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# Strategic Analysis and Suggestions to Attain Low-Carbon Development Targets in 2020

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# Strategic Analysis and Suggestions to Attain Low-Carbon Development Targets in 2020

## Abstract

As the world's second-largest economy and the largest developing country, Chinese government has attached great importance to low-carbon development, formulating a series of policies to accelerate the adjustment of industrial structure, optimize energy mix, improve energy efficiency, control emissions that are caused by non-energy activities, increase carbon sinks and carry out low-carbon development pilot demonstration. Therefore, China has seen remarkable success on energy conservation and carbon reduction, concrete results in industrial structure adjustment, progresses in energy structure adjustment, substantial increase of forest carbon sinks and steady progress in low-carbon pilot demonstration. Since "the 11th Five-Year Plan" period (2006-2010), China has seen remarkable effect of energy conservation and carbon reduction. During "the 11th Five-Year Plan" period, China's energy conservation target is decreasing the energy consumption per unit of GDP by 20% and the actual decrease 19.1%. During "the 12th Five-Year Plan" period (2011-2015), this target is obtaining a 16% decrease in the energy consumption per unit of GDP. By the end of 2014, the accumulative decreasing amplitude reached 13%. From 2006 to 2014, China's average annual growth rate of energy consumption was 6.43%, enabling the average annual growth rate of national economy to be 9.89%. The energy consumption elastic coefficient had dropped from 0.76 in 2005 to 0.30 in 2014. Furthermore, the GDP carbon emissions intensity also dropped remarkably. By the end of 2014, the carbon emissions per unit of GDP has accumulatively dropped 33.8% from the 2005 level, thus satisfying the 2020 low-carbon development target and the carbon reduction target during "the 12th Five-Year" period in advance. At the same time, favorable conditions are accumulating for China to step up to implement low-carbon development strategy, with low-carbon development becoming a priority in China's development strategy under "new normal", strong economic power laying solid material foundations for low-carbon development, large space in reducing carbon emissions through structural adjustment, tremendous potentials in market demand of low-carbon industry development, growing low-carbon development technology and talent support ability and market mechanism reform providing impetus for low-carbon development and so on.

During "the 13th Five-Year Plan" period, China's economic growth rate is expected to maintain at about 7%. The development of industrialization and urbanization enters a new phase, featured by the fast development of high-tech industries, represented by high-speed railway and aerospace, and internet-based new industries, operation types and business modes. Meanwhile, service industry becomes

the leading industry. Against this background, taking the general requirements of combating climate change and low-carbon development into consideration, China has put forward the primary targets of low-carbon development for the 2020, including the comprehensive completion of the control of greenhouse gas emission and the significant achievement in capacity building. Compared with the 2005 level, China's carbon emission per unit of GDP will decrease by 40% to 50% and more, if possible. The share of non-fossil energy in primary energy consumption reaches about 15%. China also strives to make the carbon emission of economically-developed eastern areas and key monitoring industries to peak first. Industrial structure and energy mix has been further optimized and significant results have been gained in energy conservation and carbon emission reduction of those key fields such as industry, construction, transportation and public institutions. Greenhouse gas emission produced by non-energy activities during production has been effectively controlled and the growth rate of greenhouse gas emission is declining. To that end, China should accelerate industrial restructuring and strive to make the share of added value of strategic emerging industries in GDP reach 15% by 2020. China also should accelerate the reduction of carbon emission during energy consumption in order to strive to make the share of non-fossil energy consumption in primary energy consumption reach 15%, natural gas consumption over 10% and coal consumption within 62% by 2020.

On the basis of that, during "the 11th Five-Year Plan" period, Chinese government decomposed the energy conservation targets primarily with local voluntary commitments and negotiation between central government and local governments. During"the 12th Five-Year Plan" period, central government posed further requirements for controlling the greenhouse gas emission and paid more attention to its scientific nature and the principles of equity and efficiency. However, the decomposition methods adopted during these two periods had their problems: firstly, there exist limitations for intensity control target; secondly, the target choices should be more scientific and rational; thirdly, the data foundation should be further consolidated; fourthly, importance should be attached to negotiation between the central and the local governments and bringing into full play the initiatives of local authorities. Based on the experience of "the 11th Five-Year Plan" period and "the 12th Five-Year Plan" period as well as the judgement of the conditions faced by "the 13th Five-Year Plan" period, Chinese government gives suggestions for the decomposition mechanism of carbon emission control target in "the 13th Five-Year Plan", the implementation of the "double control" in both intensity and total carbon emissions, so as to reaching the goal of reducing carbon emission intensity by 40%-45% in 2020 compared with the 2005 level.

**In terms of the regional decomposition methods of carbon intensity control target in "the 13th Five-Year Plan"**, the evaluation target system established in the decomposition mechanism of energy conservation target in "the 13th Five-Year Plan" pays more attention to representing core elements affecting China's carbon emission,

including per capita fossil energy consumption, per capita carbon emissions, the proportion of the tertiary industry and carbon dioxide emission per unit of GDP. On the one hand, on account of the recent consumption amount of carbon dioxide and fossil energy in all regions, the "responsibility" can be reflected by targets such as per capita carbon dioxide emissions, per capita fossil energy consumption, and the proportion of GDP; on account of resource endowment, development expectations and regional development policies of all regions, "rights" can be reflected by targets such as per capita energy production, expected speed for regional economic development and China's strategic guiding for regional development; on account of economic level, structural condition and efficiency level of emissions, "ability" can be reflected by targets such as per capita GDP, the proportion of the tertiary industry and carbon dioxide emissions per unit of GDP. Among them, per capita fossil energy consumption, per capita carbon dioxide emissions, proportion of GDP, per capita GDP and the proportion of the tertiary industry are positive indexes, which means that the bigger the value, the higher the requirements for control. Per capita energy production, strategic guiding for regional development, speed of regional economic development and carbon emissions per unit of GDP are negative indexes, which means that the smaller the value, the lower the requirements for control. On the other hand, following the above decomposition method of carbon intensity, based on the data of all regions and municipalities in 2010, this research decomposes the regional decline targets of carbon intensity in "the 12th Five-Year Plan" and compares them with the official decomposition scheme of China's government. The results indicate that due to the emphasis of different factors, despite the slight changes in the ranking of the comprehensive evaluation results amongst different regions, there are no subversive results except for minor exceptions. Economically developed regions, including Shanghai, Beijing, Jiangsu province, Tianjin, Guangdong province, Zhejiang province, Shandong province, always rank fairly high in the list; economically regions with low emissions, including Yunnan province, Guangxi province, Hainan province, Guizhou province, Xinjiang province, Gansu province and so on, often rank low.

Apparently, when a single factor is attached prominent importance in certain regions, it results in a significant change in the ranking, which means the way how certain features of the regions are treated has a direct bearing on the final results. For instance, when responsibility is emphasized, Shanxi province ranks amongst the first half, but in terms of the other two conditions, it respectively ranks the ninth and the fourth from the bottom; when responsibility and ability are emphasized, Inner Mongolia ranks ninth and 12th respectively, but in terms of rights, it only ranks the fourth from the bottom. The scores of comprehensive evaluation and cluster analysis show that the method of establishing target system from down-top could enable the clear classification of different regions into several categories. This research proposes to adopt differentiated treatment to establish individuated decline target ranges of carbon intensity for regions in different categories, also without significant differences for regions in the same category.

**In terms of the regional decomposition of carbon emission cap control target**, regional decomposition of carbon emission cap refers to the process of distributing cap target to different regions, under the premise that carbon emission cap control target is known. Specific targets of different carbon emission are undertaken by different regions, making sure that the total of regional specific targets equals the general target, thereby realizing a nationwide carbon emission control shared by various regions. The aim of regional decomposition of total carbon emission is to successfully distribute carbon emission cap target to different regions by a certain methodology, thus initiating their enthusiasm to achieve total control target. Different from the analytical calculation in complex models, the present decomposition method makes use of the "additive formula" to calculate the carbon emission amount of each province, with the indicator system being mainly established around "equity" and "efficiency". In order for the conciseness and easy operation of the decomposition method, this research finally identifies four indicators – population, GDP per capita, carbon productivity and national strategies. Meanwhile, the system provides the theoretical decomposition methods for the nationwide carbon emission cap target and combines the basic top-down mentality and the bottom-up process of defining specific parameter and calculating methods. To verify the practicability of the decomposition methods and compare the influences of different parameter values or the calculating formula on the decomposition results, taking 2010 as the reference year and 2012 as the target year, this research simulates and decomposes the carbon emission in 2012 and compares the targets and the actual amount in each province (municipality), hence providing support for the actual decomposition process in the future. The regional decomposition method of carbon emissions cap combines the basic top-down mentality and the bottom-up process of defining specific parameter and calculating methods. This method also takes into account local practical situations to implement equitable decomposition as well as the national policy orientation, that is, to produce demands for bigger development profits within the limited space for carbon emissions. It also takes into consideration the effects of national strategies on local carbon emission, which is also national characteristic.

On top of that, this method decomposes in compliance with the idea of "summation" and features a simple and clear decomposition process and a low demand for data, thus making it particularly applicable despite the relative lack of details and accuracy in China. The results of simulated decomposition also indicate that when disintegrating "increment target" or "increment target plus partial storage" using this method, there are relatively few differences between decomposition results and actual emission in all regions, showing that the relatively high operability of this method makes it suitable for the discussion of actual decomposition process.

After analyzing the decomposition methods of implementing of "double control" in both intensity and carbon emission cap, suggestions for decomposition mechanism of carbon emission control target in "the 13th Five-Year Plan" are put forward. The suggestions include the following aspects: (1) at the national level: intensity control

remains dominant with aggregate control being auxiliary; that is, to guarantee the achievement of national intensity control target, while aggregate control target is only the guiding target; (2) at the regional level: some regions are selected (for instance, in terms of the standard of per capita GDP) to give priority to aggregate control and combine intensity control to check the control targets of carbon emissions; other regions put intensity control first and their intensity targets will be checked by national government.

During "the 13th Five-Year Plan" preiod, in order to satisfy the goal of reducing carbon emissions intensity by 40%-45%, Chinese government should takes measures in the following aspects:

**Firstly, to improve the legal, standard and planning system for low-carbon development. Firstly, to enhance the legislation on low-carbon development and relevant laws and regulations. Firstly,** *The Law of People's Republic of China on Climate Change* shall be formulated and issued as quickly as possible to explicit and consolidate the strategic position of low-carbon development. **Secondly,** to establish medium and long-term planning and indicator system guided by low-carbon development for the whole society. The planning for low-carbon development should be further strengthened by putting the low-carbon development as an important pathway to transform development mode and embodying it into the planning system for national economy and social development. The concept of "Low-carbon development", together with the concept of "resource conservation" and "friendly environment", should be considered as the strategic concept and goals at the national level.**Thirdly,** to establish the standard system covering whole all sectors, areas and processes. Great efforts should be made to improve the evaluation standard and mechanism for the carbon emission from source-type projects, and formulate strict admittance standard on energy consumption and carbon emission.

**Secondly, to improve responsibility decomposition and statistics and evaluation system on carbon emission. Firstly,** to establish top-down compulsory target responsibility and decomposition system on carbon emission. Based on the full evaluation of achievement and potential for carbon emission control in various provinces and cities and sectors and areas, the carbon emission intensity reduction target and the total emission control target should be formulated and implemented, and the scheme for target decomposition by region and sector should be designed in a scientific and reasonable way. **Secondly**, to establish the permit system for the total carbon emission. According to the requirement of total control on carbon emission, we should implement the permit system for greenhouse gas emissions in key sectors and key regions, establish the permit threshold on carbon emission for energy-intensive and carbon-intensive industries such as power, steel and cement industries to control and restrain the greenhouse gas emissions from enterprises.**Thirdly,** to establish the basic statistics, accounting and reporting systems for carbon emission. Efforts should be made to further improve the existing method of

energy statistics, survey and accounting, as well as enlarge and detail the energy statistics and classification.

**Thirdly, to reinforce the coordination between carbon emission control and environmental protection policies. Firstly,** to formulate the joint-action mechanism on environmental protection and energy conservation and low carbon. The coordination and cooperation among departments under national leading groups on climate change should be enhanced. The department coordination mechanism should be established to improve the work on energy conservation, climate change and environmental protection and realize the overall coordination and docking in formulating programmer, action plan, standard and targets. **Secondly,** to formulate the collaborative promotion policies on energy conservation, low carbon and environmental protection. The policy design on collaborative control of pollutants and greenhouse gas should be enhanced. In the area of environmental protection, we should strengthen the collaborative management and control on the greenhouse gas emission and collaborative application of management approaches on greenhouse gas emission reduction on the basis of existing emission reduction policies. In the area of addressing climate change, we should give priority to the policies and measures with co-benefit of pollutant control, and implement the collaborative policies and incentive mechanisms integrating energy efficiency improvement and carbon emission and pollutant reduction.

**Fourthly, to improve the finance and taxation policies for low-carbon development. Firstly,** to improve the financial, financing and incentive policies for low-carbon development. The investment increment and government rewarding schemes for low carbon development should be enhanced. The special funds on low-carbon development should be established and the low-carbon technology innovation and industrialization and application in key fields should be given more importance. **Secondly,** to improve the pricing and taxation policy related to low-carbon development. Further efforts should be made to improve relevant energy price policies and gradually realize the market-oriented pricing for the competitive energy field. **Thirdly,** to strengthen the application of PPP scheme in the low-carbon development field. The use of PPP mode should be encouraged to attract social capital into the investment on low-carbon infrastructure construction that guided by governmental funds. Greater efforts should be made to complete the relevant laws and regulations related to PPP to guarantee the benefits of all sides involving the project development and promote the contribution of PPP on low-carbon development. The risk-prevention mechanism for the social capital investment should enhanced through the innovative mode of combining operation and cooperative development.

**Fifthly, to strengthen the construction of national carbon emission trading system. Firstly,** to conduct deeper studies on the national top-level designing of carbon emission trading scheme. It should be enhanced to study the policy design regarding carbon emission reporting and verification, quota assignment and allocation,

crediting mechanism, market adjustment and regulation, and the management of trading institution.**Secondly,** to establish the national-level carbon emission trading market. Based on the carbon emission trading pilots in seven provinces and cities, more efforts should be given to build up the national-level carbon emission trading market, including the establishment of national-scale carbon emission trading platform, carbon emission trading and supervision mechanism, unified registration system and third-party verification system. **Thirdly,** to gradually expand the carbon emission trading scheme from industry to building and public transportation sector. Considering the inherent law and trend of urbanization in China, both production and consumption side should be involved into the general design of the carbon emission trading mechanism. **Fourthly,** to gradually expand the carbon emission trading scheme from carbon emission sources to sink. It should be given more importance to use market-based force to solve the issue of carbon emission control and ecology and environment protection comprehensively, by coordinating the carbon emission trading scheme with the ecology compensation scheme.

**Sixthly, to improve the incentive policies for the low-carbon development in key areas. Firstly,** to strengthen the incentive policies on low-carbon city (town) pilots, low-carbon park pilots and low-carbon community pilots. The comprehensive planning and guiding mechanism should be established for the ecology and environment protection, intensive-use of land resource, the low-carbon transition of industries and the low-carbon and green infrastructure, with a purpose to concentrate the economic resources into the low-carbon demonstration areas and attract leading enterprises and social funds into the construction and development of low-carbon projects. **Secondly,** to improve the incentive policy for low-carbon industry development. More efforts should be given to formulate stricter policies on controlling and eliminating carbon-intensive industries, develop more low-carbon-oriented policies for the upgrade of traditional manufacturing industries and cultivate strategic new-type industries, and further strengthen the guiding policies on industry transformation that satisfy the need of low carbon development. **Thirdly,** to improve the incentive policies integrating low-carbon development and poverty alleviation. In the poor rural regions, it should be recommended to promote the development of ecological industries such as carbon sink industry, green organic industry and ecological tourism, in order to transform the agricultural and forestry resources into economic benefits.

**Seventhly, to enhance the promoting policy for technology innovation on low-carbon development. Firstly,** to formulate the technology lists and promoting policies for key low-carbon technologies. The long-term development plan for low-carbon science and technology innovation should be formulated. It should be given priority to develop key low-carbon technologies and increase the financial input on advanced low-carbon technologies such as nuclear and renewable energy technologies, large-scale energy-conservation projects, carbon capture and storage technologies, etc. **Secondly,** to improve the policies for the industrialization of

low-carbon technologies. The patent-protection mechanisms for the low-carbon technology transfer, R&D and industrialization should be improved and the effective transformation mechanism and patent-protection mechanism for the achievement of science and technology should be enhanced.

**Eighthly, to improve the guiding policies for public participation into low-carbon development. Firstly,** to improve the guiding policies for low-carbon consumption in the whole society. The propaganda and educational activities on low-carbon development should be conducted to increase the training and knowledge of general public on low-carbon development. Various activities such as Low-carbon Day and Low-carbon Museum should be conducted to promote the governments at all levels and the communities with different types to learn, publicize and practice low-carbon development. **Secondly,** to improve the guiding policies for public participation in low-carbon development. The information disclosure mechanism and public participation and supervision mechanism on low-carbon development should be strengthened. More efforts should be made to increase the propaganda and implementation of low-carbon related law, regulation and standard and further increase the disclosure and transparence of information about energy, low-carbon and environmental pollution. **Thirdly**, to increase the social responsibility awareness of enterprises in participating into low-carbon development. More efforts should be given to guide enterprises to formulate and implement the low-carbon development strategy and include carbon emission reduction into the decisions on research and development, management and market development and enhance the low-carbon culture of enterprises. **Fourthly**, to strengthen the participation of NGO into low-carbon development. The social organization consulting committees represented by NGOs should be encouraged to establish on all governmental levels, which can make NGOs fully play the role of providing recommendations for policy making.

**Ninthly, to improve the international exchange and cooperation policies on low-carbon development. Firstly,** to establish the promoting policies for the international exchange and cooperation of low-carbon development. The international cooperation should be enhanced with an aim of attracting foreign advanced technologies and funds. **Secondly,** to speed up the establishment of relevant international mechanism and market. More efforts should be made to actively participate in international economy, trading and financial system construction related with carbon emission trading, carbon financing and low-carbon standardization, improve the discourse right in regional and national low-carbon economy system, trading system and financial system. **Thirdly,** to improve the personnel cultivation and introduction scheme for low-carbon development. More efforts should be given to cultivate and introduce professional talents to work in key fields such as low-carbon technological research and development, low-carbon law and policy setting and carbon product market construction.

# Content

# Chapter 1 Low-Carbon Development Situation

## Section 1 Strategic Demand for China's Low-Carbon Development

### 1.1 Low-carbon development for the construction of ecological civilization

In recent years, China has put the building of ecological civilization into a prominent position by integrating it into the overall aspects and whole process of economic , political, cultural and social development. Abandoning the short-term thoughts of pursing temperate economic development at the cost of resources and environment, China has turned to the new civilization featuring respecting, observing and protecting nature and gradually completed the historical evolution from industrial civilization to ecological civilization with a view to create better environment for the survival and development of the mankind.

### 1.2 Acceleration of low-carbon development for the improvement of national core competitiveness

With the deepening of the understanding of each country towards climate change, low-carbon economy has become a new development direction of the world economy as major countries have issued low-carbon development strategy, continuing to expand the investment in low-carbon technology and speed up its exploration and proactively putting low-carbon economy into practice. Now, low-carbon technology competition has played an important role in international economic competition. Therefore, to achieve the transformation to low-carbon development is critical for the economic and social development of China, the second largest economy and the largest developing country in the world.

### 1.3 Support of low-carbon development to a large responsible country

To mitigate the worries of the outside world about China's rise, China has been taking efforts to set up a national image which is fully responsible. Though it is not

necessary for China, a developing country, to fulfill the obligations of compulsory carbon emissions reduction, China still should take an active part in global efforts to combat climate change and seize opportunities to build the image of a responsible developing country while taking the initiative to address the challenge of low-carbon development with the consideration that it is the world's largest greenhouse gas emitter and its total emission is increasing substantially.

### 1.4 Low-carbon development as guarantee for national energy security

Energy security is an important part of national security. In terms of resource endowment, China is mainly abundant with coal and relatively lack of oil and gas. This energy mix has not only resulted in severe environment pollution and greenhouse gas emissions, but also led to the continuously increasing dependence on foreign energy. Low-carbon development requires improvement of energy efficiency and adjustment of energy mix, so as to gain more time and space to lower the external dependence degree of certain energy and optimize the energy import mix.

## Section 2 International Environment for China's Low-Carbon Development

### 2.1 The rising of global low-carbon revolution providing new opportunities for China's low-carbon development

The 2008 international financial crisis has put an end to the rapid growth momentum of global economy since the middle of 1980s. Low-carbon development is gradually becoming the direction and trend of world economy with a view to get rid of economic crisis and address climate change. With advanced low-carbon technology and innovation advantage, major developed countries are continuously enhancing the strategic deployment of emerging industries such as energy conservation and environment protection, new energy, big data, industrial 4.0 and biotechnology and stepping up to implement low-carbon development strategy so as to control the commanding point in the next round of industry and technology competition.

The rise of global low-carbon revolution has not only provided beneficial suggestions for China's low-carbon development, but also made it of greater urgency. Without the innovation opportunity of low-carbon technology, China can not realize industrial upgrading and will probably continue to be at the low-end of industrial chain. The changing of external environment will certainly lead in an forced impact

on China's low-carbon development, and as a result China will expand its investment in the research and development of low-carbon technology and accelerate low-carbon development transformation, endeavoring to take an advantageous position in the future low-carbon competition.

## 2.2 The increasingly limited space for global carbon emissions and increasing pressure on China's emission reduction

The fifth IPCC evaluation report shows that, to achieve a target of temperature rise less than 2℃, countries in the world should promote the all-round transformation of development strategy and make the global carbon emissions to peak before 2020. At present, the share of emission of developing countries in global total emission is near 2/3, so these countries have faced great pressure in controlling carbon emission. Furthermore, after the financial crisis, the re-industrialization of these developed countries such as America and European countries has become increasingly apparent. This will not only change the future global industry landscape, but also prompt developed countries to further put pressure on developing countries in terms of carbon emission control.

China has explicitly put forward that it will strive to make the greenhouse gas emissions peak around 2030. As a great power with a medium-high growth rate, China has become the world's largest greenhouse gas emitter, with its emission surpassing the sum of America and European countries, the world's second and third in respective, and probably maintaining a high-level growth rate for some time. Against this background, the international community will certainly show more expectations towards China on the responsibilities that China should shoulder in combating climate change.

## 2.3 To some extent, sluggish fossil energy price weakening the development of non-fossil energy

Influenced by the energy supply and demand disparities, the international fossil energy price is continuously falling. By the end of August, 2015, the future price of crude oil in COMEX (Commodity Exchange, New York) has accumulatively decreased 53.4% compared with that in June, 2014 and the range of price drop of natural gas and coal will reach 41.30% and 28.45% respectively. It is estimated that, constrained by those factors including sluggish world economy, increasing energy supply and strong US dollar, the fossil energy price will maintain at a relatively low level before 2020.

China is an importantpower in energy import and consumption. The continuous

falling of fossil energy price is conducive to decrease production cost and increase economic growth rate, but, objectively, it will impede energy conservation and carbon emissions reduction. On the one hand, the sharp decrease of fossil energy price will blunt the competitiveness advantage of new energy and renewable energy and delay the optimization and upgrading of energy mix; on the other hand, as the resource tax revolution has not completed, it will provide enterprises and families with huge amount fuel subsidy which will correspondingly weaken people's enthusiasm in energy conservation and emission reduction and hinder the low-carbon development to some extent.

# Section 3 Achievement in Low-Carbon Development Since "the 11th Five-Year Plan" Period

The domestic resource and environment constraint that are emerging and working together to combat climate have become an irreversible trend. Against this background, Chinese government has attached great importance to low-carbon development, formulating a series of policies to accelerate the adjustment of industrial structure, optimize energy mix, improve energy efficiency, control emissions that are not caused by energy activities and increase carbon sinks and carrying out low-carbon development pilot. Therefore, China has gained good results in low-carbon development.

## 3.1 Remarkable effects of energy conservation and carbon reduction

Since "the 11th Five-Year Plan" period (2006-2010), China has successively formulated energy consumption intensity control target, carbon emissions intensity control target, total energy consumption control target and carbon emissions peaking target, and issued a series of supporting measures, resulting in a remarkable effect of energy conservation and carbon reduction. Firstly, the GDP energy consumption intensity continues to drop. During "the 11th Five-Year Plan" period, China's energy conservation target is decreasing the energy consumption per unit of GDP by 20%. This expected target has been achieved by the large with 19.1%[1] gained, actually. during "the 12th Five-Year Plan" period (2011-2015), this target is to obtain a 16% decrease in the energy consumption per unit of GDP. By the end of 2014, the accumulative decreasing amplitude reaches 13%. From 2006 to 2014, China's average annual growth rate of energy consumption is 6.43% enabling the average annual growth rate of national economy to be 9.89%. The energy consumption elastic coefficient has dropped from 0.76 in 2005 to 0.30 in 2014. Secondly, the GDP carbon emissions intensity drops remarkably. By the end of 2014, the carbon emissions per

[1] The data comes from "energy conservation and carbon emissions review during "the 11th Five-Year Plan" period: Remarkable achievements in energy conservation and emission reduction" on Chinese government official website. The URL is http://www.gov.cn/gzdt/2011-09/27/content_1957502.htm.

unit of GDP has accumulatively dropped 33.8% from the 2005 level, thus China has achieved the 2020 low-carbon development target and the carbon reduction target during "the 12th Five-Year" period faster than planned.

