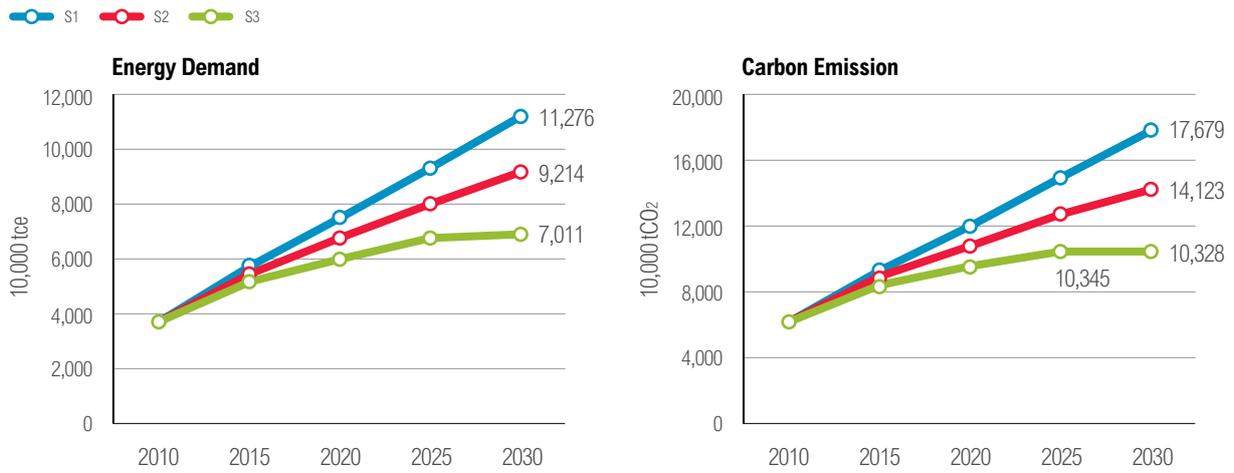


Figure 5 | Comparison of Energy and Carbon intensity

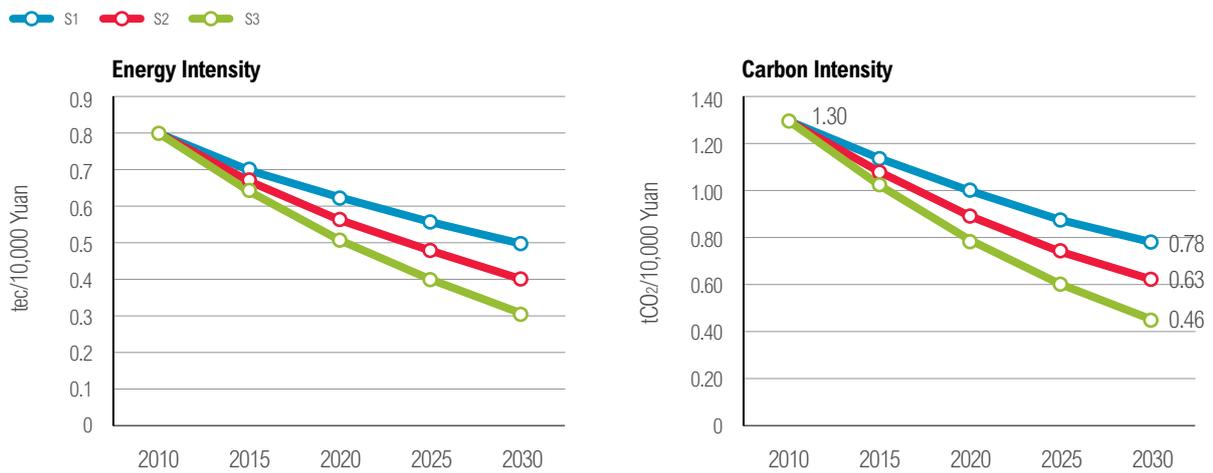
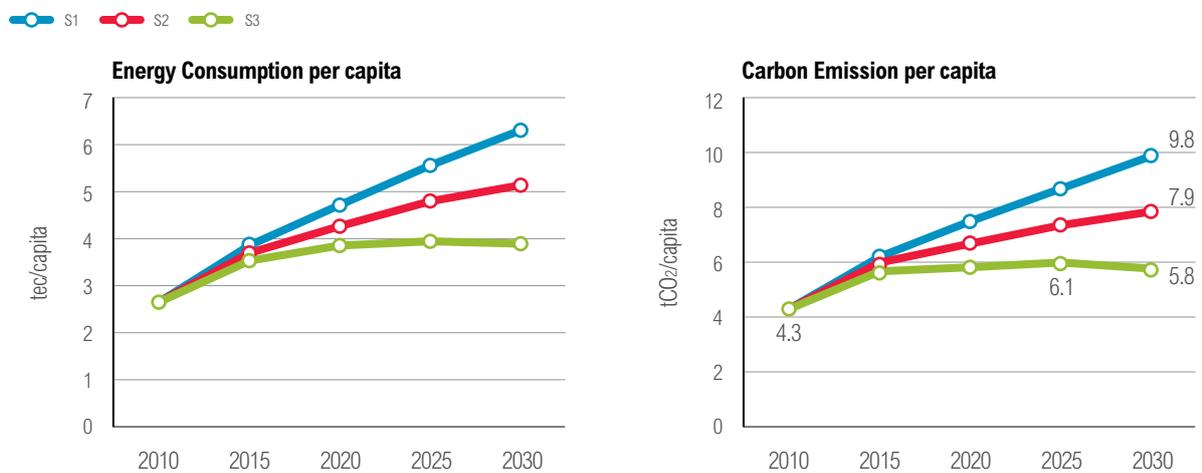