Table 1-1 Changes of Energy Consumption Intensity and Carbon Emissions Intensity Per Unit of GDP[2]

Unit: %

| | Decreasing Range of Energy Consumption Per Unit of GDP | Decreasing Range of Carbon Dioxide Emissions Per Unit of GDP |
|---|---|---|
| 2005 | - | - |
| 2006 | 3.26 | 3.34 |
| 2007 | 5.22 | 5.36 |
| 2008 | 6.50 | 7.58 |
| 2009 | 3.28 | 3.38 |
| 2010 | 2.72 | 4.17 |
| 2011 | 1.45 | 0.47 |
| 2012 | 4.24 | 5.81 |
| 2013 | 3.20 | 4.03 |
| 2014 | 5.30 | 6.61 |

## 3.2 Concrete results in industrial structure adjustment

China's industrial structure has changed dramatically in the past decade, with the feature of low-carbon development becoming more notable. By 2014, the share of tertiary industry has surpassed that of secondary industry for three successive years. The internal industrial structure has been constantly optimized. To phase out outdated and excessive capacity has been steadily accelearated. From 2006 to 2014, accumulated 149.77 million tons of steel-making capacity, 970.07 million tons of cement and 199.57 million weight cases of glass capacity have been phased out across the country. The rapid increase momentum of the share of the output value of high energy-consuming industries[3] in industrial added-value has been contained. From 2006 to 2014, the average annual growth rate of industrial added-value of the six high energy-consuming industries is 12.77%, while the average annual growth rate of total energy consumption is only 5.23%. Those emerging industries such as energy conservation and environment protection, new generation information technology, biotechnology, high-end equipment manufacturing, new energy, new materials and new energy automobile are confronting development opportunities, with the share of their output value in the added-value of industries above a designated scale increasing remarkably.

[2] Data in this table is calculated by NDRC Energy Institute based on China Statistical Abstract 2015.
[3] They are all enterprises above a designated scale.

Table 1-2 Changes of Industrial Structures of Three Industries[4]

Unit: %

| | Primary Industry | Secondary Industry | Tertiary Industry |
|---|---|---|---|
| 2005 | 11.7 | 46.9 | 41.4 |
| 2006 | 10.7 | 47.4 | 41.9 |
| 2007 | 10.4 | 46.7 | 42.9 |
| 2008 | 10.3 | 46.8 | 42.9 |
| 2009 | 9.9 | 45.7 | 44.4 |
| 2010 | 9.6 | 46.2 | 44.2 |
| 2011 | 9.5 | 46.1 | 44.3 |
| 2012 | 9.5 | 45.0 | 45.5 |
| 2013 | 9.4 | 43.7 | 46.9 |
| 2014 | 9.2 | 42.7 | 48.1 |

Table 1-3 Energy Consumption and Output Value Growth of Six High Energy-Consuming Industries[5]

Unit: %

| | Growth Rate of Energy Consumption[6] | Growth Rate of Industrial Value Added[7] |
|---|---|---|
| 2006 | 10.3 | 18.1 |
| 2007 | 9.3 | 24.7 |
| 2008 | 3.4 | 9.7 |
| 2009 | 5.7 | 10.3 |
| 2010 | 5.9 | 13.3 |
| 2011 | 6.7 | 12.2 |
| 2012 | 2.1 | 9.3 |
| 2013 | 2.4 | 10.0 |
| 2014 | 1.3 | 7.3 |

[4] Data of 2005 to 2013 is quoted from China Statistical Abstract 2015 and data of 2014 is quoted from "Report of National Bureau of Statistics on initial verification of GDP in 2014" on the official website of National Bureau of Statistics. The URL is http://www.stats.gov.cn/tjsj/zxfb/201509/t20150907_1240657.html.

[5] According to National Economic and Social Development Statistics Report 2010, the six high energy-consuming industries cover manufacture of chemical raw materials and chemical products, manufacture of non-metallic mineral products, ferrous metal melting and rolling processing industry, non-ferrous metal melting and rolling processing industry, industry of oil processing, coking and nuclear fuel processing and industry of power and heat production and supply.

[6] Data of total energy consumption of each industry during 2006 and 2012 is quoted from China Energy Statistics Almanac (2013) and this almanac has not been updated since 2013. We use elastic coefficient (=GDP growth/ energy consumption growth) to calculate the growth rate of energy consumption during 2013 and 2014. Viewing from historical data, we find the following two laws: The first one is GDP grows more slowly, the elastic coefficient is smaller. The second is with time passing by, the elastic coefficient becomes much smaller when GDP growth is almost the time. Based on the two laws and the changing of historical data, we calculate the elastic coefficient in 2013 and 2014 and so as to further calculate the growth rate of energy consumption of these six industries in 2013 and 2014.

[7] Data of growth rate of industry value added of each industry is quoted from China Monthly Economic Indicators. Since the statistical item has changed, date of 2008 to 2014 refers to growth rate of industry value added, data of 2006 is growth rate of finished products and data of 2007 is growth rate of finished products between January and November Based on the growth rate of industry value added during 2006 and 2014 and the absolute number of industry value added in 2005, the annual value added of six industries is calculated and the overall grow rate of industry value added of these six industries during 2006 and 2014 is further calculated.

## 3.3 Progresses in energy structure adjustment

Since “the 11th Five-Year Plan” period, on the premise of ensuring adequate total energy supply, by controlling coal consumption, promoting clean use of fossil energy and developing non-fossil energy, the Chinese government is constantly enhancing the energy structure adjustment and endeavoring to control the use of coal, limit the use of oil and improving the use of natural gas. Overall, the energy structure adjustment is moving towards the expected direction and, particularly, the consumption share of clean energy such as natural gas, hydro power, wind power and nuclear power is rising obviously. By the end of 2010, non-fossil energy production has hit 280 million tons of coal equivalent, accounting for 9.4% of total primary energy production. During “the 12th Five-Year Plan” period, China’s non-fossil energy development target is to make the production reach 470 million tons of coal equivalent, accounting for 10.9% of the total primary energy production, and the consumption share stand at 11.4%. In 2014, the non-fossil energy production has reached 490 million tons of coal equivalent, 13.7% of the total primary energy production, and the share of total consumption hit 11.2%.

Table 1-4 Composition of Energy Production (Consumption)[8]

Unit: %

| | Coal | Oil | Natural gas | Primary electricity and other energy |
|---|---|---|---|---|
| 2005 | 77.4（72.4） | 11.3（17.8） | 2.9（2.4） | 8.4（7.4） |
| 2006 | 77.5（72.4） | 10.8（17.5） | 3.2（2.7） | 8.5（7.4） |
| 2007 | 77.8（72.5） | 10.1（17.0） | 3.5（3.0） | 8.6（7.5） |
| 2008 | 76.8（71.5） | 9.8（16.7） | 3.9（3.4） | 9.5（8.4） |
| 2009 | 76.8（71.6） | 9.4（16.4） | 4.0（3.5） | 9.8（8.5） |
| 2010 | 76.2（69.2） | 9.3（17.4） | 4.1（4.0） | 10.4（9.4） |
| 2011 | 77.8（70.2） | 8.5（16.8） | 4.1（4.6） | 9.6（8.4） |
| 2012 | 76.2（68.5） | 8.5（17.0） | 4.1（4.8） | 11.2(9.7) |
| 2013 | 75.4（67.4） | 8.4（17.1） | 4.4（5.3） | 11.8(10.2) |
| 2014 | 73.2（66.0） | 8.4（17.1） | 4.8（5.7） | 13.7(11.2) |

## 3.4 Substantial increase of forest carbon sinks

In recent years, Chinese government has integrated forest carbon sinks with afforestation, windproof and desert-control, and forest resources protection, and proactively carried out carbon sinks and afforestation pilots,forest carbon sinks trade and built a measuring and monitoring system for forest carbon sinks, during which valuable experience has been gained. By the end of 2013, the area of carbon sinks and afforestation in 18 provinces (autonomous regions and municipalities) has been over

[8] Data resource: China Statistics Abstract 2015

300,000 mu (Chinese Unit, I mu=0.067hectare).

### 3.5 Steady progress in low-carbon pilot demonstration

To explore a low-carbon development path that is in line with China's national conditions, since "the 11th Five-Year Plan" period, China has launched pilots of low-carbon provinces and low-carbon cities, carbon emission trading pilots, low-carbon community pilots and low-carbon industrial park pilots, almost forming an all-round and multi-angle landscape for low-carbon development pilots, which ranges from provinces to communities and from production to life and gaining valuable experiences in promoting the low-carbon development concept across the country in the future.

As for low-carbon province and low-carbon city pilots, significant progress has been achieved in low-carbon pilots of the first batch covering Five Provinces and Eight Cities and the second batch including 29 provinces. All parts of the country are proactively exploring low-carbon development modes and contents, building low-carbon industries and city systems featuring high efficiency, low energy consumption and low emission, enhancing the construction of low-carbon systems and fundamental abilities and initiating green life and consumption mode, which provide rich experiences in pilot demonstration of various subdivision fields.

In 2011, the carbon emissions trading pilot was launched in five municipalities including Beijing, Tianjin, Shanghai, Shenzhen and Chongqing, and two provinces Hubei and Guangdong. By now, seven pilot provinces and cities have started trading; and most pilot provinces and cities such as Beijing, Shanghai, Shenzhen and Guangdong have issued management methods and supporting regulations on carbon emission trading, built sound systems of carbon emissions permit trading and completed greenhouse gas emissions quota allocation, while enterprise greenhouse gas emissions registering, reporting and verifying by the third party based on their trading performance.

In terms of special low-carbon pilots related to national departments have promoted the research and implementation work in some pilots such as the low-carbon industrial parks, low-carbon communities, key green and low-carbon towns and low-carbon transport system construction and advanced the construction of the first low-carbon pilot. Preliminary achievements in pilot projectshave been made in some fields.

## Section 4 Advantages of China's Low-Carbon Development

With over 30 years' development, China's technology foundation is becoming stronger, industry system is constantly improving and the contribution of human

capital and technological innovation to economic growth is gradually increasing. Therefore, advantages of implementing low-carbon development strategy in China are accumulating.

## 4.1 Low-carbon development becoming a priority in China's development strategy under "new normal"

Nowadays, China's basic conditions of economic development are changing with tendency: Quantity of labor force is in a negative growth and the low cost advantage of traditional labor forces is gradually disappearing; the gap between China's basic technology level and the international advanced one is narrowed and it becomes more difficult to introduce advanced technology; severe overcapacity emerges in traditional industries such as steel and construction materials and the marginal efficiency of investment is constantly decreasing; and the energy and resource and ecological environment constraints are becoming tighter. The traditional development mode is outdated. The economic growth rate has turned from a high level to a medium and high level. Therefore, China needs to change the traditional extensive development mode featuring with high input, high energy consumption, high emission and low output and accelerate the implementation of innovation-driven development strategy and low-carbon development strategy.

## 4.2 Strong economic power laying solid material foundations for low-carbon development

In 2014, China's economic aggregate totalled over 10 trillion US dollar and per capita GDP was reached 7,600 US dollar, thus China has jumped from a low income country in the early era of reform and opening-up to a middle and high income one. The growing economic strength has laid solid material foundations for China's low-carbon development transformation. Abundant foreign exchange reserve has provided financial guarantee for introducing advanced low-carbon technology and production process. Government's strong capabilities in regulation on economy can address issues caused by market failures and play an important role in conversion between two modes. High social saving rate has also created conditions for China to maintain a high-level economic growth rate under the low-carbon development mode and to reduce transformation impacts.

## 4.3 Large space in reducing carbon emissions through structural adjustment

After long-term efforts, significant progress has been made in China's industrialization. Since China has entered the middle and late stage of industrialization, more efforts should be made to adjust industrial structure, improve the quality and efficiency of manufacturing and promote the development of modern service industry. China should also strive to enhance the added value of secondary industry and make tertiary become a high-end and modern one. The share of carbon emissions of secondary industry in total carbon emissions is over 70% and also the share of carbon emissions of high energy-consuming industries in that of secondary industry is beyond 70%. Therefore, promoting the optimization and upgrading of industrial structure will bring dividends for reducing carbon dioxide through structure adjustment and continuously lowering the GDP carbon emissions intensity.

Meanwhile, there is still huge adjustment space in China's energy mix compared with the world energy mix. Among primary energy consumption, the share of oil consumption is over 10 percentage points lower than the world's average; the share of natural gas consumption is nearly 20 percentage points lower; but the share of coal consumption is over 30 percentage points higher. This big difference between energy consumption structures can provide considerable adjustment space. With the optimization of energy mix, China's GDP carbon emissions intensity will be further reduced.

## 4.4 Tremendous potentials in market demand of low-carbon industry development

Market is the core power to drive technological innovation and industrial reform. China has a tremendous potential in stimulating domestic demand. With the resident income reaching the middle and high level, China's consumption gap is widened; personalization and diversification become the mainstream; and consumption demand, substituting for investment demand, becomes the greatest impetus to national economic growth. The emerging of new consumption demand will promote the rapid development of new technology, new products, new industries and new business modes. Tertiary industry will replace secondary industry, becoming the pillar industry. The optimization and upgrading of traditional manufacturing and development of strategic emerging industries are accelerating, thus more results will be gained in consumption and emission reduction through industrial adjustment.

## 4.5 Growing low-carbon development technology and talent support ability

In recent years, China's overall science and technology innovation capability has improved significantly and development of strategic emerging industries and high-tech industries has made remarkable progress. In some high-tech technology fields, the gap between China and those developed countries has been narrowed dramatically. The intensifying global industry competition promotes developed countries to speed up technological innovation. As a result, due to overflow effect, more advanced and applicable technology can be introduced into China. China is also taking the initiative to strengthen low-carbon technology cooperation with developed countries. Under the combined influence of the above factors, China will constantly narrow its gap in low-carbon technology with developed countries and probably realize synchronous development.

Meanwhile, China's talent dividend is improving, with details shown as below:
The number of education years of labor forces is increasing steadily. According to related calculation, the number of average education years of newly increased labor forces is expected to increase to 13.5 in 2020 from 12.4 in 2010; the number of average education years of the working-age population is expected to increase to 11.2 in 2020 from 9.5 in 2010.

The number of high-level high-tech talents is rising. The number of people who have received education per 100 thousand is increasing from 3,611 in 2000 to more than 9,000 in 2014. The rising talent dividend has laid solid talent foundation for low-carbon development.

## 4.6 Market mechanism reform providing impetus for low-carbon development

During "the 13th Five-Year Plan" period, Chinese government will continue to promote mechanism reform in prices of energy and resources, to enable price not only to reflect the scarcity and external costs of energy and resource products, but also to contribute to straighten out the price relationship between low-carbon and high-carbon productions, so as to better play the role of price leverage, boost low-carbon energy research and development and low-carbon technology innovation, expand professional and large-scale production of low-carbon products, which will boost low-carbon development.

# Section 5 Problems Facing China's Low-Carbon Development

## 5.1 Low-carbon development concept being not deeply rooted in people's heart

The popularization and acceptance of low-carbon development need to be enhanced further since it is a new concept. There still exists some misunderstandings on low-carbon development in society. Firstly, people have a deviated understanding of the relationship between controlling greenhouse gas emissions and boosting economic development as they believe that the low-carbon development strategy will hinder the steady and rapid economic and social development. Secondly, they believe that the low-carbon development concept is over-advancing. Imposing low-carbon development will not only impede the improvement of living standards, but also impact industrialization and urbanization severely. Thirdly, people are lack of recognition of massive participation in energy conservation and carbon emissions reduction. They believe that people's life is not the key area for energy conservation and carbon emissions reduction as the energy consumption and greenhouse gas emissions in this area are relatively lower than that in production and they also think that the government should not, in the name of conserving energy and reducing carbon emissions, impede people's right of pursuing life with higher quality.

## 5.2 Incomplete policies and systems of low-carbon development

China's current financial policies on supporting low-carbon development are uncoordianted, mismatched and inefficient, so they have not given rise to significant effects. Government's procurement policy has not played its role of leading the promotion of low-carbon products and some specialized energy-saving service has not been involved in government procurement. The taxation structure, dominated by indirect taxation, has not well played its role of leading low-carbon economic development. Low-carbon taxation system has not been established and necessary limitations on products in various areas, ranging from production to consumption, are absent. The incentive of corporate income deduction to technological progress is not enough for corporations to expand investment in stimulating low-carbon technology innovation. Financial policies which are conducive to low-carbon development are imperfect and some resources are wrongly allocated to inefficient and high-carbon fields.

## 5.3 Imperfect systems and mechanisms of low-carbon development

Firstly, an efficient and unified management system of low-carbon development

has not been established. As for low-carbon development, each department acts on its own. The working target of each department is not well -connected and various polices on supporting low-carbon development are discordant and mismatched. Secondly, the market mechanism which can benefit low-carbon development has not formed. Carbon market construction is still in the exploration and initial stage; low-carbon technology innovation system and low-carbon service market system are incomplete; low-carbon investment and financing mechanism is imperfect. Thirdly, laws and standards of low-carbon development are weak. Though the government has published two guidance documents, *the National Strategy for Climate Adaptation* and *the National Plan on Climate Change (2014-2020)*, it is comparatively slow in legislation on combating climate change, which is in the stage of consultation.
There are still no laws and regulations and standards in some key fields. Fourthly, related evaluation mechanism is imperfect. Though completion of carbon intensity target has been included in government performance evaluation system, the evaluation method is imperfect, which causes the local government to adopt unreasonable and unjustified methods to achieve the evaluation target and even has negative impacts on the future low-carbon development.

## 5.4 Rigid demand for energy brought by industrialization and urbanization

As China's industrialization is not finished yet and urbanization advances rapidly, there is still large rigid demand for energy during economic and social development. On the one hand, the share of industry added value in GDP is too high and development of service industry is relatively backward. On the other hand, the important role of heavy chemical industry, featuring high consumption, high pollution and high emission, which will not change in the short term. If urbanization is accelerated, the demand for energy in fields such as construction, transportation and residential consumption will increase remarkably and energy consumption will expand as the construction of urban infrastructures and public utilities is enhanced.

## 5.5 Big inertia of low-carbon development

China's GDP scale surpasses that of Japan to become the world's second largest economy in 2010, surpassing that of the United States, becomes the world's largest in 2011. The expansion of economic scale will leads to the increase of inertia of traditional development mode, which means that more fields need to be reformed in the future and the resistance and cost of reform is increasing. This becomes more prominent when industries with high energy consumption and high emission phase out excessive and backward capacity.

## 5.6 A long way to go for energy structure adjustment

To achieve the total energy consumption control target and greenhouse gas emissions intensity control target requires accelerating energy structure adjustment. It still takes a long time to complete adjustment in light of the following reasons: Firstly, the basic condition of China's energy and resource endowment is rich in coal, lack of oil and natural gas and short of uranium. Crucial breakthroughs in key technology of developing and utilizing wind power, hydro power and solar power have not been made. Secondly, people question the security of nuclear technology. Thirdly, energy price mechanism is imperfect as the price of energy products cannot completely reflect resource scarcity, impacts on environment and market supply and demand.

# Chapter 2 International Progress and Experience of Low-Carbon Development

## Section 1 Progress of International System of Low-Carbon Development

### 1.1 Concept framework of international system of low-carbon development

#### 1.1.1 *United Nations Framework Convention on Climate Change* (UNFCCC) embodies the concept of sustainable development

The UNFCCC, signed in 1992 and took effect in 1994, has 196 contracting Parties. The concept of sustainable development and consensus on addressing climate change reached by international community are embodied in the Convention provisions. The Convention is the conventionalized product of the concept of sustainable development, related to climate change. Viewed from its principles, objective as well as stipulations, the Convention is an important literature on sustainable development, laying key legal framework and foundation for low-carbon development.

#### 1.1.2 Kyoto Protocol makes a significant contribution to establishing low-carbon development system

The Kyoto Protocol is passedadopted in 1997 with Annex B describes the

national compulsory quantified emission reduction target of Annex I countries in detail. According to the Kyoto Protocol, In the first commitment period from 2008 to 2012, developed countries shall reduce their overall emission of greenhouse gas emissions by at least 5% from the 1990 level. In addition, targets of individual Parties are stipulated in Annex B. The Kyoto Protocol mode is the usually called top-down emission reduction mode. Specific targets are set up to define collective responsibilities of developed countries as a whole, and country-specific compulsory emission reduction obligations are also in place. This is actually the most powerful experience and signalof international political will towards low-carbon development. The basic principle and system of Kyoto Protocol, which stipulates the international low-carbon system in a treaty style and detailed manner, will continue to make impactand contributeto the building of low-carbon development system.

### 1.1.3 Bali Road Map process incorporates the low-carbon development concept

During the Bali Road Map process, the concept of low carbon development, first put forward by the EU in one of its proposal.This is the first time for low carbon concept be presented in the UN climate change process. The Copenhagen Accord sets up political consensus on a global temperature below 2 ℃ threshold, and that countries to take action to meet this objective consistent with science and on the basis of equity. Countries should also cooperate in achieving the peaking of global and national emissions as soon as possible, recognizing that the time frame for peaking will be longer in developing countries and bearing in mind that social and economic development and poverty eradication are the first and overriding priorities of developing countries and that a low-emission development strategy is indispensable to sustainable development. . It is also the first time that the expression of low-carbon development is mentioned in theUNFCCC process. One of the final results of Bali Road Map consultation is that each country should formulate its own low-carbon development strategy and plan. This is also an important achievement in low-carbon development arising from international process

## 1.2 Progress of addressing climate change and deepening low-carbon development actions under theUN climate agenda

The target stipulation on emission reduction obligations of Annex I country Parties, as well as their aggregate reduction obligations, consist the core of international low-carbon system.,

### 1.2.1 Performance of developed countries in first commitment period

By the end of first commitment period, 16 Annex I countries[9] have not achieved the emission reduction target stipulated by Kyoto Protocol and 22 achieved, among

[9] Countries which fail to achieve the agreement target include: Iceland, Canada, Australia, New Zealand, Luxembourg, Liechtenstein, Austria, Brazil, America, Denmark, Switzerland, Slovenia, Norway, Japan, Italy and Ireland.

which 12 are countries in economic transition or former Soviet Union and Eastern Europe countries[10]. The emission of Annex I countries (land use not included), if not counting Eastern Europe countries which were in economic downturn, increased from 130 million tons equivalent in 1990 to 1429 tons in 2006, with the growth rate of 9.9%[11].

### 1.2.2 Working Group negotiation to set up Annex I emission targets

The Working Group that was responsible for setting Annex I countries emission reduction targets in the second commitment period, was finally able to reach relevant arrangement during the Doha Conference in 2012.and decided that the second commitment period starts from January 2013, and ends on December 31st, 2020. In the second commitment period, the overall annual average emission of 38 countries[12] including EU and Australia shallbe 18% lower than the 1990 level. , New Zealand, Japan and Russia refused to commit under the second commitment period.. Canada has submitted the written notice of withdrawing from Kyoto Protocol on December, 15th, 2011 and it is no longer acontracting party to this protocol starting from December 15th, 2012.

### 1.2.3 Action Targets in Cancun Agreement

Cancun Agreement points out that developed countries should shoulder their historic responsibilities, reducing emission as whole from25% to 40% by 2020. Under international supports, developing countries will take appropriate mitigation steps so as to deviate from BAU as a whole in 2020.

## 1.3 Outlook of international system on low-carbon development

### 1.3.1 Fifth assessment report of Intergovernmental Panel on Climate Change (IPCC) charting course for future international polices on low-carbon development

In April, 2014, the IPCC publishedthe third working group report in the fifth assessment report: Climate Change 2014: Climate Change Mitigation. Based on the latest global research finding, this report gives a holistic assessment of mitigation goals and approaches, potentials and costs of industrial sectors in emission reduction, international climate systems and regional policies and climate financing. The report's main conclusion is that stabilizing temprerature witing ther 21st century requires a

[10] Countries which have achieved the agreement target include: Britain, EU, France, Monaco, Greece, Finland, Belgium, Germany, Portugal, Holland and economic transitional countries such as Ukraine, Latvia, Estonia, Lithuania, Rumania, Bulgaria, Russia, Hungry, Slovakia, Poland, Czech Republic and Croatia.

[11] FCCC/SBI/2008/12, the 15th paragraph.

[12] Annex Ⅰ countries which agree to fulfill the emission reduction obligation in second commitment period include: EU and its 27 member countries, Norway, Iceland, Switzerland, Liechtenstein, Monaco, Croatia, Australia, Ukraine, The Republic of Belarus and Kazakhstan. Among them, Cyprus and Malta are new EU member countries and they have not shoulder the responsibility of emission reduction in the first commitment period. The Republic of Belarus and Kazakhstan are the new economic transitional countries which have joined the second commitment period.

fundamental departure from BAU. to achieve the goal that the temperature rise is less than 2℃ in 2020 compared with that in pre-industrial era, the global accumulative carbon emissions between 2011 and 2100 should be fewer than 0.63 to 1.18 trillion tons. This means that lower global GHG emission by 2050 than in 2010, from 40% to 70% lower globally, and emission level near zero or below in 2100, and lower emission by 40% compare with 2010 or return to 2010 level of emission.

The IPCC third working team report also points out related suggestions on goals and approaches of international low-carbon development, which will contribute to the understanding of the future of global climate system and economic system and become the important reference basis for establishing international low-carbon systems and national policies. The IPCC report provides policymakers with scientific conclusions and policy recommendations. However, to exert influence on the building of country-specific policies and international system still takes time and needs joint efforts of various countries.

### 1.3.2 International political impetus becoming stronger

On September 23rd, 2014, Ban Ki-moon convened the second Climate Summit, hoping to give new political impetus to Durban Platform negotiation. Over 120 heads of state or government and representatives from enterprises, financial institutions and non-government organizations have launched an initiative on combating climate change and promoting low-carbon development, playing an active role in building consensus and pushing forward global agenda.

### 1.3.3 Features of nationally determined contributions becoming increasingly prominent

In light of current consultation results, economic wide emission reduction targetswill continue to be the suitable commitment form for Annex I countries beyond 2020.Other countries will probably take diversified measures to reduce emission, and may including total emission control mesures. . Virtually, this is defined as the Independent Nationally Determined Contribution (INDC).

All emission reduction targets reflect certain extent of voluntary nature, in Copenhagen Accord, Cancun Agreement and the second commitment period of Kyoto Protocol. At Warsaw Conference held at the end of 2013, decided that emission contribution will benationallydetermined and therefore officially recognizedestablished the bottom up mode. Durban Platform requires enhancing the building of ruled based international system. Parties like EU countries are pushing forward the exam, reviewand monitor regulations to enhance nationally determined contributions. Rules ontransparency, comparabilityare very possible to be parts of the “Paris agreement”, to be concluded, hopefully, In Paris by the end of 2015.But these rules will also be guided by Convention principle. Lima Conference analyzes the quantifiable contents contained in the information of nationally determined contributions of each country and proposes that countries should appropriately mention emission reduction target baseline, time framework, range and methodology,

etc when submitting their nationally determined contributions and also should, based on their national conditions, explain the fairness of nationally determined contributions and contributions that its contributionto achieving the objective of the Convention..

### 1.3.4 EU, the United States and China successively announce the emission reduction targets beyond 2020, contribute positively tointernational process

In 2014, China announced that it endeavors to make the greenhouse gas emissions peak around 2030 and the share of non-fossil energy consumption in primary energy consumption increase from 15% in 2015 to about 20% in 2030. The United States committed to decrease the greenhouse gas emissions by 26% to 28% before 2025 from the 2005 levels. Before then, EU announced a 40% decrease of greenhouse gas emissions in 2030 based on the 1990 level. On one hand, since he emission reduction targets announced by China, the United States and EU belong to Annex I and non-Annex I, these countries should take different responsibilities on climate change, and their emission reduction obligations feature different natures, forms and degrees according to the principle of Common But Differentiated Responsibilities. On the other hand, as the world's largest greenhouse gas emitters, China, the United States and EU take the initiative in announcing emission reduction targets, to reflect the consensus of international society, as well as meet the requirement of the UN process, can be deemed as the country-specific positive contributions to 2015 Paris Agreement. concensus.

# Section 2 Lessons of International Carbon Emissions Control Practice

Control of total carbon emissions normally set up an absolute cap limit for the total carbon emissions for a target period. The reference against by this cap can either be relative to historical emissions (reference years) or be relative to the target year emissions (BAU) in the baseline scenario.

## 2.1 Targets of total carbon emissions control

In the framework of the Kyoto Protocol, most developed countries have obligations of compulsory emission reduction. Therefore, most of these countries have developed a control target of total carbon emissions, and issued a series of policies and measures aiming to achieve these targets. Major nations' targets of carbon emissions control is shown in Table 2-1.

Table 2-1: List of major nations' targets of control of total carbon emissions

| Nation | Target year | GHG Reduction Target | Reference year |
|---|---|---|---|
| EU | 2020 | 20% | 1990 |

| | | | |
|---|---|---|---|
| | 2030 | 40% | 1990 |
| US | 2020 | 17% | 2005 |
| | 2050 | 83% | 2005 |
| Japan | 2020 | 3.8% | 2005 |
| Australia | 2020 | 5% | 2000 |
| Korea | 2020 | 30% | BAU of the Target year |
| Mexico | 2020 | 30% | BAU of the Target year |
| | 2050 | 50% | BAU of the Target year |
| Brazil | 2020 | 36.1%-38.9% | BAU of the Target year |
| South Africa | 2020 | 34% | BAU of the Target year |
| | 2025 | 42% | BAU of the Target year |

Source: UNFCCC

### 2.1.1 Targets of total greenhouse gas emissions control of EU continue to tighten

In January 22, 2014, the EU announced a new climate change and energy policy, making it clear that the emission reduction targets of EU are to 2030, and three milestones path to a low-carbon economy of the EU: First, the emission reduction target: with 1990 as the reference year, greenhouse gas emissions will reduced by 40%; second, the targets of renewable energy proportion: the share in the energy consumption structure increased to at least 27%; third, to further improve the energy efficiency targets. Compared to the three “20-20-20” targets pursued by the EU in 2008, new energy and climate change polices improve the targets of quantitative emissions reduction. At the same time, the total emission in the EU-ETS is planned to declineby 1.74% per year from 2013 to 2020, and 2.2% per year between 2021 and 2030

### 2.1.2 The U.S. national emissions reduction targets combines with industrial reduction targets, and part of the region carries out a top-down total control.

*The Clean Energy and Security Act* stipulated that greenhouse gas emissions in 2020 reduced by 17% of that in 2005, and in 2050, the greenhouse gas emissions reduced by 83% of that in 2005. In June 6, 2014, US Environmental Protection Agency released a draft of reduction plan of power industry carbon emissions, which required for the first time that before 2020, total carbon dioxide emissions of all power plants in the United States should decrease by 20% compared to 2005, and then a 30% reduction target achieved in 2030.

Moreover, the United States currently has several "cap and trade" regional control mechanisms, including Regional Greenhouse Gas Initiative (RGGI) that covers a

single power industry, California Emissions Trading Scheme (CAETS) that covers more than 20 industries in single region of California.

Regional Greenhouse Gas Initiative memorandum (RGGI) is the first market-based system of compulsory emissions reduction in the US, and it is formally implemented in 2009, which consists of 10 states in the northern US, and only the power industry included. Taking fossil fuel power plants whose total installed capacity is more than 25 MW in this area after 2005 as emission units, its emissions in 2018 are required to reduce by 10% of that in 2009.

*California Global Warming Solutions Act* in California Emissions Trading Scheme (CAETS) stipulated that California's carbon emissions in 2020 must be reduced to the levels in 1990, which set a total control to accumulative emissions in this region from 2013 to 2020, and it will cover 85 % of greenhouse gas emissions of California: the ceiling set of carbon dioxide emissions of California in 2013 is 160 million tons, covering emitters of greenhouse gases like power generation, industrial sector whose emissions are more than 2.5 million tons of carbon dioxide equivalent per year; in order to control carbon dioxide emissions from transportation fuels, after 2015, the coverage of the trading scheme will be expanded to the transport industry and small natural gas customers, and emission ceiling of carbon dioxide in 2015 is set at 390 million tons, after that it will be diminished year by year while emission ceiling is 330 million tons in 2020.

### 2.1.3 Conditional emissions reduction target of Austria

Australian government committed in the Kyoto Protocol that by 2012, the greenhouse gas emissions will increase by 8% compared with 1990. Its greenhouse gas emissions in 2050 will reduce by 80% compared with 2000. But for the mid-term target in 2020, the Australian government has set the following conditions: First, by 2020, the Australian government will unconditionally reduce by 5% of greenhouse gas emissions compared with 2000; second, Australia will commit to reduce emissions by 15% if the limitation of greenhouse gas emissions of major developing countries have committed and emission reduction commitments of developed countries are comparable to Australia, yet they cannot achieve the stabilization of greenhouse gas concentrations in the atmosphere at 450 ppm case; third, Australia promise to reduce emissions by 25% if international agreements can achieve the target of stabilizing greenhouse gas concentration of 450 ppm.

### 2.1.4 Japan’s national level control of total emissions combines with that of key cities

As a member of the Copenhagen Accord, as early as in 2008, Japan had proposed that compared with 1990, its greenhouse gas emissions will reduce by 25% by 2020, then by 2030, carbon dioxide emissions resulting from the consumption of fossil fuels will reduce by 30% , and by 2050, its emissions will reduce by 80%. However, because of its loss of nuclear power in 2013, Japan revised its commitments in the

Copenhagen Accord to a proposal that its emission by 2020 will reduce by 3.8% compared with 2005, which is quite different compared with the proposal before. Meanwhile, Tokyo also controls total carbon emissions at the city level, and its target of total carbon dioxide emissions by 2020 is to reduce greenhouse gas by 25% compared with 2000.

## 2.2 Allocation of the total carbon emissions targets

### 2.2.1 Allocation methods

Currently, in the worldwide trading mechanism of total carbon emissions, initial emission rights allocation mechanism is widely used including grandfathering, benchmarking and auction. The first two belong to free quota act. Grandfathering refers to the government quotas the allocation of emission rights to the industry or sector according to historical emission levels. Auction system means that emissions quota that government sets will be allocated according to auction, including two forms: static auction and dynamic auction. Benchmarking is an allocation principle based on historical emission levels or capacity, adopting standard criteria to determine the emission rate of emission quota in various industries, sectors. The three allocation methods will be elaborated in the following several paragraphs.

**①. Grandfathering**

This method is widely used in the first two stages of EU- ETS and other carbon emissions trading mechanism: EU emissions trading system used grandfathering in the first stage and its emissions quota allocated more than 95% compared with 90% in the second stage. This method is widely used in the first two stages of EU-ETS because of political feasibility not fully considering the economic efficiency. Generally speaking, free emissions quotas system that grandfathering adopts was considered to be the subsidies that EU grants to EU members or EU members grant to domestic energy-intensive, foreign trade enterprises so as not to be affected by the emissions reduction targets of EU-ETS provisions. However, Grandfathering was criticized in its many aspects. First of all, free quota caused unexpected reallocation effect. Power sectors got free quota emission rights, and this part of the quota received government subsidies, resulting in huge profits. Secondly, the free quota allocation at national level limited coordination inside the EU-ETS, and may lead to reassign once again, thereby reducing market competition and economic efficiency of the EU-ETS. In a sense, free quota subsidies made these manufacturers keep close to their industry, which enables those with low efficiency, high energy consumption, high emission levels of equipment to continue production.

However, studies have shown that once the opportunity cost of free emissions quotas allocation is taken into account. Grandfathering will also have high economic efficiency to promote the reduction. In the initial stage of emissions quotas allocation, Grandfathering will be conducted based on historical emissions levels in a closed

market. With the emissions quota market being gradually opened up, allocated quota of grandfathering can be traded in the market. The opportunity cost of emissions quotas are measured by the profits made by emissions reduction or selling surplus emissions quotas. Taking into account the two emission quotas of Grandfathering of usefulness, the equipment inside the trade system will continue to produce and cover its emissions using their emission quotas. On the other hand, trading system companies need to ensure they will make profits by reducing emissions and sell excess emissions quotas. Therefore, companies will produce in the situation that marginal emission reduction costs equal to the price of emissions quotas, internalizing the external costs of greenhouse gas emissions so as to make trade system has a high economic efficiency.

**② Benchmarking**

Benchmark value is the metrics of greenhouse gas emissions per unit of product generate, and Benchmarking is a principle of allocation based on historical emission levels or emission ceiling ability, adopting standard criteria to determine emission rates of allocation of quotas in various industries and sectors. Grandfathering and Benchmarking refer to the free allocation methods, and correspond to the Auction system. The EU has set the benchmark value of 52 industries, covering 75% of the EU's total emissions, which valid for 8 years. According to the requirements that the total target quota reduces 1.74% per year, historical data shows that the majority of the industry improve l% to 2% of energy efficiency each year.

In Europe, Benchmarking joined free allocation after 2013 on the basis of Grandfathering. Because it is based on product industrial benchmark and conducted referring to production, so high productivity producers will get more free quotas to a certain extent and expect industry with no carbon leakage. After 2013, Benchmarking will set the benchmark value for any well-defined product in principle, and set clear boundaries directly for all types of products. The EU set up a variety of products benchmark based on the product in the EU wide range of greenhouse gas emissions in the top 10% of the best scenario, and formulate them by collecting direct emissions data checked by the relevant facilities (Rationality of data is confirmed by the comparison of the best available techniques with the best available techniques in the top 10%). In order to avoid unnecessary disputes, in the course of the use of Benchmarking, the historical activity data is often used as an important reference (allocation= benchmark * historical activity volume * carbon leakage factor + additional quota for new equipment), and the new facilities that do not have a historical activity volume can get additional quota after the normal operation.

**③. Auction**

Standard auctions are divided into two forms: static and dynamic auctions. The static auction is divided into unified pricing, differentiated pricing, secondary pricing auction according to different clearing price. In the EU-ETS, the static auction and the dynamic rise auction are concerned. The main difference between the two is the

number of rounds of the auction. There is only one round of the former while the latter may require multiple rounds to determine the final quota allocation. Member states of the first stage of ETS-EU all take static auction method because of the consideration of simplifying the operation process and reducing the cost of allocation.

Compared with the free allocation method, firstly, to a certain extent, the Auction system will increase the production costs that emission trading system covers industry, further, it will reduce the profit and the international competitiveness of the enterprise (There is also a study shows that transition of rationing from free to auction will not increase the effect of carbon quota trading on enterprise competitiveness). But it can motivate the technological innovation of enterprises, reduce carbon emissions, and the auction method requires the enterprise to obtain the emission rights through the auction bidding, thus makes the allocation more efficient. Second, the revenue from the auction can be used for the management and improvement of public environment, and it can be used to support the emission reduction of less developed areas, to encourage the development and application of clean technology, to provide subsidies for emissions intensive export enterprises who participate in the international competition, to make up for low income families because of the additional expenses caused by the rise in energy prices. Third, what is more important is that the auction can form the auction market, and the corresponding market clearing price can provide long-term price signal for the participants (Sijm, etc， 2007) and improve transaction efficiency. However, the auction law encountered relatively large resistance in the implementation.

**④. Other allocation method**

In addition to common Grandfather, Benchmarking and Auction system, there are some other carbon quota allocation methods. Based on allocation mechanism of output or production ceiling ability (OBA&CBA), the government is requested according to the actual output or existing equipment production ceiling ability level, rather than the historical emissions or industry average, to allocate the free emission quotas to the enterprise. Otherwise, Marc A. Rosen (2008), pointed out the allocation scheme based on useful energy (energy is often defined as the maximum amount of work that can be obtained when the system, material flow, or energy flow is achieved in a given situation) is the most meaningful and accurate by comparing the allocation scheme based on the energy content, the useful energy, the economic value and so on. However, Ji-Won Park and Chae Un Kim (2012) and some other people described a emission quota allocation scheme adopting Boltzmann. In physics, the Boltzmann allocation based on the principle of maximum entropy, and the equilibrium probability allocation of the energy in the physical system is obtained. In the emissions trading system, merging the concept of the economic market and the allocation of Boltzmann method can prove that the result of the allocation scheme based on the allocation scheme is reasonable, natural and fair and has the potential to use in a variety of economic conditions and environment through quantitative data analysis. Most of these methods have been proposed in the study, few of which are actually used.

### 2.2.2 Allocation of carbon emissions targets in major countries

In the process of achieving the target of control of total carbon emissions, specific decomposition of the industry coverage and greenhouse gas coverage should be firstly clear, and in that when the scope of the coverage of the industry are determined, there are some factors that need to be considered, including availability of emission data, the cost and benefit of the small industry emissions into the emissions trading system, the potential of industry emission reduction, sensitivity to carbon prices, expected return, and acceptability of politics. For example, the industry and the scope of greenhouse gases that need to clear when major national emissions trading is realized, as is showed in the table 2-2.

Table 2-2: The coverage of major countries' emissions trading

| System | Greenhouse Gases | Industries |
|---|---|---|
| European Union | Carbon dioxide | Electricity, heat, cement, glass, ceramic, iron, oil and natural gas, paper chemicals, ammonia, nonferrous metals and aluminum smelting, included in aviation industry in 2012. |
| Australia | Carbon dioxide, methane, nitrous oxide, fluorocarbon hydride | Fixed energy industry, transportation, industrial manufacturing, wastes and esceilinging gas |
| Regional Greenhouse Gas Initiative (RGGI) of the United States | Carbon dioxide | Electric power sector |
| Tokyo, Japan | Carbon dioxide | Commercial building and plant facilities |
| Switzerland | Carbon dioxide | Voluntary participation of energy intensive industries which can enjoy free carbon tax. |
| American Western Climate Initiative (WCI) | Carbon dioxide, methane, nitrous oxide, fluorocarbon hydride sulfur hexafluoride, three nitrogen fluoride | Energy, industry, liquid fuel |
| California Emissions Trading Scheme (CAETS) | Carbon dioxide, methane, nitrous oxide, fluorocarbon hydride, perfluocarbon, sulfur hexafluoride, three nitrogen fluoride | Energy, industry, liquid fuel |

### ①. The United States

Upper bound trade mechanism The United States started upper bound trade mechanism in 2006 in the 24 states which needs to set up the emission limits and set the greenhouse gas emissions that are allowed to be emitted by the enterprise. At the same time, the allocation of emission quotas to different industries and departments is made in terms of the grandfathering, auction system or the mixture of two. These emissions quotas can be traded with other players in the market. At the end of each trading period, enterprise needs to turn over the emission quota which is equal to the amount of greenhouse gas emissions to the government. The upper bound trade mechanism gives companies freedom of trading, storage and lending emissions quota. This process will minimize the economic costs of the process, also prompt the company with the minimum marginal cost of emission reduction reducing first. The most important function of the upper bound trade mechanism is to propose a carbon price, thus give the industry, enterprises, consumers a clear price signal of encouraging emission reduction behavior. Along with the implementation of the upper bound trade mechanism, different regions, industries, departments received different effect. But the government can formulate appropriate policies for balancing climate change to reduce the adverse effects of energy intensive industries and foreign trade sectors (the weakening of international competitiveness of export commodities) according to initial allocation of emission rights. Even though the use of the trading mechanism ceiling can lead to the transformation of economic development pattern, it does not affect the GDP.

Regional Greenhouse Gas Initiative (RGGI) Regional Greenhouse Gas Initiative (RGGI) is the first compulsory emission reduction system in the United States based on market. Formally implemented in 2009, this system covers 10 northeast states and central Atlanta, only including the power industry. It adopted auction in its beginning and adjusted according to the use of electricity, population, forecast of the new emitters, and other factors, such as consultation. In practice, the states have an auction of 100% of the quota and at least 25% of the quota is used for the benefit of consumers or energy strategy project. On the basis of the quota auction, RGGI allowed states to take measures to limit carbon emissions from power generation companies. Auction transactions in carbon dioxide: Quota tracking system is conducting, early in ways of single-round, sealed-bid and uniform price auction, later in ways of multi- round, rising price. RGGI also allows the use of local emission reduction targets or the use of regulatory agencies to distribute carbon offsets to fulfill carbon emission reduction obligations, but the ratio cannot exceed 3.3% of the total while at special circumstances it can be raised to 5%-10%. In addition, in order to prevent the emergence of market failure, RGGI introduces two security thresholds. The first security threshold is used to solve the problem of high price of carbon caused by the initial allocation, while the second safety thresholds can solve the problem of the risk brought by serious imbalance in the supply-demand relationship. In addition, in order to prevent the fluctuation of the quota price, there is another flexible mechanism called carbon offsetting trigger mechanism.

However, the states are reluctant to increase the cost of carbon because they are afraid of the loss in their industries, so that they provide maximum quota, coupled with the use of local emission reduction targets, causing excessive allocation of quotas and low prices (the upper limit of the mechanism is more than 50% of the actual emissions in 2009), which speed up the plan's recession. Because of the excessive allocation of quotas and low prices, most transactions are carried out in bilateral trade. This also implies that participants lost interest in the market for derivatives trading made by the over allocation of quota and some financial players have quit. Despite the expected excess quota allocation of lower degree will be achieved in 2018, but in the meantime the excess quota still greatly reduced the efficiency of the mechanism. Besides, in view of the negligence of federal legislation and the lack of concern on federal level, development of pre-market will be offset. RGGI's future is not clear. New Hampshire abolished the state's decision to participate in RGGI in legislation according to the 519th act. The terms of the pass in a certain extent, will also promote the withdrawal of RGGI of other state governments, and it is likely to delay the inspection of its emissions ceiling.

California Emissions Trading System (CAETS) In CAETS, emission quota is based on free allocation and auction as a supplement. For industrial enterprises, 90% of the emission quota will be distributed free of charge, and the rest of the market is sold through the market, the target of which is to maintain the competitiveness of industrial enterprises, promote the low-carbon transition of the industry and at the same time, avoid emissions shift caused by the large number of the relocation of industrial enterprises of California. For electric power industry, power transportation enterprises can get free emission quota to ensure that consumers can get the return of benefits, while power generation companies need to purchase emission quotas from power transmission enterprises or carbon market aiming at promoting power generation enterprises to take the emission reduction measure, to use low-carbon energy control greenhouse gas emissions. To minimize the cost of greenhouse gas emission reduction, CAETS successfully dock with other projects in the United States. In addition to its own emissions reduction measures and the purchase of quota in carbon market in California, CAETS allows enterprises to meet their emission reduction targets by buying compensation outside California in the United States, using domestic emission reduction targets, using emission reduction targets in other trading mechanism s already approved. First, in terms of compensation for the project, projects must be derived from areas in the United States in which total carbon emissions has not been controlled by legislation, according to the design of carbon trading system in California, including 4 types of emissions from deforestation, city forestry, ozone depleting substances, reduction of livestock digestive gas. It may expand to Canada and Mexico in the future, the aim of which is to encourage areas outside California to work on carbon emissions. And it is conducive to the cultivation of determined emission reduction market outside compulsory emission reduction market, which will effectively control total carbon emissions within a larger area.

Second, on the use of other domestic emission reduction targets and the emission reduction targets within other trading mechanism s that have been approved, CAETS requires the use of the ratio cannot exceed 8% of the total the target.

The Western Climate Initiative (WCI) and the total control and trading system of California.Implementation of WCI will occur in phases, and it takes a gradual development pattern. It mainly deals with the power industry and large-scale industrial facilities in its early stage, and then extends to the residents, businesses and other industries, transportation and other industries. For large industrial facilities, free allocation is the basic way, later transiting to auction, so as to help the industry to achieve the transformation and prevention of industrial emissions transferring; and the initial free development is also the change from the grandfathering to the benchmarking : The first year's quota is determined by the historical emissions data, which is close to 90% of the previous year's emissions, and later, the annual quota will be based on the output and efficiency of the benchmark. For power facilities, the quota will be distributed free of charge to protect the public interest from damage. WCI allows the transactions and storage of quotas and 4% of the total quota can be reserved into the quota price control; it also allows using emission reduction targets to connect the quota of emissions trading mechanism, but it cannot exceed 49% of the total target. In offsetting the amount, WCI allows the carbon offsets, but it set up the most stringent ceiling (8%) because they learn lessons and experience of ETS-EU and RGGI, at the same time, WCI rejected a large number of CDM projects that can be supplied, other offsets also have a lot of restrictions and they are very difficult to meet.

**②. Europe**

At present, the EU's low-carbon legislation includes four parts: (1) EU ETS directive; (2) the target allocation instruction of the department that ETS doesn’t cover; (3) renewable energy directive; (4) carbon ceiling ability and storage instruction. At the same time, the European Commission has passed the three route map related to long-term reduction targets: (1) Road map 2050—toward a competitive low-carbon economy; (2) energy Road Map 2050; (3) White paper of Europe of a single transport area road map. However, in terms of energy efficiency, EU upgraded energy efficiency program (EEP) to energy efficiency directive (EED) in 2012, so the legislation on energy efficiency is established on the EU level, but the target to improve 20% of the energy efficiency is not a legally binding one on the EU level. Energy efficiency directive established the EU-wide energy efficiency policy framework, and at the same time, EU complemented the energy efficiency directive according to minimum energy efficiency standards, energy efficiency labeling, building energy efficiency instruction and the control of several traffic areas. For example, in the road transport sector (about 12% of the EU emissions), and EU control road traffic emissions mainly through the emission standards (not more than 130 grams of C02/ km in 2020, and not more than 95 grams of C02/ km in 2015).

Since the beginning of the Kyoto Protocol, total EU allocation has experienced three stages of policy till now: 1) the negotiation among 15countries of EU of the first commitment period of the emission reduction targets under the Kyoto Protocol; 2) 2008-2012 negotiations of the state allocation plan of the member states in the second phase of ETS; 3) climate and energy package plan from 2013 to 2020 made in 2008. In these three stages of policy, in order to make the Member States better integrated into the EU's overall climate policy, EU set up a series of principles, targets and policies. These policies also provide valuable experience and lessons for the emission target decomposition of the ongoing 13th Five-Year Plan.

**The first phase (Kyoto Protocol target)**

The quantified target of emission reduction of the EU's first phase is based on the allocation of the EU in the 15 member countries, which is under the "Kyoto Protocol". First, the European Union analyzed the emission reduction targets all countries should bear based on the three element method, which account the level of emission reduction based on the electric power, the export intensive industries and the domestic sector, and add the emission reduction quota of member states up. The result of the analysis is not the final solution, but as the starting point of political negotiations, it helps define the bargaining space of the member states. Second, the method of the three elements turned the focus from the national emission reduction target allocation to the emission reduction on sector level. It allowed the demand for the increase of electricity and industrial sector emissions of the former Soviet Union countries, and treated high energy consumption and trade intensive sectors in accordance with the same carbon intensity and energy intensity reduction rate. Third, as a result of political negotiations, the targets were adjusted substantially, especially adjusted the increase of the emission reduction targets of the former Soviet Union countries to a new height.

**The second phrase (2008-2012)**

In the second phase of the EU emissions trading mechanism, the EU-ETS emission ceiling abilities are determined in a down-up manner. Each member state defines a national allocation plan, and the total emissions trading mechanism on the EU level will be formed after plans are added up. Therefore, in the second stage, there are four policy targets coexisting at the same time: emission limits for the 15 EU countries under the Kyoto Protocol, targets of member states in the Middle East, the ceiling of EU emissions trading mechanism (including the EU's 15 members and the members in the Middle East), and national allocation plan for each member state. EU emissions trading mechanism is limited to the limit of the Kyoto, since if the committee is to ensure that the quota of EU member countries in the EU emissions trading mechanism meet their Kyoto commitments, 15 countries of EU will buy extra quotas of member countries of Middle Eastern EU("Hot air") in order to achieve the Kyoto target. Therefore, the European Commission will carry out a large reduction for the majority of member states of the national allocation plan. The reduction of the Central and Eastern European member states of the national allocation plan is

particularly evident, with an average of 28.9% (only 6.8% in the EU's 15 member).

**The third phrase (2012-2020)**

The target of the third phase of the EU is to target its energy climate package plan in 2020, which including three targets: greenhouse gas emissions decreased by 20% by 2020 compared with that in 1990, and by 2020 renewable energy in primary energy accounted for 20%, energy efficiency increased by 20%, in which 20% of the greenhouse gas emissions and the target of renewable energy accounting for 20% is legally binding, so it needs to be decomposed at the European level. To this end, the European Commission considered, fairness and transparency should be reflected in the index decomposition and the degree of contribution of different member countries should be different. First of all, the European Commission has distinguished industries that are covered by the EU emissions trading mechanism and the industry has not been covered by EU-ETS. The industry that ETS covers needs to realize the 21% of the reduction in 2020 on the basis of that in 2005, which is a top-down determination of emission ceiling different from the ceiling set up in a down-top manner in the second stage. The industries that are not covered by EU-ETS need to achieve the target of 10% of the reduction in 2005 and emission reduction quotas of these industries are allocated among the EU member states according to the per capita GDP. However, for the share index of renewable energy, half of the growth quantity was equally distributed among Member States and the remaining half is allocated based on per capita GDP. The allocation is classified according to the principle of equality and ability not considering the marginal costs of member states. The realization of the EU's emission reduction targets and the share of renewable energy of the third phase depends on the trading mechanism between member states, allowing three trading mechanism of renewable energy share: renewable energy share trading among member states, joint support plan and joint personal projects.