Figure 6 | Comparison of Energy Consumption and Carbon Emission per capita



BLUEPRINT ROADMAP, CONCLUSIONS AND RECOMMENDATIONS

Currently, Chengdu's strategic objective is to be a "core growth pole" in western China. In early 2012, Chengdu was identified as a strategic site for the country's opening economy. These goals will provide many opportunities for Chengdu's move towards a low-carbon economy. Achieving its low-carbon development goals will ultimately provide a big impetus for realizing its strategic objectives.

Chengdu will be able to follow the low-carbon blueprint by adopting a series of measures impacting on macroeconomy, industry, and consumption behavior. Key measures include:

1. Set sensible economic growth targets.

Economic growth based on large consumption of resources and energy is not sustainable. Chengdu should take the opportunity of low carbon development and change the pattern of economic growth, ensuring balanced and healthy growth within the restraint of environment and resources.

(1) Based on the sensitive analysis of energy demand and carbon emissions under different GDP growth rate assumptions, we propose the following GDP growth rates: 11.9% between 2011 and 2015; 8% between 2016 and 2020; 7% between 2021 and 2025; and 6% between 2026 and 2030.

(2) If the annual average GDP growth rate between 2016 and 2030 was one percentage point higher than the proposed one, then energy demand in 2030 would rise 7.1% under S1, 6.8% under S2, and 6.1% under S3; while carbon emissions in 2030 would rise over the same period: 7.1% for S1, 6.6% for S2 and 5.6% for S3, and it would be impossible for carbon emissions to peak before 2030.

2. Make further optimization to industrial structure and layout

(1) There are three ways that the industrial structure could be improved.

- The first is improving the economic mix by expanding the tertiary sector's share. Chengdu should fully take advantage of its diverse tourism resources and its flourishing catering industry to create more development paths for the modern service industry; and to prioritize the development of the pillar industries such as tourism, commerce

and business exhibitions. By 2030, the tertiary sector should make up at least 65% of the economy.

- The second is improving the secondary sector structure by changing the mix of its component industries. Improvements include: prioritize the development of less energy-intensive industries, such as electronics and IT, food processing, beverage and tobacco manufacturing, and the pharmaceutical industries; enforce strict controls on the production capacities and outputs of energy-intensive industries; discard all plans to expand the petrochemical, metallurgy and building materials industries; implement tougher policies on the phasing out of backward capacities and shut down excess capacity. For instance, annual cement output is expected to reach the ceiling of about 15.5 million tons by 2015 and start to decline before 2020, so that it is less than 12 million tons in 2030.

- The third is improving key industries by adjusting their product mix. For some traditional industries, product upgrade is an important measure to reduce energy intensity and carbon intensity. They should develop a brand economy as well as upgrade the industrial chain, and gradually build a production and export pattern with higher value-added, higher return, lower energy intensity and lower emission intensity.

(2) With the national strategy of industrial allocation and regional cooperation taken into account, industrial parks of intensive pattern should be planned and built in order to optimize the spatial allocation of industry. Optimized spatial allocation can not only accommodate more people and industries, but is also conducive to increase linkages between industries and improve resource utilization by avoiding redundant construction.