**The fourth phrase (2020-2030)**

At present, the EU is preparing for the emission reduction targets of 2020-2030 and their decomposition of total amount. The targets include greenhouse gas emissions reduction of 40%, energy efficiency increasing by 30%, and renewable energy accounting for at least 27%. The three targets are similar to the target in 2020. The reduction targets of greenhouse gas emission will be decomposed in the ETS and the departments that ETS doesn’t cover, and the latter part will be further decomposed into member states, while the renewable energy targets continue to be decomposed among members. The decomposition method has not been finalized yet, but the current EU documents show that the decomposition method will continue the method of per capita GDP before.

**③. Australia**

Australia is the country of highest carbon dioxide emissions per capita in the Kyoto Protocol Annex I. In 2010, the Australian government announced that it will implement the fixed carbon pricing mechanism for 3-5years, and will gradually shift

to emissions trading mechanism. After negotiation with the Council and the legislative branch, the government decided to implement the carbon pricing mechanism in July 1, 2012. At the same time, Australia has also developed the domestic offset program, aiming to provide economic growth opportunities for peasants, farmers and landowners and improve environment by reducing carbon dioxide emissions. Some offsetting quotas may be allowed to use during fixed prices. At the national level, renewable energy targets are still the most important market mechanism to reduce carbon dioxide emissions. With the announcement of the new plan in 2011, Congress passed the application of the separation of RET into two parts, and RET was split into a large- scale renewable energy target (LRET) and small-scale renewable energy program (SRES). At the state level, the plan including GGAS is being implementing. GGAS is the world's first batch of compulsory greenhouse gas emissions trading system, aiming to reduce greenhouse gas emissions associated with production and power.

Australia's carbon pricing mechanism is divided into two stages. **The first phrase** is the fixed price stage (July 1, 2012 -June 30, 2015), which didn't set emission ceiling, and its emission quota is divided into free and fixed price auction. In this stage, some enterprises mainly involved were the top 500 carbon emissions in Australia, and the emphasis are enterprises whose carbon emissions is greater than 25000t greenhouse gas, not including carbon emissions from small businesses and households. The industries involved include fixed energy, transportation, industrial manufacturing, sewage, garbage landfill, and escaping gas, covering about 60% of carbon emissions in Australia. The industries with higher emissions adopted the method of free allocation, but other industries (including energy, transportation, industrial sector and other industries, etc. About 500 fixed emitters) must obtain emission quotas by auction with the price of 23 Australian dollars / ton that government stipulated. After2012, until the end of the first phase, carbon prices increased by 2.5% per year (inflation needs to be considered). **The second phrase** is the phase with floating price (after July 1, 2015). The "ceiling trade" mechanism is implemented in this phase, fixed carbon price is canceled, and prices will be determined by the market. Early in 2014, the Australian government has set up the 2015-2020 emissions ceiling, and real ceiling trading system will be taken into use. Electricity sector, fossil fuel companies, and transportation departments will be included according to the relevant requirements of the carbon pricing mechanism, and the price was expected for 29 Australian dollars / ton in 2016. In the "ceiling trade" mechanism of the second phase, the government will grant the allocation of emissions quotas for free or by auction. The carbon market participants can get some part of the emission quotas for free based on the amount of carbon emissions in the base year, but free emissions will be reduced year by year. Participants can meet emission ceiling through technological progress or the purchase of domestic emissions quotas. In this stage, Australia allows the accumulative use of carbon emissions units, and the carbon emissions units in the future are also allowed to use in advance, in other words, it allows the storage and borrowing of carbon quota. However, it should be noted that

the cumulative amount of use is not limited, and the carbon emissions unit used in advance cannot exceed 5% of the total annual quota.

On offsetting mechanism, Australia allows the use of emission reduction targets from the CDM and JI projects in two stages with the ratio of use not exceeding 50%, and it also accepts the emission reduction targets from CFI, but in the first phase (June 2015 30) the ratio of the use cannot exceed 5% and it won't be limited in the second phase (July 1, 2015).

**④. Japan**

Tokyo is the first city in Asia who has control of total carbon emissions and trading mechanism, also has the world's first carbon emissions trading system in the city level. Control target of total carbon dioxide emissions in Tokyo is that by 2020, greenhouse gas emissions reduced by 25% compared with that in 2000. The basic idea of the decomposition of the target is to improve the system of grandfathering, fully consider the factors of social and economic development and simulate the baseline scenario of 2020 in the situation of maintaining current policy, so as to determine the reduction of each department, fully consider the fairness and efficiency of the society. At the same time, it uses the principle of grandfathering on the quotas allocation of pollution sources within the various departments, that is distribute them to the enterprise freely on the basis of the level of facility history. Carbon emissions control of Tokyo city includes industrial and commercial sectors (Including large buildings and facilities).

**⑤. New Zealand**

In November 2002, New Zealand's parliament passed the "climate change bill". In September 2008, New Zealand policy makers amended the bill, because they thought that transfer new products to other countries that were relatively loose would have a negative impact on the economic and social two aspects of the New Zealand economy on the premise of considering the impact of carbon leakage on the domestic environmental efficiency, thus giving NZ ETS (New Zealand carbon market) the possibility to reduce the international competitiveness of manufacturers.

According to the amendment, NZ ETS is an emission trading system with no ceiling for all departments and all the greenhouse gases. The system takes a step by step approach, and different industries enter the emissions trading system in different phrases (Forestry carbon sequestration project in 2008-2010 stationary energy sources, industrial and liquid fossil fuels-agricultural sector in 2015). In transition period, participants have to buy NZU with a price of 25 dollars / ton, and fixed energy sector, liquid fossil fuel and industrial processing sector turned over 1 unit NZU every discharge of 2 tons of carbon dioxide. For sectors affected by emissions trading, quota will be free of charge. Although the new bill is set out to protect the industrial sector, the new law is a fiscal neutral on the whole and the revised bill is expected to increase government revenue in the medium and long term. The amendment proposed that

allocation quotas will be distributed by the 90% of the 2005 emission levels, and then decline until 2029. The amendment bill extended the allocation system of free emission rights quota to 75 years. Although the bill provides a more obvious incentive for enterprises to increase their own output in a certain way, the allocation of quotas is not directly referring to the actual emission levels. In accordance with regulations, emission quota will be distributed on the basis of the output of the private enterprise and the benchmark values for different kinds of activities.

Study of many models (Graichen, etc 2009) showed these concerns were often overstated. Allocation system of emission quota was considered to be the culprit in the first phase of ETS NZ because it caused massive economic losses in the power sector and high emission intensity of exports soared. But in the NZ ETS directory, Kerr and Zhang(2009) found that changes in land use patterns and intensity will not produce the price of 25 dollars / ton carbon and emphasized that the carbon leakage in the agricultural sector in New Zealand is very limited. The cost of free quota method's preventing the production from reducing is very high when considering the negative effects of agricultural production to the environment.

In the first half of 2011, New Zealand government conducted a comprehensive verification of ETS NZ to determine whether it was comprehensive and effective. Verification is mainly concentrated in the impact on domestic investment and operational decisions from agricultural sector, the allocation mechanism of NZUS, the rationality of the fixed price ceiling (25 dollars), greenhouse gas emissions and trading system. In 2011, New Zealand NZUS market was relatively stable. The market price was between 17 and 22 New Zealand dollars, tending to follow the CER price to produce 10%-15% of the fluctuations.

## 2.3 Lessons learnt for China's low carbon policy

### 2.3.1 Making clear the control of total carbon emissions targets of China and establishing the national carbon trading system by legislation.

In 2009, the government put forward the target of carbon emission intensity 40%-45% lower than in 2005 by 2020. During the "12th Five Year Plan" period, the target is proposed to reduce carbon emissions 17% lower than in 2010 by 2015. In 2014, the Chinese and American leaders put forward the target of reaching the peak of China's carbon emissions before 2030. These targets form a good basis for China to set up absolute total carbon emissions. To ensure a clear mitigation signal to industries and residents, a total carbon emission target is suggested. Actually, it is not difficult to combine the trends economic and social development and industrial structure with the anticipated improvements of low carbon technologies to clearly lay out the national total emission path in the near future. Putting out the total control target step by step can not only exert clear drivers for energy-saving and low carbon technology development, but also avoid sunk cost locked in carbon intensive industries and

infrastructures during the further urbanization and industrialization process in China.

The set of the total emission targets should comply with the principle of putting difficulty after the ease and putting tight after the loose, so that enterprises gradually adapt to the situation and there are differences of the emission reduction efforts between existing enterprises and the future of new entrants. For example, under the framework of the European Union, the third phase (2013-2020) of the total annual emissions in the third phrase fell by 1.74% than the period from 2008 to 2012 and 2.2% in the fourth phrase (2021-2030). And in the RGGI system of the United States, enterprises maintain the existing emissions in the first phrase (2009-2014) and the emissions begin to decline 2.15% per year from 2015.

At the same time, China needs set up a national carbon trading system by legislation, and it is clear that the legal system of the carbon trading system is compulsory and effective. The Chicago Climate Exchange (CCE) is the world's first voluntary participation in greenhouse gas emission reduction platform which is operated since 2003. However, there is no transaction but for a few months therefore it already exists in name only. From its failure we can find that it is difficult to achieve the established emission reduction targets and protect the climate security just through voluntary trading.

The legal effect of the carbon trading system is to establish strict enforcement mechanism, to guide the implementation of the carbon trading system, and to punish the destruction of the carbon trading system. The EU's experience is worth our thoughts. According to the EU regulations, during the EUETS trial run phase, per excess emissions of 1 tons of carbon dioxide will be punished 40Euros for the enterprises. In the formal operational phrase, the amount of fines is raised to 100 Euros per ton, and it will also be deducted from the excess emissions from the following year's business emissions permits. Clear targets, complete laws and regulations and strict enforcement mechanisms, all of these make the EU's EUETS gradually become the global leader in the global emission reduction actions. But in Australia, if the enterprise in the phrase still cannot meet the carbon emission reduction targets through carbon trading and offset, the carbon emissions per unit shortage should be paid , and the shortage of carbon emissions per ton of carbon for the same period of 200%.

### 2.3.2 Setting clear the provincial and municipal targets to develop national unified plan

The ideal case for implementing a national total emission target in China is to allocate it into provinces and municipalities directly. However, the EU experience is suggested to learn to avoid political difficulties. In the first and two phrases of the EU-ETS, the European Union has not set the absolute total control target, but rather to hand over it to all the member states. According to their own situation, the member states have established the relative total control mechanism based on the emitters. And it also can be embodied from the national allocation plan. And the total emission for

the member states is controlled by the allocation of the quota. This approach is conducive to the understanding the specific circumstances of the country, in order to prepare for the setting of the overall absolute amount of the target in the EU level in future. And this also will mobilize the enthusiasm of the country which is conducive to the development of the early trading system. During the third phase of the EU-ETS, the EU canceled the national allocation plan. A whole EU's total carbon emissions, that is, the absolute total control targets in the EU level replaces the total carbon emissions of 30 EU countries (including 27 member countries). The total control mechanism of the third phase not only expands the scope of emission industries, but also helps the total emissions decrease year by year in accordance with the plan in a linear way. The practice design of carbon emissions trading practices from member countries to the EU level has great implications for the development of carbon trading system in China.

For the development of carbon trading market in China,.f**irst of all,** the method of making a local plan should be taken in the early phrase of the implementation of total carbon emissions and carbon emissions trading system, that is, each province develops the province's emission reduction plan according to the total carbon emission target, thus the summation becomes the national total control target. Because of the large differences in industrial structure and energy consumption in different provinces, the localization of emission reduction plan will help to improve the environmental and economic benefits of emissions trading system as well as relieve the political difficulties.

**Secondly**, with the continuous development of the total carbon emissions and carbon trading system and more comprehensive understanding of the carbon control policy and regime both nationally and locally, and more importantly, with the necessary legislation for carbon trading system mature, the country will allocate its national target into provinces and municipalities.

### 2.3.3 Making clear the principle of quota allocation to industries

In the early years of the total carbon emissions and carbon trading system, the provinces and municipalities independently develop the local targets, but there must be a clear quota allocation principle set nationally, to guide the provinces and municipalities for quota allocation to the industry. On the whole, our country's quota allocation principle is suggested shift from "majority free quota with auction quota as supplement" to "majority auction quota with free quota as supplement". At present, the 7 pilot provincial carbon trading systems all adopt the allocation system of "majority free quota with auction quota as supplement".

**Firstly,** in the early days of the implementation of the "majority freewith auction quota as supplement", the allocation mechanism, the improvement of policy feasibility and the impact on enterprise competitiveness should be taken into consideration. The free allocation of quota has greatly weakened the willingness to

resist the participation of enterprises, but also has stimulated the enthusiasm of market players in the transaction. In addition, because the total the emissions subject to its historical emissions level or industry benchmark value as a benchmark, it can meet the needs of enterprises in the past, the general situation will not have a big impact on the business. And if the enterprise reduces the emission, the enterprise can also sell the surplus quota to obtain the profit, so that the enterprise can fully enjoy the emission reduction flexibility given by the emission trading market. Free issuing quota is the first and the highest acceptance of the quota issued by the legislators and the enterprises in the market. It can effectively avoid the negative impact on the economic development in the early phrase of the carbon market. But the free quota method, especially the grandfathering in many aspects of scale disease, such as free quota allocation caused by reallocation effect of the expected, limiting the carbon trading system internal coordination, thereby reducing its economic efficiency.

**Secondly**, it is the inevitable trend in the future to shift from the "majority free quota with auction quota as supplement" to "majority auction quota supplemented by free quota". **First**, in the auction quotas in the process of transformation from the free quota to, according to international experience, generally to participate in international competition in the industry (such as electricity and heat production) can be first introduced quota auction system and gradually expand the auction. And for those departments participate in the international competition and have the impact of the international carbon spill, continue to use the free allocation method to carry out the quota allocation, which can achieve the emission reduction of the international competitiveness of our country. **Then**, in this transition process, the free quota method is also needed to be changed from the system based on the grandfather to the system based on the benchmark, because the benchmark system is more able to mobilize the initiative of the enterprise, driven by the development of energy-saving and emission reduction technology. But the achievement of this point has a relatively large degree of difficulty. It is necessary to pay attention to the different stages of the same period, which may be in the different stages of the transition process, and need different allocation mechanism. Therefore, this process must put the industry as the starting point for different industries to develop a different specific allocation mechanism. But all industries in general conform to the above process of transformation. Shanghai, for example, adopts the principle of the implementation of the system for the majority of industries in the industry, and the condition of the benchmark system allocation for some of the industry. And Shenzhen adopts the allocation mode based on the industry benchmark system for part of the industries in the first trading period, such as electricity, water industry, etc. For other industries, method of making combination with historical emissions, industry emissions levels, future emission reduction commitments and other factors and then take the same industry in the competitive game of enterprises in the innovative way to determine the quota.

In the transformation process from "free quota based, with the auction quota as a supplement" to "auction quota based, supplemented by free quota", it is not required

for the whole country to enter the "auction quota based, supplemented by free quota" mechanism for the vast territory of the China and different level of the development of the different areas. Different provinces can gradually adopts the mechanism of "auction quota based, supplemented by free quota" according to their own level of development. And the nation should control the ultimate time node of the "auction quota based, supplemented by free quota" allocation mechanism.

In the allocation mechanism of "auction quota based, supplemented by free quota", there are two types of auctions that can be sold at a uniform price auction and in order to unify the price auction and to distinguish the price auction. In order to maximize the economic value of the quota, when the quota is relatively scarce, it should be taken to distinguish the price of the auction; when the quota is relatively sufficient, should adopt a uniform price auction. The uncertainty of production cost will weaken the ability of the individual value of the tender, and reduce the efficiency of the government tax revenue and the auction. When the uncertainty is high, the government should adopt the different pricing.

**Thirdly,** after the "auction quota based, supplemented by free quota", the achievement of the "full auction" is closely related to the development of the country. If the quota is not for the auction, the allocation will be influenced by political factors, but the full amount of carbon emission quota will increase the production cost of enterprises, influence the industrial development, and the long-term development of China's economy. Any state of the RGGI is not willing to lose the industry because of the cost of carbons. For example, the state has to provide the maximum limit, which leads to a low-carbon price. Currently in the EU, EUETS quota allocation mechanism still adopts the mixed allocation mode of free allocation and allocation and still has not been developed to the full extent of the auction. And all of this can effectively promotes the full implementation of EUETS and avoids the loss of income caused by all free allocation modes. It is easier for the company to accept the emissions than all auctions. However, the EU forecast to achieve full auction before the ripe of the conditions in 2030. And by this time their experience is worth our thoughts. From the 7 carbon trading pilot provinces and cities in China, we can find that they are all economically developed regions. Currently full auction is unable to implement, because this may cause the relocation of enterprises, capital loss, the declination of the attraction of investment and also has the greater impact on the local economy. Therefore, the time of the all auction quotas for China's carbon trading should take full account of China's economic development trend, the economic structure changes and other conditions.

### 2.3.4 Continuing to expanding gradually the industry and trading gas coverage

Combined with the United States, the EU's total carbon control and the industry coverage of carbon trading market, a gradual process is reflected from the main emission industries and emissions gas.

In the United States, WCI expanded the industry coverage of the emissions trading system putting RGGI as a starting point. The electric power industry is the key industries and areas of the existing regional emissions trading system. The main reason is that the power industry is the main source of carbon emissions and it has a relatively low cost of emission reduction space, a relatively standardized and complete regulatory and better data base. In addition, the power industry is not involved in the international competition and the domestic competition is not fierce. Therefore, the impact on the overall economy is still under control. In the EU, the first phase of EUETS only covers the main power and large industrial enterprises exceeding more than 10000 large emitters. And all the emissions of these controlled enterprises accounted for 50% of the total emissions of greenhouse gas emissions and about 40% of the carbon dioxide emissions. And all of these aim to accumulate experience and lay the foundation for the subsequent stage. And a greater range of corporate emissions and greenhouse gases is beginning to be covered in the second period, such as the emission of carbon dioxide, nitrous oxide and so on of the traffic industry, petroleum chemical industry. In Australia, the first phase of the carbon trading mechanism is mainly related to the Australian carbon emissions in the top 500 enterprises, focusing on the greenhouse gas companies whose carbon emissions is greater than 25000t, not including small businesses and family carbon emissions, covering about 60% of carbon emissions in Australia. In the second phase more industries will be covered. And in Tokyo, Japan, commercial development is great and the industry is relatively small, and the largest carbon emissions are from the commercial areas, accounting for 37% of the total carbon emissions in Tokyo, more than 26% of the civilian areas and 26% of the transport. To this end, the government will focus on reducing emissions of carbon dioxide emissions, for those large commercial office buildings, factories of the carbon dioxide emissions to establish a compulsory carbon emissions trading system, and the purpose is to implement the emission reduction responsibility on the shoulders of large emitters.

Therefore, we should focus on the carbon industry and enterprises in China, including high pollution and high emissions industries, such as steel, cement, electric power, chemical and other industries. And then try to integrate the low emission industries, such as transport, agriculture into the control, taking a gradual method. Aiming at the selection of the targets, the carbon can be considered as a starting point, from the point to the surface, and it is gradually extended to the greenhouse gases such as methane and hydrogen.

At the same time, being different with the United States whose electricity price is greatly impacted by the market, most of China's power companies are state-owned enterprises, whose prices is decided by the government. If the electric power industry is put into the carbon trading system, the Chinese government must take into account that the cost of power generation companies will lead to the rising demand for electricity prices, thereby causing a series of complex issues such as price increases. However, because of the balance of the China's regional economic development and

the large income gap, the different groups of people have the different affordability on the price.

### 2.3.5 A price risk management system is suggested to establish in order to adjust and stabilize the carbon market.

In the initial phrase of total carbon control, the government should set aside a portion of the quota when determining the total allocation and the allocation mechanism. This part of the quota can be used to provide for the new comer of the industry in order to avoid excessive increase industry evaluation threshold, which greatly affect the development of the industry and competitiveness. On the other hand, it can help to adjust the carbon market price when greater volatility is appeared in the carbon price and to stable carbon market, playing the role of "safety valve", in order to effectively avoid the occurrence of the EU market quota prices continued to fall or change radically etc.

In addition, considering that the market mechanism is not perfect, the role of price risk management mechanism should also be played in the process of building emissions trading system in China. For example, the introduction of the "daily limit board" system which has been maturely operated in the stock market, can not only make up the disadvantages caused by fixed price and other rigid policies that lack of flexibility but also be appropriate to reduce the price uncertainty caused by purely relying on the market mechanism, thus regulating and stabilizing the carbon trading market.

As early as the country's carbon trading pilot in these 7 major cities, the method of the retention of a portion of the quota and the establishment of a price risk management system have been passed to stabilize the carbon trading market. Shenzhen, for example, increase the market supply and inhibit the rapid rise in prices in order to control the price of fixed price to the control unit for the sale of market regulation reserved quota. And the provisions of the market to adjust reserve quota can only be used to meet the emission reduction obligations of the unit, cannot be used for market transactions. In addition, Shenzhen has also passed the quota recovery mechanism to reduce the supply of carbon units in order to prevent the emergence of too low prices, and the amount of the repurchase cannot exceed 10% of the total year. Shanghai has also established the corresponding risk management system to limit the rise or fall. Beijing's carbon price protection mechanism includes: most transactions should be done on the electronic trading platform, but if the parties have a large relationship or transaction volume, the OTC way is needed to be chose to avoid the emergence of price volatility in the trading platform; price early warning mechanism should also be established when the emission quota trading price is abnormal fluctuations. And the government will stabilize carbon emissions trading prices by means of an auction or recycling quota. This is similar to the mechanism in Shenzhen.

In Japan, the Tokyo government is free to install solar power, and all emissions

are for the Promotion Center of Preventing Climate Warming. These reduced emissions will be stored in the solar power bank by the center, and then will be sold in the form of green electricity certificates. Government can also put these quotas for the use of regulating the carbon market, not only embodying the emission reduction market value, but also popularizing the awareness of energy conservation and emission reduction thus encouraging the participation enthusiasm of enterprises and public and realizing the "three win" situation among the government, society and the public.

**2.3.6 A complete compulsory reporting system should be established**.

For the carbon trading market, independent, target and accurate carbon emissions monitoring is the most basic guarantee. Currently pilot provinces and cities have adopted a relaxed attitude with no compulsory requirements for the application of emission quotas, and incorporate the unit of compulsory emission reduction obligations into quota management.

In the EU, EU- ETS set up the three compliance monitoring procedures including "emission permit and registration", "inspection, report, verification", "the quota shall be paid, canceled and punished". On compulsory emission permit and registration system, EU-ETS stipulated that controlled emission enterprises must first apply for and obtain a permit for greenhouse gas emissions and open an account in the national registration system to ensure that the issuance, holding, trading and cancellation of the quotas are accurately recorded and tracked. On the monitoring, reporting and verification of greenhouse gas emissions, emission enterprises shall submit to the competent authority at the end of each year to submit a certified greenhouse gas emissions report. If the competent authorities are not satisfied with the report, then its quota shall not be transferred until the report is certified and the competent authority is satisfied. In the turn over, write off and punishment procedures of the quotas, emission enterprises shall turned over the emissions quota equal to actual emissions in the previous year after the annual quota of the controlled enterprises was discharged by the competent authority, and quota would be canceled and couldn’t be used. If the actual discharge is higher than the assigned quota, enterprises need to obtain quotas from the market or use the emissions that the CDM mechanism or JI mechanism generate to hedge the actual emissions. If failed to complete the performance, they will be sentenced to a fine. However, the EU has the problem of the punishment mechanism that cannot be paid in full, because EU-ETS stipulated that they must accept the punishment by paying a fixed penalty. If the market price is lower than the penalty unit price, the controlled enterprise will perform by purchase quota through the market; if the market price is higher than the penalty unit price, it may occur that the controlled enterprises sell excess quota and are willing to bear the phenomenon of a fine. Fixed penalty unit has lost its original significance of performance penalty in the case of the continuing lower of the current EU quota prices.

In the national carbon trading system, it is recommended that the government

provide compulsory permit system of greenhouse gas emissions to identify the source of the right to emit greenhouse gases in controlled enterprises; establish compulsory reporting system and the enterprise under compulsory implementation report the company's carbon emissions information to the regulatory unit; set up special monitoring agency of carbon emissions, independent verification mechanism of the third party, and specialized trading platform of carbon emissions to supervise the market transactions and statistical monitoring and assessment of carbon emissions data for enterprises. In the paid, write off and punishment procedures of the quota, it should collect the experience of the pilot provinces and cities in the punishment mechanism, and set a fine based on the average price of the market, and at the same time penalty mechanism including the suspension of the qualification of various financial funds, energy-saving projects should be implemented based on China's national conditions.

To ensure independence and objectivity, the third party verification system should be established and improved in the verification and certification of carbon emissions, and ensure that the true interests of the third party certification body and the scientific and target authentication method. For example, the emergence of repeated sale of CER events occurred because of the existence of loopholes in the third party certification system in EU in 2010. Firstly, China should establish strict quality standards and foster third party certification market on learning from the experience of the credit rating industry; secondly, we should improve the internal and external supervision system of the third party certification body, and strengthen the internal control of the third party certification body in accordance with improving the external regulatory behavior of the government, society; finally, clear market exit process should be established, and enterprises that lost the certification qualification should be ordered to exit carbon trading market as soon as possible.

# Section 3 Practice and Supporting Policies of Low-Carbon Policy in Various Countries

## 3.1 The choice of the policy instruments

### 3.1.1Practice of low-carbon policy in various countries

Since 2010, the major countries have actively adopted the low-carbon policies and measures to address climate change. The targets and tools of low-carbon policy in various countries are not the same, but mainly include economic instruments (carbon tax and carbon trading) and regulatory policies. The following table lists the main policy targets, systems and the progress in some important areas of major developed countries and developing countries since 2010, such as America, Germany, Britain, Japan, India, Brazil and South Africa and so on.