(3) Apart from that, technology upgrade should be promoted. On the one hand, existing energy saving and emission reduction technologies should be spread widely. On the other hand, research and innovation of new technologies should be encouraged.

3. Control carbon emissions from the transport sector, starting from rational urban planning

Chengdu should take measures to curb the rapid

increase of transport related energy consumption and carbon emissions from three aspects as below:

(1) From the aspect of urban planning:

- The development of low carbon transport can be promoted through measures like the integration of regional spatial planning and transport, urban density control, TOD and joint development. Individual transport patterns are largely affected by urban planning. An efficient land use mix can shorten traveled distances, and for short distances citizens are more likely to choose non-motorized traffic. If Chengdu emphasizes green transport in urban planning during the current phase of rapid development, it can avoid long term lock-in in a carbon-intensive pattern of urban transport.

(2) From the aspect of travel modes within the city:

- Attention should be paid to the improvement of the public transport system, particularly high-capacity, low-emissions public transport such as the subway system. For example, Chengdu should promote the construction of the city's railway network, improve and expand the regular bus system, encourage people to use the BRT (Bus Rapid Transport) system and increase the number of bus lanes and bus stations. Also, improvements should be made to the non-motorized traffic system in the downtown area and to urban greenways. The construction of the public bike system should be promoted, by expanding the covered area and increasing the total number of bikes. Under the Blueprint Scenario, compared to 2010, the level of service (LoS) of the subway should maintain an annual increase of 30%; while the LoS of buses should grow by nearly 5.8 times.
- Educate the public about energy saving, encourage them to choose public transport. Study the policy effects of a road congestion tariff and regionally differentiated parking fees that discourage people from driving their own cars. Integrate transport information resources, build a unified information platform for the public transport service, and promote green low-carbon travel.

(3) From the aspect of transport technology:

- Promote the application of CNG in buses and taxis, as well as LNG in buses. Also, promote the application of electric and hybrid cars as taxis

and private cars, and encourage the public to buy new energy vehicles. Optimize the energy structure of the transport system and increase the share of clean energy, such as electricity and natural gas. Under the Blueprint Scenario, in the year of 2030, the electricity penetration of total energy consumed by these two kinds of cars will reach 9% and 10% respectively. The penetration of natural gas shows obvious uptrends in both inter-city passenger transport and buses, reaching more than 90% respectively.

- Adopt advanced technology to improve energy efficiency in the transport sector. Promote the application of fuel-efficient vehicles, develop drop-and-hook transport, new-type energy-efficient buses and taxis, and gradually carry out low-cost reform on airplanes. Compared to 2010, under the Blueprint Scenario, the energy consumption per unit freight ton-kilometer or passenger kilometer of all vehicles will decrease by 26% to 44%.
- Build a smart transport system. Collect real-time information about road condition and vehicle management to improve travel efficiency.

4. Control carbon emissions from the building sector by controlling the population size and encouraging low-carbon consumption behavior of citizens

Chengdu should adopt measures to control energy consumptions and carbon emissions from the buildings sector as below:

(1) Control the size of population to reduce the demand of building space. Chengdu's residential population should be kept below 18 million by 2030 through measures like enhancing the leading role of Chengdu as a western growth pole, narrowing the economic gap between Chengdu and surrounding areas, and thus reducing the immigration from areas around. If population is allowed to grow unchecked and reaches 20 million by 2030, then even under the Blueprint Scenario, just the energy demand from buildings will be 25.6 million tce.

(2) Control the growth of per-capita floor space by strengthening citizen's consciousness of energy saving. With rational economic regulations to control building spaces, under the Blueprint Scenario, per-capita floor space should be kept

below 35.1 m², of which urban per-capita floor space should be kept below 31 m², and rural below 49.5 m². Compared to current levels of 30m², 21m² and 49m² respectively, the Blueprint Scenario allows urban per-capita floor space increases properly with the development of urbanization and the increase of individual incomes, but strictly controls rural per-capita floor space.