Table 2-3: the collection of the low-carbon policies in various countries

| Countries | Targets | Major policies and systems | The progress in some important areas |
|---|---|---|---|
| America | To reduce America's emission of the greenhouse gases by 26% to 28% by 2025;<br>To deal with the influence of the climate change;<br>To make efforts to lead the world to deal with the influence of the climate change; | America's plans of actions for climate change published in 2013 mainly contains:<br>To decrease the emissions of the carbon of American existing power companies;<br>Loan guarantees of 800 million are being used to support the energy efficiency;<br>To realize the energy efficiency standards and reducing the emissions carbon dioxide up to 300 million by 2030;<br>To improve the fuel consumption of camions;<br>To reduce the emissions of the HFC and deploring the complete plans to decline the emissions of methane and to protect the forests and the soil; | EPA published the new standards of the emission of carbon for power companies in September 2013 and the existing standards in June 2014;<br>The government budget of the clean energy was improved by 30% in 2014;<br>Being in the process of researching the standards of fuel consumption for camions after 2018;<br>The government is in the priority of purchasing the substitution of HFC; |
| Germany | To reduce the emission by 40% by 2020, by 55% by 2030, by 70% by 2040 and by 80% to 95% by 2050;<br>To increase the proportion of renewable energy by 60%;<br>To reduce the use of primary energy by 20% by 2020 and by 50% in 2050;<br>To improve the speed of the renovation of the buildings to the | To implement the trading of total carbon emissions;<br>To establish the structure of the renewable energy-based supply of the energy;<br>To promote the further reformation of the electric power mint;<br>To develop the intelligent electrified wire netting and divergent electric power generation;<br>To devote 340 million Euro to the plan of energy investment;<br>To deplore the stored energy and PZG technology; | Reformulating a series of laws such as thermoelectric law and energy tax law and establishing he transmission channel of the renewable energy;<br>Devoting 20 million Euro to deplore the stored energy;<br>Reformulating the standards of the building energy efficiency and demanding the use of renewable energy to supply heating for some new buildings; |

| | | | |
|---|---|---|---|
| | energy efficiency standards from 1% to 2%; | | |
| Britain | To reduce the emission 80% lower than the 1990 level by 2050, and 34% lower than the 1990 level by 2020; | To pass the second legislation to determine a five-year-period carbon budget and the fourth carbon budget will cover the period from 2023 to 2027, 50% lower than the annual emission; | Introducing the emission standards for the passenger vehicles and light or heavy lorries;<br>Introducing the lowest limit of the price of carbon;<br>Establishing green investment banks;<br>Updating building energy efficiency standards;<br>Introducing the quota of the renewable energy; |
| Japan | To reduce the emission 3.8% lower than the 2005 level by 2020; | To improve the building of the low-carbon communities;<br>To establish the intellect traffic system;<br>To improve the technology of high-efficient electric power generation;<br>To decline the emission of the greenhouse gases during the garbage disposal; | Passing the law of low-carbon city;<br>Improving the research and development of technology of the advanced super criticality and battery generation using coal gasification fuel;<br>Realizing the practicality of the use of CCS by 2020; |
| India | To reduce the emissions per unit of GDP 20% to 25% lower than the level of 2005 by 2020;<br>To increase 30GW renewable energy from 2012 to 2017; | To develop the advanced technology of coal fuel electric power generation;<br>To run the national wind energy plan;<br>To run the national solar power plan;<br>To improve the energy efficiency of the steel, cement and other industries;<br>To improve the standards of fuel consumption of the passenger vehicles;<br>To further use of the standards of green buildings;<br>To spread the lighting equipment and the identification of energy efficiency; | Establishing the system of energy efficiency trading---PAT;<br>Developing the in-line PVZOGW, off-line PVZGW and 20 million square meters by 2020;<br>Establishing the lower price of surfing the Internet by using the renewable energy and declining 5% of the import tax of photovoltaic units; |

| | | | |
|---|---|---|---|
| Brazil | To reduce the emissions 36.1% to 38.9% lower annual BAU by 2020; | To decrease and control the actions of destroying the forests;<br>To develop the alternative energy; | Establishing fifty million hectares protected land and satellite monitoring system;<br>Spreading the use of ethanol for cars and the use of charcoal as reducing agent; |
| South Africa | To reduce the emission 34% lower annual BAU by 2020 and 42% lower by 2025. | To increase the energy efficiency by 35% by 2020. | Establishing the lower price of surfing the Internet by using the renewable energy;<br>Improving the standards of the building energy efficiency. |

With the downturn of the world economic, the sovereign debt crisis in Europe, debt and financial crisis of the United States, coupled with Japan's Fukushima nuclear accident in 2011, Germany and other countries gradually abandon the use of nuclear power and begin to seek new alternative energy. This declines the strength of global emission reduction apparently but also encourages various countries to pay more attention to the exploit of the clear energy. At present, the main national low-carbon policy presents the following trends:

**①. Paying attention to the development of low-carbon market.**

Britain in March 31, 2010 published the *More Than the Copenhagen - British Government Climate Change International Action Plan* thoughts that in the process of converting to low-carbon economy, the countries that make early actions will take advantage in emerging markets which is featured by low-carbon products and services. According to estimates, there is about 3.2 pounds of low-carbon market among the global economy. In this competition of low-carbon, the United Kingdom, of course, is not far behind. Britain's low-carbon products and services market is the world's sixth largest market, providing 112000000000 pounds worth of products and 910000 total groups of posts. The investment of the UK in the field of coastal wind energy development is placed in the world's leading and is expected to provide 70000 new jobs by 2020. According to the plan, it aims to realize the targets of reducing the emissions 34% lower by 2020 and at least 80% lower by 2050 by taking the measures listed in the British low-carbon transmission plan. These initiatives include four large commercial scale carbon capture and sequestration projects.

**②. Paying attention to the development of the low-carbon technology.**

Japan has taken great efforts to use renewable energy, to achieve zero emissions of buildings, to create an innovation of the air conditioning and ventilation aspects and also to make a new generation of vehicles and pipeline system in order to promote the accelerated development of these advanced technologies. Meteorological satellites and other means are used by Japan Meteorological Agency and other

departments to strengthen the observation of climate change. "Venus exploration program" has also been set up to study the rules of the atmosphere of Venus, and to reveal the laws of the earth's climate change. The study of climate change, such as the automatic measurement of carbon dioxide, methane, carbon monoxide is also strengthened. India is also planning to launch a satellite to monitor greenhouse gas emissions in 2013. In August 26, 2011, the Japanese Senate plenary meeting adopted the *Special Measures for Electric Utilities to Buy renewable energy and Electric Power* (referred to as *Renewable Energy Law*), providing a new "fixed price to buy renewable energy system", and that would be implemented in July 1, 2012, to further promote the development and utilization of renewable energy technology in Japan.

**③. Promoting employment with low-carbon and green development.**

13075 jobs have been provided by green economy in the United States, and the study believes that the green economy in 2038 will be a new increase in the United States 4200000 green jobs. According to the plan, the 10% of the total electricity in the United States in 2012 will be generated of wind energy, solar power and other renewable energy, the proportion will reach 25% in 2025. Obama proposed in the union of the states in 2012 that the United States should strive for the target of achieving 85% of electricity supply from the clean energy. The Obama administration has introduced some concrete measures to develop green industry and promote employment. Take some examples: nearly $2000000000 has been used in support of solar power companies, increased efforts has been taken to transform and support the development of the automotive industry, for the first time to launch a national unified vehicle fuel consumption standards, accelerating the upgrading of the United States and the United States car industry, and promised to provide $2400000000 in funding for the development of hybrid vehicles and new fuel cells, and also cut tax for the purchase of energy-efficient car consumers. As one of the measures to promote the development of green economy, in February 2011, the United States government also announced to headquarters in Atlanta, Georgia, the Southern Co to provide about $8000000000 in government loan guarantees to support the construction of two nuclear reactors, which is the first construction of nuclear power plant for the United States in the past 30 years. In August 11, 2010, Obama signed the United States manufacturing promotion act, through tax cuts to improve the competitiveness of the U.S. manufacturing sector, thereby creating more employment opportunities.

**④. Actively responding to external environmental changes**

After the Australia's new prime minister taking office, he first proposed the use of carbon emissions trading, holding the attitude of observing the actions of other countries firstly. But in September 13, 2011, the Gilad Administration formally submitted to Parliament a carbon tax "package plan", which contains 18 bills, and which marks the formal legislative process for Australia's introduction of the domestic carbon emissions trading mechanism. In October 12, 2011, the house of Commons in Australia is in a small majority of the carbon tax bill, that is, clean energy act 2011". In November 8, 2011, the Australian Parliament passed a carbon tax bill, so far, this

has become a formal law. After 3 years of carbon tax levy, it may transit to greenhouse gas emissions control and emissions trading mechanism officially. Australia, New Zealand and other countries take actions and train carbon trading talents in regard to promote the upgrading of low-carbon emissions industry competitiveness. Therefore, this is the strategic measure, which is also used by various countries to pay attention to the action of other countries, as well as the impact of these actions on their own and other countries, and then put forward their own countermeasures and make some early preparation.

### 3.1.2 The Characteristics of major countries' low-carbon policy and their enlightenment to China

**①. The characteristics of major countries' low-carbon policy:**

(1) Coexistence of multi-policy targets. For example, in the EU, they make a coexistence of the 2020 emission reduction targets, the total ETS quota, renewable energy and energy efficiency targets, and the coordination of different targets and policy tools is essential.

(2) Complement of market and non-market mechanism with each other. For example, the ETS coverage of the quota and the non ETS sector emissions reduction targets can be dissolved from the EU emission reduction targets. And ETS mainly covers the power, industrial and other single facility emissions, while transportation, construction and other sectors of the emissions are mainly through energy efficiency standards, identification and control. Due to the lack of legislation and market reduction means, most of the policy tools focus on the energy efficiency standards at the departmental level in other major developed countries outside the EU. For example, the construction of emissions reduction in the United States, in the transport and power mainly rely on energy efficiency and emission standards.

(3) Great attention to both carbon dioxide and non-carbon dioxide. Major countries have not only concerned about the energy related greenhouse gases, but the full consideration of non-carbon dioxide emissions opportunities, in the land use, waste management, HFCS and other fields to promote non-carbon dioxide emissions.

(4) Match between emission reduction policies and funds budget. For example, the United States, Germany and the United Kingdom give the corresponding financial support to the annual budget for emission reduction policies. With full budget support, the government can use the relevant resources to ensure the implementation of policies, greatly enhancing the credibility of the policy and implementation.

**②. For our country, the future needs:**

(1) To strengthen the combination among climate change targets and energy-saving targets, air quality targets, renewable energy targets and other targets,

coordinating the policy targets and policy tools of different sectors of and reducing the conflict between policy targets or tools.

(2) To make a complementary between the market and regulation and introduce some means of control in the centralized emitters, and the use of regulatory measures in the decentralized mobile source, but also to pay special attention to the management of the relevant industry and emitters in the carbon market after the establishment of the national carbon market.

(3) To pay more attention to emission reduction of carbon dioxide and push forward the reduction of non-carbon area.

(4) To establish the supporting funds and budget and the supporting financial budget in the annual budget in order to strengthen the implementation of the policy, and the relevant policy targets for the periodic review, through the evaluation of the effectiveness of policy targets and policy tools to effectively promote the effective policy targets.

## 3.2 Support system of total decomposition

### 3.2.1 Legal safeguard system

A legal system has been formed by EU ETS which is under the directives, plans of EU and regulations of the European Commission.

The EU directives: it is a legal requirement that the EU is to coordinate the current laws of various countries. Responsibilities should be taken by each member state government to coordinate their own laws and directives and to revoke the existing national laws that are in conflict with the instruction. The European Union's fundamental target is to eliminate the technical barriers to trade between EU Member States and to achieve "free flow" between Member States . A number of directives on emissions trading which is issued by the EU Commission is the basic legal documents of EU emissions trading system, which determines the various member countries to implement the emission trading system to follow the common standards and procedures. The allocation plan of the emission quantity and emission rights of all countries shall be effective after the approval of the relevant directive by the European Commission.

Projects: it includes the carbon emissions allocation scheme and the monitoring and reporting scheme for the carbon emissions and emissions of carbon emissions in the EU.

EU ETS Emissions Directive requires each member state to develop its own separate NAP, which is the national legislative basis for EUETS. Each member state

determines the total the country's total EU, assigned to the trading and non trading parts of the proportion and the amount allocated to each of the emission entities.

Rules formulated by the European Commission: the main contents of the implementation of the relevant rules for the implementation of the directive.

### 3.2.2 Technical law support

In addition to the Directive 2003/87/EC, EUETS ZOO g/29/EC and ZOO4/101/EC Directive, three basic legal systems, the EU also has a legal system in terms of technical support. The EU has strict requirements for the monitoring of greenhouse gas monitoring statistics (including the role of the third party agency during the period).

The legal system of the EU's greenhouse gas monitoring statistics report is the combination of the relevant laws and regulations of the European Union emissions trading framework on the relevant laws of the regulations on the monitoring of statistical reports (mainly includes the EU emissions trading directive Directive2003/87/EC, decision directive Directive2009/29/EC, the EU quota rating bar Regulation No 2216/2004, MRGZOO4 and MRGZOO7 and so on), the EU's detection and decision(Decision 280/2004) and the EU's greenhouse gas monitoring system operation decisions(Decision 2005/166/EC). All these relevant laws and regulations ensure the effective operation of the EU carbon market.

In addition, the EU has a relevant legal support for the emission reduction technology. Carbon capture and storage, for example, is a technology for the exploration and utilization of greenhouse gas emissions. In order to provide a legal and policy framework for the application of CCS technology, the EU released the “CCS directive” (Directive 2009/31/EC) on April 23, 2009.

### 3.2.3 Market supervision legislation

The financial market law associated with the carbon spot market can be considered as the external policy of EUETS, which mainly includes the relevant laws of financial instruments and market abuse. At present, the reform of the relevant financial market law has not been completed.

*Markets in Financial Instruments Directive* (MIFID) and the Markets in Financial Instruments Regulation (MIFIR) .The MIFID target in 2008 is to regulate the behavior of financial institutions, mainly for the management of banks, investment companies, financial instruments and investment services (including intermediary, consulting, trading, asset management, etc.) and the operation of the exchange. In order to improve the transparency of the carbon market, and to ensure that the regulatory agencies can make quick react to the carbon market misconduct and illegal acts, EU proposed to put the two level of carbon spot market be included in its regulatory scope in its MIFID reform proposals, the *Markets in Financial Instruments*

*Directive* II (MIFID II) in October 2011. And it also aims to expand the scope of the MIFID's regulation to the carbon market, which is classified as a financial instrument to achieve the carbon quota. At present, MIFIDH has not been approved by the European Parliament and the European council. Approval is also required within two years after the implementation of the legislation of Member States.

Relevant laws under the framework of *Market Abuse Directive*（MAD). MAD began the implementation in 2003 in view of the insider trading and market manipulation-these two kinds of financial instruments to disrupt the market abuse behaviors. Since MIFIDH classifies the carbon spot as a financial tool thus MAD will also apply to the carbon spot market. The EU proposed the reform of MAD in October 2011 and also introduced the *Market Abuse Regulations* (MAR) and *Criminal Sanctions for Market Abuse Directive* (CSMAD). After the implementation of the new bill, the carbon spot market will be incorporated into the regulatory scope of MAD to reduce the risk of carbon market insider trading and market manipulation. The new MAD not only applies to the two stage of the spot market, but also applies to the quota auction of the first grade market. In September 2013, the European Parliament has signed a political agreement to agree to new markets abuse of regulations, but the final adoption needs to wait for the pass of MIFIDH, because the scope of application of MAR depends on M1F1D II.

Other financial regulatory laws and regulations related to MIFID will also be extended to the carbon spot market, including the *Anti Money Laundering Directive* and *Settlement Finality Directive*. However, due to the difference between the carbon markets and the traditional financial markets, those financial supervision laws do not apply to the carbon spot markets: *Prospectus Directive*, *Transparency Directive*, *Undertakings for Collective Investment in Transferable Securities Directive* and *Financial Collateral Directive*.

### 3.2.4 MRV system

2003 / 87 / EC directive lists the principles of management of the monitoring, reporting and certification of the emissions. There are two choices of measures, namely, the standard and acceptable method of account or measure. The monitoring and reporting principle is determined by the European Commission which provides it additional guidance. The EUETS report is consistent with the existing reports in order to lessen the business burden, and it is also required to certify the emissions of EUETS to ensure the accuracy and authenticity of the report. Certification work is realized by a qualified certification body.

#### ①. Reporting process of carbon emissions

The European Commission shares agreement for the EU Member States to reduce the emission reduction targets and the EU internal emission reduction, according to the Kyoto Protocol, determining the carbon dioxide emissions of member countries, and then distributing plan plant to the country's enterprises by the member states

according to the national allocation plan. The first emission entity must be reported to the competent authorities to obtain a permit to emit greenhouse gases after each calendar year, and the permit provides the requirements for monitoring and reporting emissions. Annual emissions of greenhouse gases must be reported by operators after each calendar year. One of the conditions for the issuance of permits is the ability to monitor and report on the emissions of enterprises. In accordance with the provisions of the 2003 / 87 / EC act, companies need to develop a detailed monitoring plan in the application report and to provide and monitor the relevant materials in the application of carbon emissions quota, which must be specified in the method and frequency of monitoring emissions. And the authorities will review the program to ensure the reliability of its operation.

**②.Verification system of carbon emissions**

After each year, the EU requires that the enterprise should verify and collate the data required to discharge the report, and to complete the calculation of the actual emissions in accordance with the relevant formula. And the next step is to format according to the report, to summarize the calculation results, and to finish the first draft of the report. After the completion of the first draft, the enterprises do not directly submit to the relevant authorities, but submit to the third party verification agency (obtaining the qualification certification), and then put themselves into the verification process to ensure the authenticity of the business report data. After the completion of the verification by the verification mechanism, the enterprises need to put forward specific verification comments of the discharge report. If there is a big problem of the enterprise's emissions report, the enterprise should revise the report as soon as possible, and submit the inspection again. If the inspection results are satisfactory, the verification agency's opinion and emission reports are needed to be submitted to the relevant departments by the enterprises, accepting the supervision and inspection.

**③. The third party verification agencies have strict evaluation requirements and work specifications**

The EU has strict requirements for the third party verification agency. First of all, the third party verification agencies should have a higher qualification, the qualified level of greenhouse gas monitoring, calculation and measurement, as well as the level of audit firm related reports. Benchmark and application have become the third party verification agencies and they have strict process requirements, to ensure their authorities. Finally, the validation of the third party verification agency must follow strict procedures and be responsible for their own behavior.

### 3.2.5 Compliance Mechanism

In the first phase of the transaction (2005-2007), in order to guarantee the performance of emission reduction obligations, the EU makes regulations: those enterprises whose actual emissions are lower than the quota can enter the market to sell the surplus index, however, while the actual emission is higher than the quota of

enterprises, it is required to buy from the market to sell the emission rights of other enterprises. If those enterprises do not purchase the right to discharge, they will be fined $40 per ton. In the first phrase, the quotas which has not been exhausted by enterprises shall not be stored, that is, making the annual quota storage applied in the next annual extension, and shall not be allowed for early borrowing, that is, making the annual quota applied in advance in this year.

In the second phase of the transaction (2008-2012), the proportion of the quota to auction transactions is increased to 10% which is on the basis of the quota allocation. And the field of industry is also expanded to the aviation sector. Penalties for the incompleteness of the emission reduction targets have been increased to $100 per ton of carbon dioxide. The emission reduction quota of the second phrase can be smoothly brought to the third one.

In the third phase of the transaction (2013-2020), the coverage of the emission reduction has been expanded. And the new regulations establish a strict process of monitoring, reporting and certification to ensure the integrity of the EUETS. But for those high energy consuming departments who lack the competitiveness, a certain exemption will be given.

We can find the attention of the EU for the system through the rose of the monitoring and reporting system of guides from the first and second phrase to the third one. From the range of monitoring the greenhouse gas, the species of the greenhouse gas have been gradually increased. Only carbon dioxide emissions are monitored in the first and second phrase, however, the emissions of nitrogen oxide and PFCS begin to be monitored in the third phrase. From the monitoring process, the role of monitoring program is more important and prominent and it is also the main basis for business accounting, reporting and verification of the third party. And from the method of monitoring, the method in the third phrase which is based on the calculation and measurement is more detailed for data acquisition and more clear for the requirements. The greenhouse gas emissions reporting， RTKs report verification and verification of the certification requirements which are released by the European Union in 2012 are suitable for the EU in its third phrase, so that a more complete monitoring, reporting and verification system can be realized.

EU ETS allows companies to offset the amount of emissions reduction targets through project cooperation under the CDM and JI mechanism, which is for the EU's internal industrial and enterprises to provide their own emissions reduction targets. And EUETS also gives a chance of sustainable development for developing countries and countries with economies in transition.

During 2008 to 2020, the EU Member States allows emission reduction targets imported from the CDM and JI projects to account for 50% of the national emission reduction targets. In the third phase, the EU will ensure that new industries and new

entrants can use at least 4.5% of the CDM and JI emission reduction targets for their certified emissions by using their certified emissions in advance. For the newly added air lines, they are required to use at least 1.5% of it.

From 2008 to 2020, the CERS can purchase a maximum of 1400000000 tCO2e, equivalent to 280000000 tCO2e/a. If the project was approved by the CDM-EB before 31, December, 2012, and the emission reduction occurred after that date, the carbon credits of the output can be used for the entire third phase of EUETS. And the project outputs CERS and ERUS which are registered after 31, December, 2012 can only be used for EU ETS for those countries which come from the LDC or has a bilateral agreement with the EU.

### 3.2.6 Market Supervision

From the perspective of financial markets, the EU carbon market can be divided into the primary market (that is, the auction), the secondary spot market and the secondary derivatives market. Among them, the carbon market belongs to the traditional financial markets, and other types of derivatives market are subject to the jurisdiction of financial regulatory laws. And the carbon spot market in the first two phrases of the EUETS lacks the supervision. This situation will be changed in the third phase. The EU proposed the inclusion of the European Union's carbon spot market in 2011, and the relevant legislation is currently awaiting approval from the European Parliament and the European Council.

Secondary spot market and the secondary derivative markets can be divided from the grade-two market. As other derivatives markets, the two level carbon derivatives market of the EU is also subject to strict financial law regulation. But the secondary carbon spot market lacks the supervision of the market and does not have the requirements of the market transparency, the insider trading and market manipulation. The EU is currently undergoing financial regulatory reform. And after the pass of the current framework of MAO and MI, this situation will be changed. The carbon spot market will be accepted the financial regulation which is with the same size of the secondary derivatives market, that is, the unification of the regulatory rules of the two markets.

# Chapter 3 Overall Framework and Main Targets of China's Low-Carbon Development in 2020

## Section 1 Economic Growth Momentum during "the 13th Five-Year Plan" Period

Since reform and opening-up, China has undergone a continuous 30-years' economic boom period. From 1978 to 2014, the average annual growth rate of GDP is 9.8% and that of per capita GDP is 8.7%. Since 2010, aggregate economic output of China has surpassed that of Japan, become the world's second largest economy. The per capita GDP has reached the level of middle-income country and it hits more than 7000 US dollar in 2014. The past 30-years' high-speed growth is mainly driven by production factors which include cheap labor force and high investment accumulation. During "the 13th Five-Year Plan" period, the slump in economic growth, due to the adjustment of economic laws in a certain stage of economic development, has its rule to follow. Meanwhile, China's economic development still has enormous potentials, large space and high tenacity. This enables China's economy to grow at middle- and high-speed while finding its way to more coordinated and sustainable devleopment.

### 1.1 Changing conditions which can influence China's economic growth

In recent years, great tendency changes have taken place or are taking place in many fundamentals of China's economic development. The size of China's working population, at the age of 16 to 60, has been shrinking since 2012. The average decreasing range maintains about 0.3% during "the 13th Five-Year Plan" period. The cost of labor force is rising rapidly. The aging population is increasing and saving rate is decreasing. In 2010, China's saving rate began to fall after it peaks, reaching 51.8%, and it is expected to fall to 47% in 2020. Severe overcapacity appears in many traditional industries including steel and cement and the marginal efficiency of investment is constantly decreasing. The technology gap between China and developed countries is narrowing, so it becomes more difficult to introduce advanced technology. Since the outbreak of financial crisis, the growth potential of world economy has been declining sharply; trade protectionism in various forms emerges again; a new round of technological revolution is in incubation; increase effect brought by technology diffusion is reduced. Contradictions accumulated during year's high-speed growth are intensifying and some economic and financial risks begin to appear. Under "new normal", China's economic growth rate will gradually decrease.

## 1.2 Enormous potential, large space and high resilience of China's economic development

With over 30 years' development, China's material and technological foundation is intensifying and the industry system is complete. Though declining s slightly year by year, China's national saving rate is still much higher than that of many other countries in the world. Contributions of human capital and technological innovation to economic growth are increasing. China has a comprehensive advantage of combined production factors which include capital, labor force and technology. The deepening of reform and opening-up will mobilize and stimulate the impetus and vitality of economic and social development. In recent years, China has accelerated the administrative restructuring, delegated a large number of administrative approval items to the lower level and lifted control over infrastructure construction, promoting the development of private economy and service industry and forming the good situation of mass entrepreneurship and innovation. Coordinated development of regional economy has reached a new level and innovative development capacity of eastern regions has strengthened. The new technology, new product, new format and new business mode are showing sound development momentum. By guiding reasonable flow of production factors, the implementation of strategies such as One Belt and One Road, Coordinated Development among Beijing, Tianjin and Hebei, Yangtze River Economic Zone Development Strategy and *the National Program for Rural Poverty Alleviation (2011-2020)* can help cities and coastal regions which may lose their advantageous industries to obtain new advantages in rural and inland areas, so as to prolong the life of industries and products. This cross-regional industry gradient transfer and promotion effect will produce new productivity for a great power. The large domestic market requires that domestic potential should be expanded and released. China has paid high attention to safeguard and improving people's livelihood for the past few years, thus the resident income is increasing rapidly and the income of urban low income groups and rural migrant workers have improved remarkably in particular. Meanwhile, the social security system covering both urban and rural areas has been established, which lays a foundation to expand domestic consumption. Accelerating the elimination of system barriers to urbanization in the aspect of household registering system, land and education and reliably promoting urbanization will create new consumption and investment demand. The macro-control capacity has improved and macro polices are still useful. China has effectively coped with the 1997 Asian Financial Crisis, 2008 International Financial Crisis and 2010 European Sovereignty Debt Crisis and gained good results in macro-control. We have obtained rich experiences in weighing the regulation direction, strength and timing and utilizing regulation means and tools. In the meantime, there is still much space for China's macro policies. The financial deficit and government outstanding obligation are below the safe line, much lower than that of those major economies such as the United States, European countries and Japan. The banks of China have high

benchmark interest rate and reserve requirement ratio and have enough means and tools to adjust liquidity.