(3) Improve buildings' energy efficiency to restrain the growth of buildings' energy consumption per unit of floor space. Measures include implementing renovation for energy saving of existing buildings and strict energy saving supervision to new buildings, promoting green buildings and increasing the popularity of energy-efficient appliances. Under the Blueprint Scenario, by around 2020, the energy consumption per unit floor space of all types of buildings should start to fall. The increase of energy consumption intensity of large-scale public buildings should be restricted to around 9% from 2010 levels; for urban residential buildings, it should not rise above 6%, while rural residential and small- to medium-sized public buildings should even show a slight negative growth.

(4) Establish scientifically a series of feasible sectoral regulations, set specific carbon emission indices and energy saving targets, and track energy saving performance. Set a baseline and standard for carbon emission calculation in the buildings sector, and establish real-time monitoring for large-scale public buildings, laying the data foundation for carbon emission control.

5. In face of continuing growth of energy demand, the only way to get carbon emissions to peak early is to improve the energy mix.

Our scenario analysis showed that whatever Chengdu's future development path might be, energy demand growth is inevitable under the assumed economic growth target. Even in S3, energy demand almost doubles between 2010 and 2030; and carbon emission only peak in 2025. In S3, the only way to attain this peak is to improve Chengdu's energy mix to lower the carbon intensity per unit of energy consumption.

(1) Chengdu's main non-fossil fuel source of energy is hydropower, which includes both local and imported hydropower. There is no plan in near future to increase local hydropower. Additionally, as a result of geographical and

climatic restrictions there is little potential for the large-scale exploitation of renewable energies such as wind power and solar power: Chengdu only has an annual average ground wind speed of 1.2m/s and 780 annual sunshine hours on average. In the future, Chengdu is very likely to rely more heavily on imported electricity in order to increase non-fossil fuels' share in the energy mix. However, hydropower is quite vulnerable to seasonal factors and other natural changes, which introduces uncertainty to the effort of increasing the share of non-fossil fuels.

(2) Chengdu is relatively rich in biomass resources. Annual utilization of straw and forestry waste reaches 3 million tons, which can replace 2.3 million tons of coal. In addition, a large number of kitchen disposals were produced due to the prosperity of catering industry. Therefore the development and utilization of biomass should be focused.

(3) Since Sichuan is highly rich in natural gas and shale gas. Chengdu should take advantage of this to further decrease the share of coal consumption, which has already fallen to below 20%. Under S3, Chengdu has the potential to peak its coal consumption in 2015, and coal will only be used for electricity generation after 2025. The main coal-fired facilities in Chengdu are the two units of Jintang Power Plant with a capacity of 600MW each; no further expansion is expected in the future. With a coal consumption of 320 gce/kWh and an annual average 5,500 hours of operation, annual coal demand can be cut by 2.1 million tons of standard coal if these two units are converted to natural gas. It would also reduce carbon emissions by 2.4 million tons.

(4) As China has released a series of policies to promote the application of distributed power generation, Chengdu is suggested to take advantage of these policies to launch such kind of pilot projects and then gradually scale up.

6. Low-carbon development requires an energy consumption and carbon emission statistic and a management system to provide technical support.

Establishing a greenhouse gas emission statistic and management system is an important and fundamental task. It has great significance on creating a GHG emission inventory, setting of emission reduction targets, designing low carbon action plans and establishing emission trading.

(1) This study recommends that Chengdu starts by improving the energy management of major energy consumers, implementing energy management projects, focusing on encouraging the establishment of energy management control centers, and improving the dynamic monitoring of energy use. Following this, Chengdu is expected to build up an energy management system for industrial enterprises and widen its function to carbon emissions management.

(2) Afterwards, Chengdu should gradually incorporate more entities into the system, for example from the industrial sector, the buildings sector, and the transport sector, as well as waste management facilities. Eventually, Chengdu should set up a city-level energy and carbon emission management system.

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AUTHOR

Hongpeng Lei Energy Program Lead, Senior Associate,
Email: hlei@wri.org, Tel: +86 10 6416 5697 ext 22

Ziwei Mao Research Analyst, Energy Program,
Email: zwmao@wri.org, Tel: +86 10 6416 5697 ext 25

Min Yuan Research Analyst, Energy Program,
Email: min.yuan@wri.org, Tel: +86 10 6416 5697 ext 63

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CHINA OFFICE
RM K-M, 7/F, TOWER A, THE EAST GATE PLAZA, DONGCHENG
DISTRICT, BEIJING, CHINA 100027
PHONE: +86 10 6416 5697
FAX: +86 10 6416 7567
WWW.WRI.ORG.CN WWW.WRI.ORG