## 1.3 During "the 13th Five-Year Plan" period, China's economic growth rate to be about 7%

The development of industrialization and urbanization enters a new stage. Generally, China has entered the middle and later periods of industrialization. High-tech industries, represented by high-speed railway and aerospace and new industries, new formats and new business modes based on Internet technology are developing fast. Service industry has become the leading one.

Table 3-1 Change trend of China's economic structure in 2020

Unit: %

| | 2015 | 2020 |
|---|---|---|
| GDP growth | 7.5 | 7 |
| Urbanization rate | 55.5 | 59.0 |
| Share of primary industry | 9.2 | 7.1 |
| Share of secondary industry | 43.7 | 43.3 |
| Industry | 37.2 | 37.6 |
| Construction industry | 6.5 | 5.7 |
| Share of tertiaty industry | 47.1 | 49.7 |

(Notes: GDP growth of 2020 refers to the average growth rate during "the 13th Five-Year Plan" period.)

# Section 2 Overall guideline, Basic Principles and Primary Targets

## 2.1 Overall guideline

China's low-carbon development should center on accelerating the transformation of economic growth, optimizing energy mix, saving energy and improving energy efficiency and be driven by technological innovation and system mechanism innovation and guaranteed by sound laws and regulations and policy systems. China should keep a balance between economic and social development and ecological environment construction, and coordinate the overall low-carbon development with regional economic development. On the basis of learning from foreign and domestic experiences, China should look for ways to establish carbon emission control targets, decomposition mechanisms and policy systems that are in line with its national conditions, implement low-carbon development strategy in various regions, sectors

and fields of society and strive to form a low-emission industry structure, growth pattern and consumption mode, so as to pioneer a low-carbon development course with Chinese characteristics.

## 2.2 Basic principles

**Coordinating domestic low-carbon development with international carbon emissions obligations.** The world is working together to tackle climate change. Against this background, China need to shoulder its responsibilities as a developing power, take an active part in establishing international regulations on combating climate change and ensure to meet the carbon emissions commitment to the international community. Meanwhile, from the overall situation of domestic demand, social sustainable development and ecological civilization construction, China should regard low-carbon development, which is in line with its national conditions, stage features and development needs, as an active choice for seeking for new international competition advantage and fighting for a new round of development rights. China should also appropriately determine its carbon emission control target and realization ways. It should mainly focus on its own, take different steps and adopt a holistic approach.

**Coordinating greenhouse gas emissions control with sustainable and rapid economic development.** China is in the process of striving to build a comprehensive well-off society and achieve modernization. As for low-carbon development, China should, based on the internal relation between carbon emissions and economic growth, keep a balance between greenhouse gas emissions and economic growth, efficiently manage the stage, progress and intensity of carbon emission control and appropriately set up the carbon emissions intensity target and total carbon emission control target.

**Coordinating national low-carbon development with regional coordinated development.** Accelerating regional coordinated development is a crucial strategy of China. Low-carbon development insists on regional differentiation strategy and reasonably decomposes the total carbon emissions and intensity targets of various regions while intensifying and improving top-level design and guarantee the realization of national overall target, so as to ensure that the carbon emissions space each region matches with its population, resource endowment and economic development stage. Low-carbon development can work as a system which can guide regions to avoid vicious competition and contain the expansion of extensive capacity. The low-carbon target can force various regions to improve industrial development quality and promote inter-regional coordinated development.

## 2.3 Development targets

Taking the general requirement of combating climate change and low-carbon

development, China has put forward the primary targets of low-carbon development in 2020 which are shown as below:

**Targets of controlling greenhouse gas emissions are fully achieved.** China's carbon emissions per unit of GDP has decreased by 40% to 50% from the 2005 level. China is striving to achieve the ceiling or even higher target. The share of non-fossil energy in primary energy consumption reaches about 15%. China also works hard to make the carbon emissions of eastern developed areas and key monitoring industries to peak first. Industrial structure and energy mix has been optimized further and significant results have been gained in energy conservation and carbon emission reduction of those key fields such as industry, construction, transportation and public institutions. greenhouse gas emissions produced by non-energy activities during production have been controlled effectively and the growth rate of greenhouse gas emissions is declining.

**Significant progress has been made in capacity building.** The law and regulation system of addressing climate change has formed initially. Management system and policy system become more complete and much advancement is made in basic theory research, technology research and development and demonstration promotion. Scientific research, observation and impact evaluation of regional climate change have improved remarkably. Statistical, accounting and examination systems which are related to climate change have been gradually improved. The number of talents is increasing. The awareness of climate change of the whole society is strengthening. Decomposition mechanism of carbon emission control target and national carbon emissions trading market are consistent with China's national conditions have basically formed.

# Section 3 Primary Task

## 3.1 Accelerating industrial restructuring

**Stepping up the transformation and upgrading of high-carbon industry.** To strictly implement *the Guidance Catalogue of National Industrial Restructuring* and avoid investment in newly overcapacity industries; to strictly control the expansion of high energy consuming and high emission industries; to accelerate the promotion of low-carbon technology and procedures; and to guide enterprises to take the initiative in promoting reduction operation mechanism so as to reduce excess capacity.

**Promoting the development of strategic emerging industries**; to master the new direction of technological and industrial development and formulate overall plans and systemic layout for the development of strategic emerging industries; to improve the system mechanism and enhance indigenous innovation capacity; to enhance integrated innovation and joint efforts and strengthen introduction, absorption and

then innovation; to intensify policy support and deepen system mechanism reform and make enterprises play the main role; to deploy the major forefront fields early, make breakthroughs in key core technology and master related intellectual property rights; to speed up the commercialization of innovation output, build emerging industry clusters and promote advantageous regions to develop first; and to strive to make the share of added value of strategic emerging industries in 15% in the total GDP by 2020.

**Vigorously developing modern service industry:** to develop modern service industries such as finance, modern logistics, information service, technical service, headquarter economy, commerce exhibition, culture creativity and tourism; to step up service industry clusters and promote resource integration, enterprise concentration and format condensation of service industry; to integrate manufacturing with modern service industry and promote industry cluster to expand to high-end fields such as marketing center, technical center and creative center while improving the level of manufacturing center; to accelerate the building of service industry standardization and promote scale, brand and internet operation; and establish monitoring and early warning mechanism and improve regular investigation statistical system of service industry.

## 3.2 Speeding up the reduction of carbon emissions through energy consumption

**Optimizing energy mix:** to accelerate the reduction of share of coal in total energy consumption in the regulative means of price, taxation and industry policy; to encourage the development and utilization of non-fossil energy and natural gas and increase the share of clean energy in energy consumption; to encourage the development of various dispersed energy system in line with local conditions; to expand international market and keep a foothold in domestic market; to encourage the development and utilization of natural gas and advance exploitation of non-traditional oil and gas resources like coal-bed methane and shale gas; to develop nuclear power in a safe and efficiently way and speed up the exploitation of renewable energy such as hydro power, wind power, solar power, geothermal energy and biomass energy; to strive to make the share of non-fossil energy consumption in primary energy consumption reach 15%, natural gas consumption over 10% and coal consumption within 62% by 2020.

**Improving energy utilization efficiency:** to work hard on energy conservation management of key industries and key enterprises; to strengthen energy conservation and efficient utilization; to continue to implement major energy conservation projects and launch development, demonstration and promotion of advanced energy conservation technology; to carry out coal and electric upgrading and transforming action plan and advance energy conservation in key fields and key industries such as

industry, transportation and construction; to put emphasis on carrying out the specialized management of some small-scale enterprises and actively carry out central heating and build combined heating and power infrastructure; and to encourage the building of large coal enterprise group, implement production quota management and improve coal utilization efficiency.

## 3.3 Advancing optimization and adjustment of space structure

**Formulating low-carbon development policy on territorial space:** to define land use combinations with various intensity through duel constraints of overall function and carbon emissions reduction: to integrate green and low-carbon factors into new type of urbanization and appropriately formulate controlling lines for survival, development, ecology and guarantee; and to carry out national low-carbon territorial comprehensive supporting experimental zones.

**Establishing low-carbon regional cooperation development mechanism:** to research and establish regional cooperation mechanism of low-carbon development, inter-city development cost sharing mechanism, regional resource sharing mechanism and ecological environment protection mechanism by taking mutual-construction and sharing and observing the function of central city responsible for core economy, small and medium-sized city for distinctive industry and small towns for; and to make market fully play the decisive role, set carbon fund to effectively launch carbon trading market pilots and encourage the building of urban low-carbon cooperation alliance.

## 3.4 Improving carbon sinks capacity of forests and ecosystem

**Improving carbon sinks capacity of forests:** to implement specialized forestry action plans to address climate change; step up afforestation actions and promote "greening around" and urban garden greening; to increase carbon sinks pilots and to launch major forestry ecological projects such as natural forests protection, conversion of farmland to forests, protection of forests building and treatment on rock desertification, and to promote sound and orderly development of carbon sinks forestry.

**Improving carbon sinks capacity of farmland, grassland and wetland:** to continue to carry out projects of converting farmland and grazing into forests, increase soil organic carbon storage, increase agricultural soil carbon sinks and promote conversion tillage measures of returning straw mulching, precise farming and minimum or no tillage; to establish long-term grassland ecological compensation mechanism and further implement grass land protection systems of banning grazing, delaying grazing and rotational grazing in pastoral area; to continue to carry out the building of grazing withdraw projects and sandstorm source in Beijing and Tianjin

governance projects; and to strengthen wetland protection, improve wetland carbon storage capacity and launch coastal wetland carbon sequestration pilots.

## 3.5 Accelerating the building of low-carbon development system mechanism

**Improving government guidance mechanism:** to establish low-carbon development planning system, establish the mechanism which integrates low-carbon development plan with national economic and social development, regional development plan, urban development plan and industrial development plan, and establish balance sheet of low-carbon development index system; to establish laws and regulations system which serves to low-carbon development and mechanism which coordinates with current laws and regulations, and speed up the legislation of Laws on Climate Change; and to improve low-carbon standard system, formulate greenhouse gas emissions standard of industries, particularly for those key industries such as electricity, steel, nonferrous metals, petrifaction, chemical engineering, transportation and construction, and enhance low-carbon construction and governance in all aspects.

**Improving market-driven mechanism:** to establish price mechanism that is conducive to low-carbon development, differentiate energy utilization price system and taxation system that is related to economic activities and carbon intensity; to learn from developed countries' experience of building carbon emissions trading market so as to gradually promote the building of a unified carbon emissions trading market; to establish financing mechanism that is conducive to carbon emissions reduction, build national carbon emissions trading system according to quota or write-off principle and encourage the development of derivative carbon finance products such as carbon forwards, carbon futures and carbon options; and to establish market cooperation mechanism that is conducive to professional division, enhance the promotion of contract energy management and encourage the development of third party service agencies.

**Establishing public participation mechanism:** to build a public-oriented low-carbon propagation mechanism, enhance urban low-carbon publicity and education and carry out education campaigns in the theme of low-carbon economy in order to build low-carbon environment, promote a way of low-carbon living and promote low-carbon community; to carry out systemic low-carbon education activities by taking advantage of the power of parents, schools and communities; to expand volunteer team and support the development of low-carbon NGOs; to strengthen public supervising mechanism and low-carbon consultation system and assessment system with broad public participation; and to set up information platform of carbon emissions in key industries, releasing the emission condition of those key carbon emissions enterprises to the public through media so as to accept supervision

of social sectors.

# Chapter 4 Research on Regional Decomposition Mechanism of Carbon Emission Control Target

By reviewing and redefining the decomposition methods of energy conservation and carbon intensity target adopted by China during “the 11th Five-Year Plan”and “the 12th Five-Year Plan” periods and then summarizing its successful experience and problems needed to addressed, we put forward the decomposition methods of carbon intensity control target and total carbon emission control, combines the anticipation for the economic and social development situation during “the 13th Five-Year Plan” period, and makes clear the initial idea of decomposition mechanism of carbon emission control target during “the 13th Five-Year Plan” period.

## Section 1 Analysis of Decomposition Mechanism of Energy Conservation and Low-Carbon Target

### 1.1 Decomposition mechanism of energy conservation target in “the 11th Five-Year Plan”

In March 2006, China issued the *Eleventh Five-Year (2006-2010) Plan for National Economy and Social Development*, bringing the target of decreasing the energy consumption per unit of GDP by about 20% into the national plan as an obligatory target. Relevant guarantee of supporting measures were needed for achieving such target, so the State Council formulated a series of policy measures, a core one of which is responsibility assessment of energy conservation target.

This responsibility assessment system was based on the establishment and decomposition energy intensity decline target. During “the 11th Five-Year Plan” period, Chinese government decomposed the energy conservation targets, with local voluntary commitments and negotiation between central government and local governments to establish the targets as the major methods. In the first place, Central government raised the target of decreasing the energy consumption per unit of GDP by about 20% by 2010 according to the restrictions of resources and environment nationwide and the task of restructuring. Secondly, local governments brought forward the willingness to undertake the target voluntarily in line with local situation. At last, for the regions that voluntarily committed that their targets would be higher than national one, central government would establish the system; for the regions

that voluntarily committed that their targets would be lower than national one, central government would negotiate with local governments and establish reasonable energy conservation targets for those regions, with ensuring the achievement of national energy conservation target as the prerequisite.

From the results of energy conservation target decomposition during “the 11th Five-Year Plan”, it can be indicated that Jilin province enjoys the highest energy conservation target (30%) among 31 provinces (or municipalities and autonomous regions) throughout the nation; Shanxi province and Inner Mongolia take second place (25%); Shandong province is relatively high (22%); 20 regions including Beijing, Tianjin and Hebei province share the target of 20%; Yunnan province and Qinghai province are 17%; Fujian province and Guangdong province are 16%; Guanxi province is 15%; Hainan province and Tibet have the lowest target (12%). Because some regions committed their targets irrationally and it was hard to ensure the achievement of targets in these regions, so in the actual implementation, central government and local governments negotiated to decrease the energy conservation targets in Jilin province, Shanxi province and Inner Mongolia from the original percentages to 22%, with other regions remaining their own original targets.

## 1.2 Decomposition mechanism of energy conservation target in “the 12th Five-Year Plan”

On the basis of comprehensively summarizing the experience and shortcomings of energy conservation project during “the 11th Five-Year Plan” and drawing on the researches on the methods of global greenhouse gas emission reduction target decomposition, the energy conservation target decomposition brought about by “the 12th Five-Year Plan” paid more attention to its scientific nature and the principle of equity and efficiency, took into overall consideration all factors related to energy conservation target decomposition, including the responsibility, potential, ability and degree of difficulties of energy conservation, and then established the system of comprehensive evaluation targets. By comparing different regions and distinguishing different types, this system could realize the decomposition target that “similar regions undertake similar energy conservation targets rather than unified treatment”.

According to the comprehensive evaluation results and clustering analysis results, China’s 31 regions can be classified into three categories. Based on the prerequisite of established national energy conservation target, the system would ascertain the range of energy conservation targets in different regions. To facilitate evaluation and comparison, each type of regions undertake the same energy conservation target. In light of this, national energy conservation target would be decomposed to each region.

On the basis of the experience of “the 11th Five-Year Plan”, to take the way of both local voluntary commitments and negotiation between central government and

local governments to allocate the targets would help to mobilize the energy conservation initiative of local governments, and this was also feasible for “the 12th Five-Year Plan”. The decomposition results above could be the reference for the negotiation between central government and local governments, and thus evaluated the targets voluntarily committed by local governments.

## 1.3 Decomposition mechanism of carbon intensity target in “the 12th Five-Year Plan”

During this period, central government raised further requirements for controlling the greenhouse gas emissions. Based on the energy conservation target decomposition scheme in “the 12th Five-Year Plan”, central government considered some carbon reduction measures, such as optimizing the energy mix, controlling the emissions in industrial process and increasing carbon sink, and kept regional decomposition of carbon intensity targets in line with regional decomposition of energy conservation targets.

Table 4-1 The regional decomposition methods for energy conservation and carbon intensity decline in “the 12th Five-Year Plan”

| Regional Categories | | Decline target of energy consumption per unit of GDP in "the 12th Five-year Plan" | Decline target of CO2 emissions per unit of GDP in "the 12th Five-year Plan" |
|---|---|---|---|
| 1 | Beijing | 17 | 18 |
| | Tianjin | 18 | 19 |
| | Shanghai | 18 | 19 |
| | Jiangsu | 18 | 19 |
| | Shandong | 17 | 18 |
| | Guangdong | 18 | 19.5 |
| | Zhejiang | 18 | 19 |
| 2 | Hebei | 17 | 18 |
| | Shanxi | 16 | 17 |
| | Inner Mongolia | 15 | 16 |
| | Henan | 16 | 17 |
| | Liaoning | 17 | 18 |
| 3 | Jilin | 16 | 17 |
| | Heilongjiang | 16 | 16 |
| | Anhui | 16 | 17 |
| | Fujian | 16 | 17.5 |
| | Jiangxi | 16 | 17 |
| | Hubei | 16 | 17 |
| | Hunan | 16 | 17 |
| | Guangxi | 15 | 16 |
| | Chongqing | 16 | 17 |

| | | | |
|---|---|---|---|
| | Sichuan | 16 | 17.5 |
| | Yunnan | 15 | 16.5 |
| | Shaanxi | 16 | 17 |
| 4 | Guizhou | 15 | 16 |
| | Gansu | 15 | 16 |
| | Qinghai | 10 | 10 |
| | Ningxia | 15 | 16 |
| 5 | Hainan | 10 | 11 |
| | Tibet | 10 | 10 |
| | Xinjiang | 10 | 11 |

## 1.4 Decomposition mechanism of total energy consumption control target in "the 12th Five-Year Plan"

Regional decomposition of total energy consumption targets, in conformity with the principle of considering both "equity" and "efficiency", adopts the basic way of "checking basic number and decomposing the increment". Taking into account the availability of targets and the correlation among different targets, it also optimizes and simplifies the targets by referring to the expert opinions, thus obtaining the evaluation target system of total energy consumption regional decomposition. It establishes the comprehensive evaluation index and comprehensively assesses all provinces. After sorting in accordance with the assessment results, it can reflect that the regions ranking high will get relatively strict energy consumption control target, and that the regions ranking low will get relatively loose one.

## 1.5 Inspiration and reference

In general, the target decomposition of energy conservation and carbon reduction in last decade basically complies with the principle of considering both "equity" and "efficiency". With the help of strict target responsibility assessment policy, it reaps positive effects. From the practice of target decomposition of energy conservation and carbon reduction in "the 11th Five-Year Plan" and "the 12th Five-Year Plan", we can get inspiration as follows.

### 1.5.1 There exists limitation for intensity control target.

First of all, if the system distributes national intensity control target to all provinces as the form of intensity targets regardless of the economic growth and total energy consumption (or carbon emissions), it is likely that national overall target can not be reached though all provinces can achieve their intensity targets, resulting from the fact that total energy consumption (emissions) of China is the sum of that of all provinces, and so is the economic aggregate. National overall energy consumption

(emissions) intensity $I=\frac{\sum Ei}{\sum Gi}$, and its variation $\Delta I=\Delta(\frac{\sum Ei}{\sum Gi})\neq f(\Delta\frac{Ei}{Gi})=f(\Delta Ii)$. Therefore, the variation of national overall energy consumption (emissions) intensity has not simple mathematical relations with that of different provinces. Due to those facts, the target decomposition should notice the completeness so that when all provinces finish their targets, the national target can also be achieved.

On top of that, the practice of energy conservation and emission reduction in "the 11th Five-Year Plan" indicates that only restriction for decline of energy consumption per unit of GDP can not hinder the overheated economy. Under the circumstances that there remains space for further decrease of energy consumption per unit of GDP in different regions, this method may lead to the rapid growth of both regional economy and energy consumption. Theoretically, under the limitation for decline of energy consumption per unit of GDP (carbon emissions), to implement the limitation of energy consumption (carbon emissions) aggregate again and transform "single control" into "double control" will prescribe a reasonable range for economic growth.

### 1.5.2 The index choices should be more scientific and rational

The comprehensive evaluation target system of energy conservation target decomposition in "the 12th Five-Year Plan" take into full consideration all factors related to energy conservation target decomposition, including responsibility, potential, ability and difficulty of energy conservation. Establishing comprehensive evaluation index system, China realizes the decomposition target of "similar regions undertaking similar energy conservation target while different schemes for different regions" through comparison among regions and differentiation of various types, which shows certain scientific nature. For some targets, however, the results measured from different perspectives will bring about opposite evaluation. For example, the proportion of the value added of high energy consumption industry to industrial value added is listed as the topic of energy conservation difficulty, and the higher its target is, the more difficult for energy conservation; from the other point of view, it can be also regarded as substantial potential for energy conservation. As a result, the target choices should pay more attention to scientific nature so as to avoid repetition and ambiguity.

The carbon intensity target decomposition of "the 12th Five-Year Plan" coordinates with its energy conservation target decomposition and ensures effective link of targets, but the core factor of energy conservation is rather different from that of controlling carbon emissions. Therefore, the targets should be selected and set scientifically.

### 1.5.3 To further consolidate data foundation

China's carbon dioxide emissions are mainly from the utilization of fossil energy, so no matter whether the intensity control or aggregate control will be adopted, it is necessary to classify and calculate the subdivision of different types of fossil energy

so as to get the fundamental data of national and regional carbon emissions. Besides, it needs further research on the issue of emissions transfer. For some developed regions without abundant resources, extraneous electric power accounts for a large percentage in terminals' electric power consumption, but the emissions of this part are included in some of energy-exporting provinces and thus result in inter-provincial emissions transfer. When disintegrating emissions control targets, it needs to conduct further research into how to think about this part of emissions and how to think about its corresponding economic value.

It also needs to further study energy structure adjustment of all provinces. Although the optimization of energy mix is the direction of efforts from all provinces, different provinces are fairly different in terms of developing renewable resources and bringing foreign low-carbon energy due to the limitation of resources endowment, location and economic strength. As a result, the reasonable weight of energy structure adjustment factors set to all provinces should be based on the in-depth research into the feasibility of energy structure adjustment.

### 1.5.4 To attach importance to negotiating with central government and bringing into full play of initiative of local authorities

Carbon emission control target is not only an obligatory target, but, more significantly, the major driving force to stimulate the transformation of local economic growth model and to improve the quality of economic growth. Therefore, to set carbon emission control targets for different regions in the way of negotiation between central government and local ones can bring into full play the initiative of local authorities to save energy and lower carbon consumption. In the meantime, the establishment of comprehensive evaluation system and the target assessment of targets committed by local governments will be beneficial for local governments to fully tap potential and transform into the economic development model of "being better and faster", with controlling carbon emissions as an opportunity.

## Section 2 The Research on Regional Decomposition Methods of Carbon Intensity Control Target in "the 13th Five-Year Plan"

According to the experience of emission reduction of international society's greenhouse gases and the implementation experience of target decomposition of China's early energy intensity control, "equity" and "efficiency" should be attached equal importance. The principle of equity and that of efficiency have substantial difficulties in terms of how to evaluate scientifically, and it is even widely acknowledged that both "equity" and "efficiency" can not be obtained in the same time. Therefore, this research takes indirect quantitative method and utilizes current data foundation to establish a decomposition scheme that is pragmatic, effective and easy to evaluate from bottom-up for the purpose of representing the requirements above. Drawing on the idea of analytic hierarchy process and aiming at meeting the

principle of equity and efficiency, it takes into account all factors related to the decomposition of carbon intensity control target, including responsibilities, rights and abilities of emission reduction. It sets the reference and evaluation system for targets decomposition to reach the target of "similar regions undertaking similar control target while different schemes for different areas" through the comparison of different regions and the differentiation of different types.

Compared with the decomposition mechanism of energy conservation target in "the 12th Five-Year Plan", the evaluation target system established in this study pays more attention to representing key elements that affect China's carbon emission, including per capita fossil energy consumption, per capita carbon emissions, the proportion of the tertiary industry and carbon dioxide emissions per unit of GDP, which are shown in the following Table.

Table 4-2 Comparison between the decomposition mechanism of energy conservation target in "the 12th Five-Year Plan" and this research

| | decomposition mechanism of energy saving target in "the 12th Five-year Plan" | This Research |
|---|---|---|
| Index System Topics | Responsibility, potential, ability and difficulty of energy conservation | Responsibility, rights and capability of emissions |
| Specific Indexes | Energy consumption proportion to national total;<br>Per capita energy consumption;<br>Regional economic development speed;<br>SO2 emissions proportion to national totalemissions;<br>Industrial increment value to national total GDP;<br>Local fiscal revenue proportion to national total;<br>Per capita GDP<br>R&D expenditure proportion;<br>Self-sufficiency rate of energy;<br>High energy-consuming industry proportion to Industrial increment value | Per capita fossil fuels consumption;<br>Per capita CO2 emissions;<br>GDP proportion to national total;<br>Per capita energy production;<br>Regional strategy for development;<br>Development speed of egional economy;<br>Per capita GDP;<br>Third industry proportion;<br>CO2 emissions per unit of GDP |

## 2.1 General idea of decomposition

It establishes the reference and evaluation system for target decomposition, which means indirectly representing multiple decisions' requirements in the way of

assessing comprehensively of bottom-up, selecting corresponding targets, and showcasing the policy inclination and target significance by combining different weights on the basis of the performance of different target principles in actual problems of carbon intensity control. On grounds of all these, it can provide quantitative reference for achieving the scientific decomposition of carbon intensity control target through calculating the comprehensive evaluation scores of different regions.

Concretely speaking, it draws on the idea of analytic hierarchy process and puts the responsibility, rights and capability of carbon intensity as the first hierarchy by combining the intrinsic characteristic of carbon intensity control. Then, it chooses specific targets that effectively reflect the requirements of all topics, thus forming the overall framework of evaluation target system. To establish target system in accordance with different topics can indirectly reflect the requirements of the principle of efficiency and equity, and it covers all aspects that are referred to by scientifically decomposing carbon intensity control target.

## 2.2 Index system

On account of the amount of carbon dioxide emission and fossil energy consumption in all regions recently, the “responsibility” can be reflected by indices such as per capita carbon dioxide emissions, per capita fossil energy consumption, and GDP proportion to China’s total; on account of resources endowment, development expectations and regional development policies of all regions, “rights” can be reflected by indices such as per capita energy production, expected speed for regional economic development and the China’s strategic guiding for regional development; on account of economic development level, structural condition and efficiency level of emissions, “capability” can be reflected by targets such as per capita GDP, the proportion of the tertiary industry and carbon dioxide emissions per unit of GDP. The connotation of every evaluation index is shown in Table 4-3, where per capita fossil energy consumption, per capita carbon dioxide emissions, GDP proportion to China’s total, per capita GDP and the proportion of the tertiary industry are in positive direction, which means that the more the value is, the higher the requirements for control they will have. Per capita energy production, strategic guiding for regional development, speed of regional economic development and carbon emissions per unit of GDP are in negative direction, which means that the larger the value is, the lower the requirements for control they will have.

Table 4-3 The connotation of evaluation targets

| Number | Evaluation index | Index connotation（relations with aggregat control） |
|---|---|---|
| 1 | Per capita fossil fuels consumption | The more per capita fossil fuels consumption is, the heavier the responsibility for controlling is（+） |

| | | |
|---|---|---|
| 2 | Per capita CO2 emissions | The more per capita CO2 emissions are，the less space for emissions will be with heavier controlling responsibility（+） |
| 3 | GDP proportion to national total | The larger the GDP proportion is, the heavier the responsibility for controlling is（+） |
| 4 | Per capita energy production | The more per capita energy production is, the more the rights to pursue development by using energy are（-） |
| 5 | Strategic orientation for regional development | Regions encouraged by national strategic orientation for high-speed development can enjoy more rights to pursue development by using energy（-） |
| 6 | Development speed of regional economy | The higher the expectations for economic development are, the more the rights to pursue development are（-） |
| 7 | Per capita GDP | The more the per capita GDP is, the stronger the economic tolerance is, with stronger controlling ability（+） |
| 8 | The third industry proportion | The more the thrid industry proportion is, the less dependence of economy on energy, with stronger controlling ability（+） |
| 9 | CO2 emissions per unit of GDP | The more CO2 emissions per unit of GDP are, the more dependence of economy on fossil fues energy, with weaker controlling ability（-） |

## 2.3 Decomposition methods

### 2.3.1 Data standardization treatment

It can be indicated that integrated index system above involves many aspects including carbon emissions, energy consumption and economy and combines both qualitative analysis and quantitative analysis. There are not only description index of exact value, but relative index representing the order among different regions. As for the data, some are absolute numbers and the others are relative numbers. Besides, on basis of the index value's influences on decomposition results, different index value for various topics has different bearing on the final results. In order to unify the evaluation standard and ensure the scientific nature of index system, we uphold the basic principle that the more the scores of them are, the larger the targets of carbon intensity decline they will undertake accordingly. With the support of standardization treatment for index data, the orientation and value-setting problems of all indices will be resolved.

The principle of standardization treatment is to first define the positive index and negative index, after which their data will be treated through standardized process. In other words, for a certain target Xi (i represents a province or city), the system will find out the maximum value Xmax and the minimum value Xmin from all provinces

or cities, and then conduct normalized treatment according to the orientation of this certain index.

For the positive index, its value after normalized treatment is:

$$Z_i = \frac{X_i - X_{min}}{X_{max} - X_{min}}$$

For the negative index, its value after normalized treatment is:

$$Z_i = \frac{X_{max} - X_i}{X_{max} - X_{min}}$$

It can be seen that after value setting and transformation process, indices' values are within the range of 0 to 1. 0 represents the smallest decline target of carbon intensity and 1 represents the biggest. Standardized treatment of indices aims at clearing up the differences between orientation and dimension among different indices and ensuring the comparability of them, thus laying a solid foundation for further determining the weights and establishing models.

### 2.3.2 Determination of weight

Weight is the variate of difference level of all indices in the index system and their influence level on other indices. Reasonable weight allocation should start with the aim of comprehensive optimization and reflect the differences of significance of all indices. Meanwhile, weight can play the role of guidance, represent policy orientation through different weight, and guide actions of local governments.

Theoretically, the determination of weight can be divided into subjective one and objective one. Subjective weighting means determining relative weight of all indices through the evaluation based on experts' experience. It has several methods including subjective experience method, rank-sum ratio method, expert ranking method, Delphi method, expert meeting method and analytic hierarchy process (AHP), with Delphi method and AHP being more frequently adopted. Objetive weighting is a way of determining weight by referring to the objective information reflected by index value, and its weight is to be determined according to the information adequacy of all targets, and its major methods include regression analysis method, factor analysis method, correlation coefficient method, weight method of arithmetic mean mix, and multiplication mix method.

Though objective weighting method eliminates the subjective idea when weighting, but its results are affected by data amount and value to a great extent, and this method only reflects the amount of information included in all indices or difference with other indices. Considering the availability of data and the requirements brought about by some problems, we can choose the method of subjective weighting with experts making assessment. Subjective weighting can simplify complicated problems and highlight the knowledge and experience

accumulated all along by all kinds of experts. In the meantime, different weights can showcase the development focuses of China and other regions in different stage, and can be rapidly adjusted in accordance with actual situation and environmental change, with great flexibility and pertinence.

On the basis of determining the weights, we can calculate the topics of the second level with the way of linear weighting and then further calculate final scores of integrated evaluation. The reason why the linear weighting model has been chosen lies in that its weights can show the effective level of all topics on decomposition results and policy inclination with the features of being simple and pragmatic.

### 2.3.3 Clustering analysis

In order to compensate for the limitation and instability that may exist in subjective weighting, this research makes comparison between the objective cluster results of secondary indices and the results of integrated evaluation through the method of "clustering analysis". With this contrast, the study can examine the rationality of the provinces' order of different topical dimensions.

Cluster analysis method can not only start with multiple dimensions and classify similar regions into on category, but also obliterate the effects brought about by high correlation among some indices. To begin with, each region is classified into single category, and then the most similar categories are merged into one. Next, it will recalculate the distance or similarity measure between new category and other categories, and this process will not stop until all regions are merged into one category. This process of merging categories can be described by pedigree cluster figure. Because of multiple observation indices in every region, so "distance" is defined as WARD method, which presumes that there is relatively large sum of deviation square to ensure that similar regions can be imbued with homogeneity to some extents and different regions can have relatively apparent differentiation. If it is reflected in pedigree cluster figure, the most similar regions will be classified into one category at first. The results of clustering analysis can be inter-verified with those of quantitative analysis of integrated evaluation so as to provide foundation for determining the categories of regions of target decomposition.

### 2.3.4 Determination of range of intensity control targets of regional carbon emissions

Under the prerequisite of the fixed intensity decline target of national carbon emissions for "the 13th Five-Year Plan", the ranges of intensity decline targets of carbon emissions in regions of different types should be determined. According to the integrated evaluation results with reference to regional clustering analysis results, 30 regions of China (Tibet is excluded for it is short of data foundation) are classified into different categories, and regions from the same category can be divided into different types, then the relative target ranges (maximum target, target relatively higher that national average, national average target, target relatively lower that

national average and the minimum target) of different categories and types can be finally determined.

## 2.4 Examples of decomposition

According to the decomposition method of carbon intensity mentioned above, this research will conduct regional decomposition for decline target of carbon intensity in "the 12th Five-Year Plan" and compare it with the official decomposition scheme of China's government on the basis of data of all regions in 2010.

### 2.4.1 Data processing

**①. Per capita carbon emissions**

The population number can be determined in accordance with the regional population number in *China Statistical Yearbook*.

The carbon emissions produced by fossil energy combustion is the major part of total carbon emissions, and China's current statistical data also determine that it is necessary to maintain emissions from fossil energy combustion as the major part. The energy balance sheet of all regions in 2010 collected in *China Energy Statistical Yearbook 2010*, provides the energy consumption value (physical quantity) of different types in different years and the quantity of electric power input and output. Referring to the requirements of *Guidebook for Compilation of Greenhouse Gas Emissions Inventory for provinces*, the carbon emissions should include sum carbon emissions of disposable energy consumption and those of corresponding electric power input (output), among which the carbon emissions targets of coal, petroleum and natural gas are converted into 2.59t $CO_2$/tce, 2.121t $CO_2$/tce and 1.484t$CO_2$ /tce respectively. Besides, the factor of electric power emissions can comply with the regional emissions factor regularly issued by National Development and Reform Commission.

**②. Per capita fossil energy consumption**

It will be checked with accounting method by standard coal consumption of different fossil energy types of different regions according to *China Energy Statistical Yearbook 2010*.

**③. GDP proportion to national total**

It will obtain regional GDP data in 2010 from *China Statistical Yearbook* and then get national total GDP through adding.

**④. Per capita fossil energy production**

It will be checked with accounting method by standard coal production of different fossil energy types of different regions according to C*hina Energy Statistical Yearbook 2010*.

**⑤. The strategy orientation of regional development**

This target is hard to quantify owing to its wide influences. For the sake of making it simple, the trial calculation gives 4, 3, 2, 1 points to Chinese eastern, middle and northeastern, western, and western and minority provinces respectively so as to reflect the strategic orientation for development in different regions.

**⑥. The regional economic growth rate in "the 12th Five-Year Plan"**

Only less than half of provinces clearly put forward their average annual GDP growth rate in local national economic development outline in "the 12th Five-Year Plan", so the economic development rights of different regions will be temporarily reflected by the actual average annual GDP growth rate of different regions during "the 11th Five-Year Plan" period.

**⑦. Per capita GDP**

Total population and GDP value can be determined in accordance with the corresponding data of all regions in *China Statistical Yearbook*.

**⑧. The proportion of the three industries**

It can be determined in accordance with the corresponding data of all regions in *China Statistical Yearbook*.

**⑨. Carbon emissions per unit of GDP**

They can be determined in compliance with GDP values and carbon emissions values which have been verified in different provinces in 2010.

### 2.4.2 Results of simulated analysis

**①. Results of integrated evaluation under different weights**

To better observe the decomposition results, different weights are set in compliance with three conditions of stressing responsibility, rights and ability. The overall scores of all regions after calculation can be seen in Table 4-4.

Table 4-4 integrated evaluation results under different weights

| | Stressing responsibility | Stressing rights | Stressing ability |
|---|---|---|---|
| level one weight | 0.5:0.25:0.25 | 0.25:0.5:0.25 | 0.25:0.25:0.5 |
| Regional overall evaluation | Shanghai | Shanghai | Shanghai |
| | Beijing | Beijing | Beijing |
| | Jiangsu | Zhejiang | Tianjin |
| | Guangdong | Guangdong | Jiangsu |
| | Shandong | Jiangsu | Zhejiang |
| | Tianjin | Shandong | Guangdong |
| | Zhejiang | Tianjin | Shandong |
| | Liaoning | Fujian | Fujian |
| | Inner Mongolia | Hebei | Liaoning |
| | Hebei | Liaoning | Hebei |
| | Ningxia | Heilongjiang | Hubei |
| | Fujian | Jiangxi | Inner Mongolia |
| Soceres rank | Shanxi | Hubei | Jilin |
| | Heilongjiang | Anhui | Heilongjiang |
| | Hubei | Jilin | Hunan |
| | Jilin | Hunan | Jiangxi |
| | Xinjiang | Henan | Anhui |
| | Henan | Gansu | Qinghai |
| | Hunan | Xinjiang | Henan |
| | Qinghai | Qinghai | Chongqing |
| | Anhui | Ningxia | Hainan |
| | Jiangxi | Shanxi | Sichuan |
| | Shaanxi | Guizhou | Shaanxi |
| | Chongqing | Sichuan | Xinjiang |
| | Sichuan | Shaanxi | Gansu |
| | Gansu | Chongqing | Ningxia |
| | Guizhou | Inner Mongolia | Shanxi |
| | Guangxi | Hainan | Guangxi |
| | Hainan | Yunnan | Guizhou |
| | Yunnan | Guangxi | Yunnan |

This Table indicates that though the order of integrated evaluation results of different regions have some changes under the circumstances of stressing different factors, there are no subversive results except a few provinces. Economically-developed regions, including Shanghai, Beijing, Jiangsu province, Tianjin, Guangdong province, Zhejiang province, Shandong province, always rank fairly high in the list; economically-developing regions with low emissions, including Yunnan province, Guangxi province, Hainan province, Guizhou province, Xinjiang province, Gansu province and so on, often lag behind those prosperous regions.

Certainly, when some regions attach prominent importance to a single factor, their ranks will change a lot, so it demonstrates that how to look at the features of these

regions will have some bearing on the final results. For instance, when Shanxi province emphasizes on responsibility, it ranks the first half of China, but in terms of last two conditions, it ranks the ninth and the last fourth from the bottom respectively; when Inner Mongolia stresses responsibility and capability, it ranks ninth and 12th respectively, but as regards rights, it can only ranks the fourth from the bottom.

Regional integrated evaluation results can be verified by results of cluster analysis (figure 4-1). According to comprehensive evaluation target system, 30 regions of China can showcase relatively good cluster results.

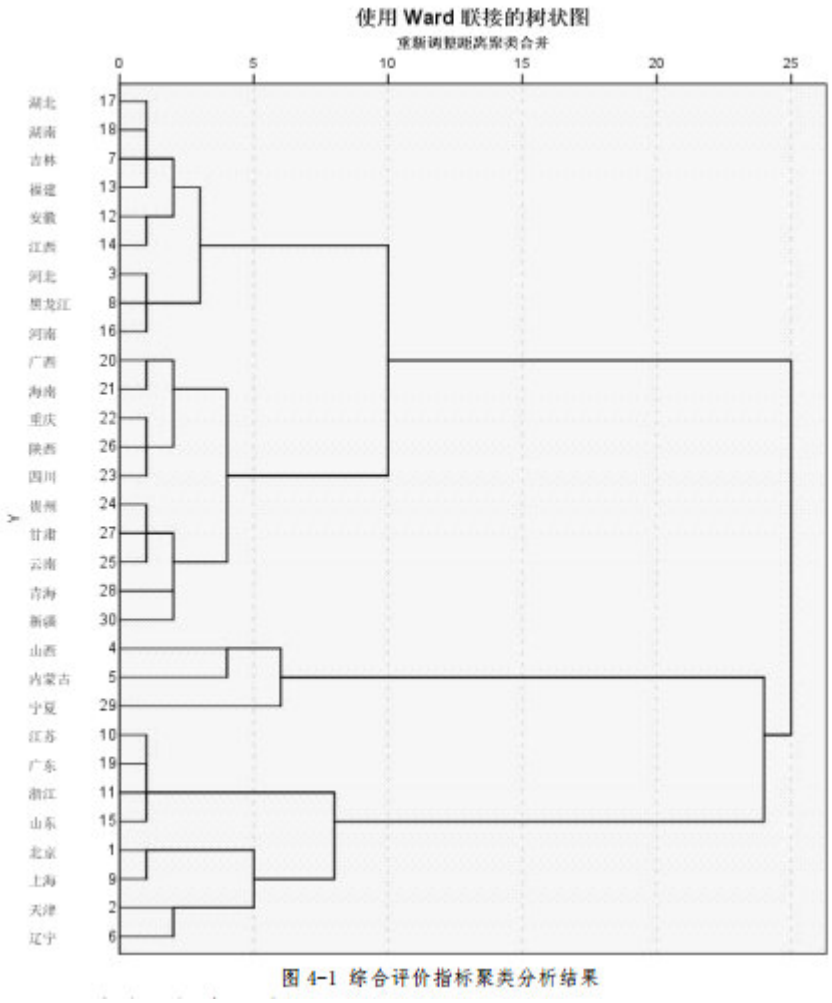


图 4-1 综合评价指标聚类分析结果

figure 4-1 The cluster analysis results of comprehensive evaluation target

**②. The target decomposition range which are suggested**

Referring to the results of integrated evaluation and cluster analysis, the targets decomposition as suggested is shown in following Table.

Table 4-5 The decomposition range of decline target of carbon emissions in “the 12th Five-Year Plan” as suggested

| Regional categories | provinces (with high scores prior to the rank) | Target ranges |
|---|---|---|
| 1 | Shanghai, Beijing, Jiangsu, Guangdong, Zhejiang, Tianjin | Maximum target |
| 2 | Liaoning, Fujian, Hebei | Little higher than national average target |
| 3 | Heilongjiang, Inner Mongolia, Hubei, Jilin, Hunan, Jiangxi, Ningxia, Anhui, Shanxi, Henan | National average target |
| 4 | Qinghai, Xinjiang, Shaaxi, Gansu, Chongqing, Sichuan | Little lower than national average target |
| 5 | Guizhou, Hainan, Guangxi, Yunan | Minimum target |

### 2.4.3 The results analysis

With the fixed decline target of national carbon intensity in “the 12th Five-Year Plan” as prerequisite, this research compares the government package (Table 4-6) with the decomposition target range raised in this study after regional decomposition of carbon intensity decline target in “the 12th Five-Year Plan”, indicating that the both are generally same in terms of partition of different regions.But the both are different with regard to decomposition mechanism, leading to some differences of classification for some regions, which are highlighted by Beijing, Guangdong province and Guangxi province.

Table 4-6 The decline targets of carbon dioxide emissions of all regions in “the 12th Five-Year Plan”

| Regional categories | provinces | Decline target of carbon intensity |
|---|---|---|
| 1 | Guangdong | 19.5% |
| | Shanghai, Tianjin, Jiangsu, Zhejiang | 19% |
| 2 | Beijing, Hebei, Shandong, Liaoning | 18% |
| 3 | Fujian, Sichuan | 17.5% |
| | Shanxi, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Chongqing, Shaanxi | 17% |
| 4 | Yunnan | 16.5% |
| | Inner Mongolia, Heilongjiang, Guangxi, Guizhou, Gansu, Ningxia | 16% |
| 5 | Hainan, Xinjiang | 11% |
| | Qinghai | 10% |

The decline potential of carbon emissions intensity per unit of GDP of Beijing is limited, so Beijing is classified into the second category in national package. However, from the views of the results of integrated evaluation target system, it ranks second of

China in terms of responsibility, rights and capability of emission reduction, so this research classifies it into the first category.

Yunnan province and Guangxi province are from the fourth category in national package, but according to the evaluation results, Yunnan province ranks first, second and first from the bottom as regards responsibility, rights and capability of emission reduction respectively, and Guangxi province ranks third, first, and third respectively. As a result, the both provinces are classified into last two regions in the fifth category.

## 2.5 Conclusion

There is no absolute means of the target decomposition of carbon emissions intensity. Under current circumstances of China, all regions are short of the capability to accurately predict the space demand for their economic development and carbon emissions, and they lack the comprehensive understanding of potential for and approach to reducing carbon emissions. The results of integrated evaluation scores and clustering analysis show that it is possible to clearly classify different regions into several categories according to the method of establishing target system from bottom-up. It is suggested to adopt differential treatment towards different categories to set different decline target ranges of carbon intensity for regions from different categories without much differences for regions within the same category.

# Section 3 Research on Regional Decomposition of Total Carbon Emission Control Target

Regional decomposition of total carbon emission refers to the process of distributing total carbon emission control target to different regions. Each region undertakes a sub-total target, making sure that the total of regional targets equal general target, thereby realizing a nationwide carbon emission control target shared by all regions.

Low-carbon development situation at home and abroad requires carbon emission control to transit from intensity target to total quantity target. The regional decomposition is an effective method to implement total carbon emission control. However, it is a worldwide problem with different factors need to be carefully considered during practice. In this section, we provide a new methodology for regional decomposition of total carbon emissiontarget, and further analyze the principle factors and possible choices in actual operation.

## 3.1 Decomposition methodology

### 3.1.1 Guiding concept

The aim of regional decomposition of total carbon emission target is to distribute total carbon emission target to different regions employing an agreed methodology, thus to initiate their enthusiasm to achieve total control target together. The decomposition process calls for joint consultation from all sides, and the result needs to be fair and reasonable to ensure its acceptability. At the same time, the method should be an embodiment of national major policy orientation. The guiding concept of decomposition could be summarized as two points.

First is equity. The core idea is to "allocate equally", which means the decomposition should be based on different circumstance of provinces (municipalities) to ensure the acceptablility of final results.

Second is efficiency. The core idea is to allocate in the principle of "maximized output" which means that the decomposition methodology should be beneficial to realize a greater economic output, and achieve a greater development benefit under the fixed national total carbon emission control target.

### 3.1.2 Basic ideas

Different from decomposition process employing complex models, this method only use a simple"additive formula" to calculate carbon emission space for each province. The basic ideas are described as the followings.

First, study and determine the indicator system reflecting "equity" and "efficiency" based on the guiding concept, and endow each indicator with relevant weight coefficient.

Second, decompose total carbon emission control target according to the indicators and its weight coefficient. Each indicator should have a corresponding total carbon emission sub-target which is determined by both weight coefficient and total carbon emission control target. Moreover, the total quantity of sub-targets should equals total carbon emission control target.

Third, allocate each sub-target to every region by using a certain methodology reflecting both equality and rationality.

Last, sum up all allocations corresponding to all indicators for each province and municipality and get the decomposed total carbon emission target of every region.

### 3.1.3 Indicators system

The Indicators system is mainly determined by the principle of "equity" and

"efficiency". Taking regional difference into consideration, "equity" is mainly divided into interpersonal equity and development phase equity. The differences lie in the regional population and development phase. "Efficiency" is considered from the national aspect, and it mainly considers differences of carbon productivity in various regions. In some extent, it shows national policy orientation of enhancing carbon productivity. In addition, in view of China's national special situation – usually the central government would arrange major project to the local government based on National Development Strategies. The carbon emission of these major projects would occupy local carbon emission space, therefore, a national strategic indicator is set in this decomposition methodology.

In order to make decomposition methodology concise and easy to operate, four indicators are selected in this study, which includes population, GDP per capita, carbon productivity and national strategic indicators.

**①. Population. Population is the permanent resident population in each province (municipality).** It is a positive indicator, mainly presents interpersonal equity. According to the "people-oriented" concept, regions with more population should receive more carbon emission space.

**②. Per capita GDP. Per capita GDP is the average level of per capita GDP in each province (municipality).** It is a negative target, mainly shows development level equity. Regions with lower per capita GDPshould receive more carbon emission space.

**③. Carbon productivity. Carbon productivity is GDP per unit of carbon emission generated in each province (municipality).** It is a positive target, mainly indicates utilization efficiency of carbon emission space. According to "maximized output" concept, regions with higher level of carbon productivity should receive more carbon emission space.

**④. National strategic indicator. National strategic indicator is set for national reserved strategic carbon emission space.** It is allocated to local government according to the national strategic projects arrangement.

### 3.1.4 Major parameters

In the decomposition process mentioned above, the relevant major parameters and their connotations are as follows:

**①. Weights of different indicators**

The national total carbon emission control target is divided into four parts,

$$E = \sum_{j=1}^{4} E_j \quad \text{(Formula 4-1)}$$

$$\omega_j = \frac{E_j}{E} \text{ ( Formula 4-2)}$$

$$E_j = \omega_j \times E \quad \text{(Formula 4-3)}$$

Among these formulas, E represents national total carbon emissions control target; j means the "j[th]" indicator; $\omega_j$ represents the weight of the "j[th]" indicator, so:

$$\sum_{j=1}^{4} \omega_j = 100\% \text{ ( Formula 4-4)}$$

$$E_j = \omega_j \times E = \sum_{i=1}^{31} E_{ij} \text{ (Formula 4-5)}$$

$E_j$ means sub-target corresponding to "j[th]" indicator.

**②. $\theta_{i,j}$: the decomposition weights for all regions corresponding to different indicators**

Corresponding to indicator of population, the "i[th]" province (municipality) will get the carbon emission space $E_{i1}$

$$E_{i1} = \theta_{i,1} \times \omega_1 \times E \text{ (Formula 4-6)}$$

Corresponding to indicator of per capita GDP, the "i[th]" province (municipality) will get the carbon emission space$E_{i2}$:

$$E_{i2} = \theta_{i,2} \times \omega_2 \times E \text{ (Formula 4-7)}$$

Corresponding to indicator of carbon productivity, the "i[th]" province (municipality) will get the carbon emission space$E_{i3}$:

$$E_{i3} = \theta_{i,3} \times \omega_3 \times E \text{ (Formula 4-8)}$$

Corresponding to national strategy indicator, the "i[th]" province (municipality) will get the carbon emission $E_{i4}$:

$$E_{i4} = \theta_{i,4} \times \omega_4 \times E \text{ (Formula 4-9)}$$

③. $E_i$ carbon emission control target for each province (municipality):

$$E_i = \sum_{j=1}^{4} E_{ij} \text{ (Formula 4-10)}$$

$E_{ij}$ means the carbon emission space constitution based on each indicators for every

region; $E_i$ refers to the carbon emissions control target that is distributed from central government to the "ith" province (municipality).

## 3.2 Major choices existing in the actual decomposition

The methodology mentioned above put forward the basic idea of top-down decomposition of national total carbon emissions target, meanwhile the actual operation needs further determination of major parameters such as $\omega_j$、$\theta_{i,j}$. Besides, due to the inevitable trend that China's carbon emissions will maintain high speed of growth, it is also a possibility to adjust the target (national total carbon emissions) which is decomposed employing the methodology mentioned above. . This section will mainly analyze major choices existing in the actual operation, and it is up to consultation between central government and local governments to determine the final choice. .

### 3.2.1 Weight coefficient of different indicators

The weight coefficient of different indicators reflects the importance of different indicators in the national carbon emission control target decomposition. Different regions have their own preferences while considering their own benefits. For example, regions heavily populated may demand for a higher weight of population indicator, regions whose carbon productivity ranks high throughout whole country will propose a higher weight of carbon productivity indicator, and relatively more developed regions will ask for a lower weight of per capita GDP indicator. Therefore, the final weight coefficient should be determined by consultation between central and local governments.

### 3.2.2 The allocation weights for region under different indicators $\theta_{i,j}$

Apart from the fact that national strategic indicator should be implemented according to actual situation, the allocation weights for region under other three indicators will have a great bearing on the decomposition results.

#### ①. The allocation weight under population indicator $\theta_{i,1}$

Conforming to the principle that "all men are created equal", the decomposition weights corresponding to population indicator is in line with their proportion to whole country in terms of total population, namely:

$$\theta_{i,1} = \frac{P_i}{\sum_{i=1}^{31} P_i} \quad \text{(Formula 4-11)}$$

#### ②. The allocation weight under per capita GDP indicator $\theta_{i,2}$

A higher per capita GDP, means higher level of development. In compliance with

the principle of "equity", less carbon emission space should be allocated to region with higher per capita GDP, which implies allocation weights of per capita GDP indicator are inversely related to their per capita GDP level.

According to this requirement, the following methods are proposed for calculating$\theta_{i,2}$:

The first is to get the reciprocal for per capita GDP of different regions, and then take the allocation weight as the weight of per capita GDP reciprocal for a region in the sum of per capita GDP reciprocal for all regions namely:

$$\theta_{i,2} = \frac{1/(\frac{GDP_i}{P_i})}{\sum_{i=1}^{31} 1/(\frac{GDP_i}{P_i})} \quad \text{(Formula 4-12)}$$

The second is to measure the gap between per capita GDP of a region and a certain per capita GDP target, and the allocation weight will correspond to the weight of the gap of one region in the sum of total gaps of all regions, namely:

$$\theta_{i,2} = \frac{GP_T - \mathrm{GDP}_i/P_i}{\sum_{i=1}^{31}(GP_T - \mathrm{GDP}_i/P_i)} \quad \text{(Formula 4-13)}$$

$GP_T$ is national per capita GDP level in some future year, which means that the allocation process is based on the development concept of "common prosperity".

Taking into account that there is a huge gap among different regions in terms of per capita GDP level (with the maximum gap of nearly seven times), if national per capita GDP of a year in future (like 2020) is selected as the target value, the regions with the highest GDP level may be distributed with negative value, which indicates that these regions should set aside development space for the relatively underdeveloped regions.

### ③. The allocation Weight of Carbon Productivity indicator $\theta_{i,3}$

The carbon productivity level of a region will be positively correlated with its allocation weight, which means that regions with higher carbon productivity should get more carbon emission space. With regard to national conditions, more development benefits will be reaped with the same carbon emission. According to this requirement, the proposed methods to calculating $\theta_{i,3}$ are as follows:

The first is to allocate carbon emission space in accordance with the weight of carbon productivity of this region in the sum of carbon productivity of all regions, namely:

$$\theta_{i,3} = \frac{\mathrm{CP}_i}{\sum_{i=1}^{31} \mathrm{CP}_i} \quad \text{( Formula 4-14)}$$

In this formula, $CP_i$ means carbon productivity of the "i[th]" province (municipality).

According to this method, if the carbon productivity of Beijing is four times more than that of Guizhou province, Beijing will get carbon emission space which is four times larger than Guizhou province during the allocation process corresponding to carbon productivity indicator. At present, there are huge differences among different regions in terms of carbon productivity (the maximum level is about six times higher than the minimum level), thus may resulting in large gap among the allocation results of different regions.

The second is to represent the differences of carbon productivity properly, but it does not mean distributing completely in compliance with the proportion of carbon productivity among different regions. Instead, a certain coefficient will be introduced to be defined as the proportion of allocation value of region with highest carbon productivity and region with lowest (this proportion will be less than the carbon productivity proportion of two regions), and other regions will be converted according to the mutual proportion of carbon emissions, namely:

$$\theta_{i,3} = [\frac{CP_i - CP_{min}}{CP_{max} - CP_{min}} \times (\mu - 1)] \times (\theta_{i,3})_{min} \quad \text{(Formula 4-15)}$$

$$(\theta_{i,3})_{min} = \frac{1}{\frac{\mu - 1}{CP_{max} - CP_{min}} \times \sum_{i=1}^{31} (CP_i - CP_{min}) + 31} \quad \text{(Formula 4-16)}$$

### 3.2.3 The allocation aggregate

The allocation aggregate is the total carbon emission space which shall be decomposed to different regions according the methodology mentioned aboved. In terms of allocation aggregate, we have several choices as follows:

The first choice is to allocate the total carbon emission target of the whole country in a certain year in future, such as the control target of the total carbon emission in 2020. Theoretically, we can obtain a relatively fair and reasonable allocation result on the basis of above methodology. However, the gap is rather large between historical carbon emission space and the theoretical decomposition results for various regions, as carbon emission is not considered during the development process in history. It's very difficult to reverse this situation in a short period. For instance, the carbon emission lock-in effect will exist in the recent new invested construction projects in a short term which cannot be completely adjusted in the light of the fair and reasonable decomposition results. Thus, it may be very difficult to directly distribute the total carbon emission throughout different regions in a satisfying way in recent days.

The second choice is to allocate the increment space of carbon emission in the

entire country in future, such as distributing the incremental control target of carbon emission during 2015-2020 throughout different regions by implanting the above methods. The control target of the actual total carbon emission for each regionfor 2020 is equal to “decomposition result of incremental emission target” + “the practical carbon emission in 2015” (presuming carbon emission in 2015 is already known). Referring to the adjusted reform strategy of “increment change drives storage change”, we confront small political obstacles when directly allocate increment recently and the compromising results can be much easier reached among regions. However, this method also has disadvantages. If the space of increment is small, it cannot achieve the effects of driving the storage adjustment.

The third choice is to allocate the “increment + partial storage”, by using the above methods, such as a part of the practical carbon emission (storage) in 2015 and the incremental carbon emission space of the whole country during 2015-2020. In this case, the carbon emission control target for each region is equal to “the adjusted storage + the allocated space ”.

In the practical decomposition process, the above selections include indicator weighting coefficient, calculating formula of local decomposition coefficient and decomposition aggregate are mutually affected. These choices can be defined through consultation between the central government and the locals. For example, the central government and locals can discuss and select the decomposition methodology, which is beneficial to avoid the repeated adjustment of the specific decomposition results so as to promote the decomposition process in a better way.

## 3.3 Simulation decomposition

The above contents provide the theoretical decomposition methods for the national total carbon emission target,which combines top-down process of decomposition and bottom-up process of defining the specific parameters and calculating formula. To test and verify the practicability of the above decomposition methods and compare the different parameter values or the influences of the calculating formula on the decomposition results, we take 2010 as the reference year and 2012 as the target year, and simulate decomposition of the carbon emission in 2012 so that we can analyze the divergent changes of decomposition and practical values in every provinces (municipality) so as to support the actual decomposition process in future

### 3.3.1 Basic data processing

To proceed the simulation, we need to deal with the basic data problems which include: Firstly, the sum of the data including the population, GDP and the energy consumption in every provinces (municipality) released by the National Bureau of Statistics is not equal with the countrywide data. What’s more, partial data show large differences which should be modified; secondly, there is no authoritative public

carbon emission data[15] which can be acquired directly and we have to calculate the national and the local carbon emission data separately.

**①. The rectification of population data and GDP data**

The basic idea is to rectify the population data and GDP data of all regions according to national total population and GDP.

According to total population and GDP (of that year) of 31 provinces (cities) collected by *China Statistical Yearbook*, the national value after summarized calculation can come to hand, which is larger than national total population and GDP. Unified contractive parameter is defined to let the sum of all regions maintain the same with national total: $\tau_{t,P}$ and$\tau_{t,GDP}$[13]

$$\tau_{t,P} = \frac{POP_t}{\sum_{i=1}^{31} POP_{i,t}}$$

$$\tau_{t,GDP} = \frac{GDP_t}{\sum_{i=1}^{31} GDP_{i,t}}$$

In these two formulas, $\tau_{t,P}$and $\tau_{t,GDP}$ are the contractive parameter of population and GDP of every regions in the year of t; t represents time, namely 2010, 2011 and 2012; i means every region (province). $POP_t$ and $GDP_t$ refer to national total population and GDP respectively, and $POP_{i,t}$ and $GDP_{i,t}$ mean the population and GDP of i province in the year of t.

The population data and GDP data of every region will be adjusted by the following calculation formulas:

$$POP_{i,t}{}' = POP_{i,t} \times \tau_{t,P}$$

$$GDP_{i,t}{}' = GDP_{i,t} \times \tau_{t,GDP}$$

In these formulas, $POP_{i,t}{}'$ and $GDP_{i,t}{}'$ represent the population and GDP of i province in the year of t after adjustment.

**②. Calculation of national and provincial carbon emissions**

It is necessary to calculate carbon emissions data of whole country and all regions respectively. Because carbon emissions produced by fossil energy combustion take up

[15] From national information notification are only part of carbon emissions data available.

the major part of all carbon emissions while considering relatively poor statistics capability for carbon emission in China, only carbon dioxide emitted from fossil fuel combustion will be calculated.

(1) National carbon emissions

According to the total primary energy consumption and structure from 2010 to 2012 provided by China Statistical Yearbook on Energy, national total emissions will be calculated, among which the carbon emissions coefficients of coal, petroleum and natural gas are 2.59t $CO_2$/tce, 2.121t $CO_2$/tce, and 1.484t $CO_2$ /tce respectively.

(2) Regional carbon emissions

According to *Guidebook for Compilation of Greenhouse Gas Emissions Inventory for provinces*, carbon emissions of all regions include two parts, one is the direct carbon emissions corresponding to fossil fuel consumption; the other is the carbon emissions corresponding to net input (output) of electric power of all regions. There is also a gap between national data and the sum of all regions for energy consumption, so we will refer to the data adjusting methods previously used for population data and GDP data to rectify data of different types of energy in all regions, thus finally calculating carbon emissions of all regions after adjustment in compliance with the same carbon emissions coefficient used for national carbon emission calculation. For the indirect carbon emission corresponding to net electricity input, the factors of electric power emissions of regional power grids is used in calculation process, together with the net input of electric power in the energy balance sheet of all regions.

$$EC_{i,t} = \sum_{a} E_{i,t,a} \times \frac{E_{a,t}}{\sum_i E_{i,t,a}} \times f_{1,a} \times f_{2,a} + TE_{i,t} \times f_{3,t,i}$$

n this formula, $EC_{i,t}$ is carbon emissions after adjustment of i province in the year of t, and “a” corresponds to three kinds of primary energy, namely coal, petroleum and natural gas. $E_{i,t,a}$ represents the energy consumption corresponding to a-type energyconsumption of i province in the year of t, and $E_{a,t}$ is the energy consumption of a-type energy of the whole country in the year of t. $f_{1,a}$ and $f_{2,a}$ correspond to the standardized coefficient and carbon emissions coefficient of a-type energy respectively. $TE_{i,t}$ means the net electric power input of i province in the

year of t, and $f_{3,t,i}$ represents the carbon emissions factor of electric power input of i province in the year of t.

According to the authoritative information issued by National Development and Reform Commission, China's regional power grids and relevant electric power emissions factors are shown in Table 4-7

Table 4-7 The electric power emissions factors of regional power grids

Unit: $tCO_2/MWh$

| Regional power grids | provinces and cities involved | **2010** | **2011** | **2012** |
|---|---|---|---|---|
| North China power grids | Beijing, Tianjin, Hebei, Shanxi, Shandong, Inner Mongolia | 0.8845 | 0.8967 | 0.8843 |
| Northeast China power grids | Liaoning, Jilin, Heilongjiang | 0.8045 | 0.8189 | 0.779 |
| East China power grids | Shanghai, Jiangsu, Zhejiang, Anhui, Fujian | 0.7182 | 0.7129 | 0.7035 |
| Central China power grids | Henan, Hubei, Hunan, Jiangxi, Sichuan, Chongqing | 0.5676 | 0.5955 | 0.5274 |
| Northwest China power grids | Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang | 0.6958 | 0.686 | 0.6671 |
| South China power grids | Guangdong, Guangxi, Yunnan, Guizhou, Hainan | 0.596 | 0.5748 | 0.5271 |

**③. The Processing results of basic data**

The processing results of basic data including population, per capita GDP, carbon emissions and carbon productivity are described as follows:

(1) Population distribution

China boasts 1.34 billion population in 2010 with unbalanced distribution in all regions, among which four province have population that is more than 4% of national total (namely over 80 million), including Shandong, Henan, Guangdong and Sichuan. There are 10 provinces with population that is from 2% to 4% of national total (namely from 40 million to 80 million), including Hebei, Liaoning, Jiangsu, Zhejiang, Anhui, Jiangxi, Hubei, Hunan, Guangxi and Yunnan. The other provinces (municipality) have population less than 40 million, among which Qinghai province has the lowest population that only takes up 0.5%[16] of national total.

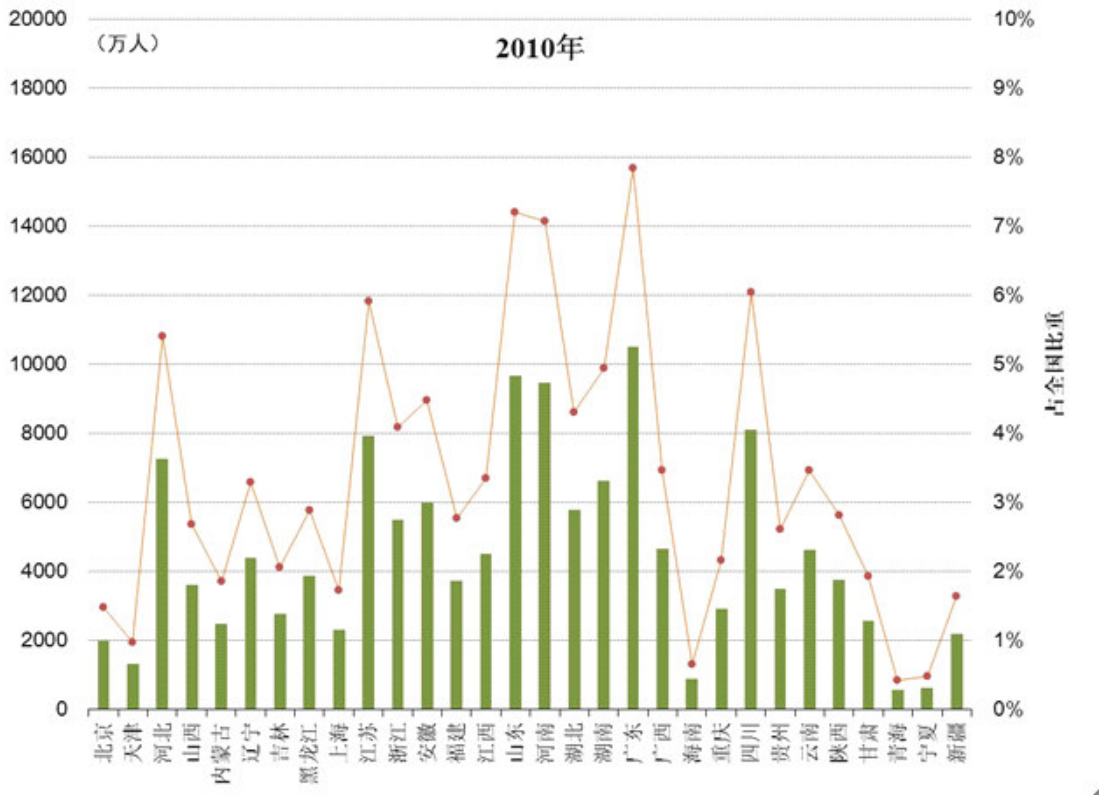



figure 4-2 National and regional population in 2010

(2) Per capita GDP

In 2010, national per capita GDP is about 29.9 thousand yuan with ever-growing gap among different regions. The region with highest per capita GDP is Shanghai (68.1 thousand yuan), and the region with lowest one is Guizhou (12.1 thousand yuan), with a gap of 5.6 times between two regions. From the helicopter view, Beijing, Shanghai and Tianjin enjoy highest level of per capita GDP which is within the range of 60 to 70 thousand yuan; Inner Mongolia, Liaoning, Jiangsu, Zhejiang, Fujian, Shandong and Guangdong are the second tier with per capita GDP in the range of 30 to 50 thousand yuan; the level of these 10 provinces (municipality) mentioned above is higher than national average; the per capita GDP for 13 provincesare in the range of 20 to 30 thousand yuan, including Hebei, Shanxi, Jilin, Heilongjiang, Henan, Hubei, Hunan, Hainan, Chongqing, Shaanxi, Qinghai , Ningxia and Xinjiang ; the other eight provinces including Anhui, Jiangxi, Guangxi, Sichuan, Guizhou, Yunnan, Tibet and Gansu have relatively low development level with per capita GDP of 10 to 20 thousand yuan.

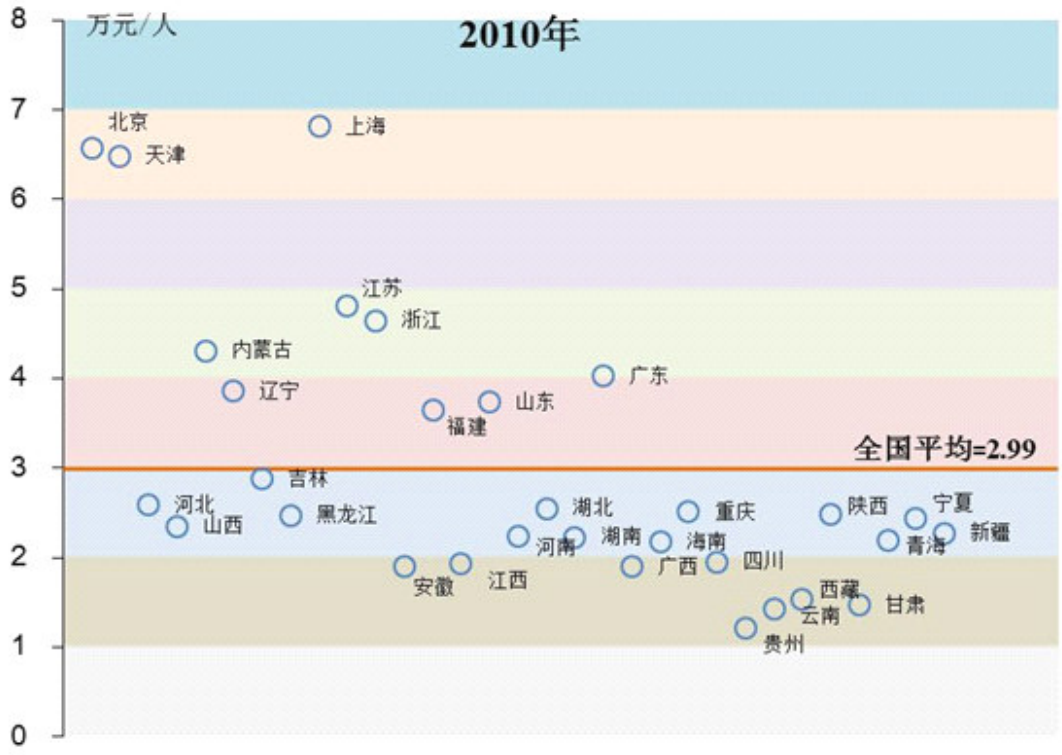



figure 4-3 National and regional per capita GDP data in 2010

(3) Carbon emissions

China's total carbon emissions come at about 7.206 billion tons in 2010. The provinces (municipality) which have more than 400 million tons of carbon emissions include Hebei, Shanxi, Jiangsu, Shandong, Henan and Guangdong; regions with 200 to 400 million tons of carbon emissions include Inner Mongolia, Liaoning, Heilongjiang, Shanghai, Zhejiang, Hubei, Hunan, Sichuan and Shaanxi; 11 provinces (municipality) have 100 to 200 million tons of carbon emissions, including Beijing, Tianjin, Jilin, Anhui, Fujian, Jiangxi, Guangxi, Chongqing, Guizhou, Yunnan and Xinjiang; regions with less than 100 million tons of carbon emissions include Hainan, Qinghai , Gansu and Ningxia. China's total carbon emissions increasing to 8.031 tons in 2012, among 30 provinces (except Tibet), 28 have some growth in terms of carbon emissions, and only Shanghai and Henan province have some decline.

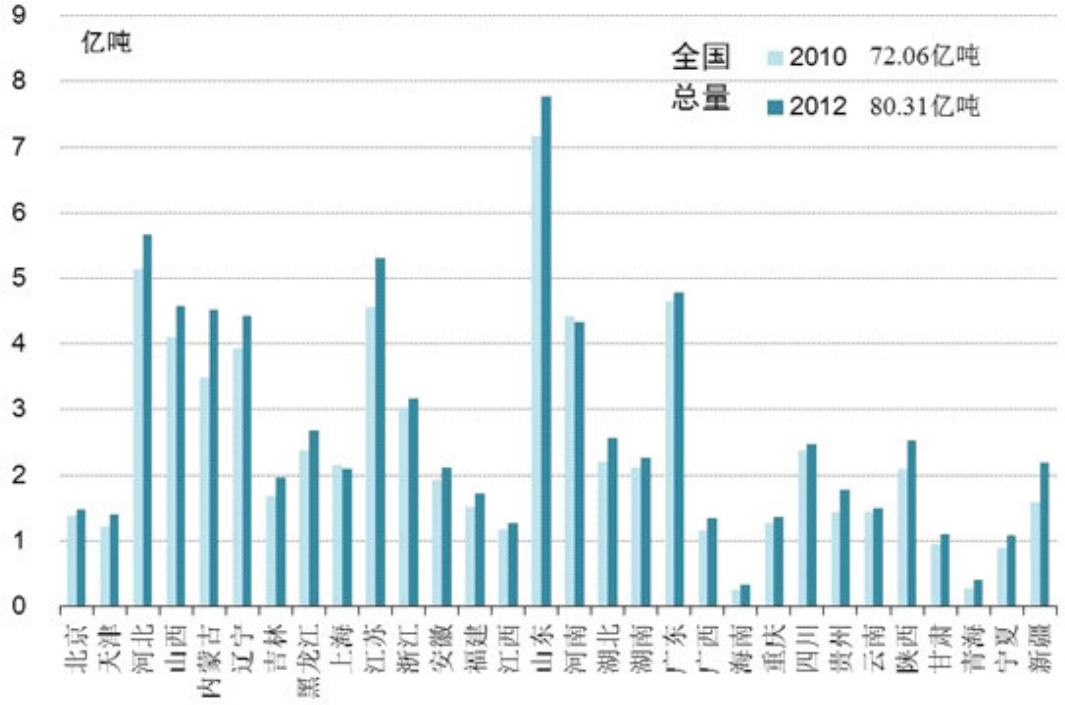



figure 4-4 national and regional carbon emissions in 2010 and 2012

(4) Carbon productivity

China's carbon productivity was around 5600 yuan per ton of $CO_2$ in 2010. For regional carbon productivity status, the regions whose carbon productivity was higher than the national average level and regions lower were half and half. Beijing boasted the highest carbon productivity that was 9320 yuan per ton of $CO_2$, while Ningxia had the lowest carbon productivity that was 1720 yuan per ton of $CO_2$, which was only 18% of Beijing. Eastern coastal areas enjoyed comparatively high-carbon productivity, such as Guangdong, Zhejiang, Jiangsu and Fujian, while western regions and energy resource based regions remained lowcarbon productivity, such as Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang and Inner Mongolia.

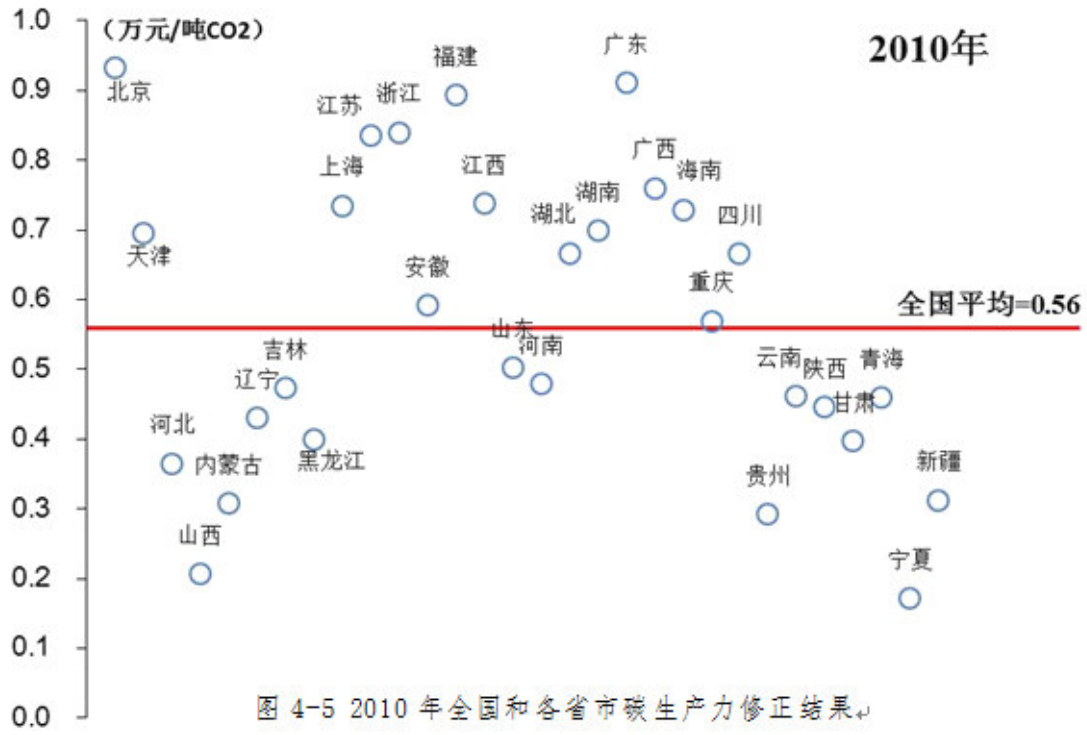



figure 4-5 national and regional carbon productivity in 2010

### 3.3.2 Analysis of simulation decomposition results

**①. Representation of differences between allocation and actual emission**

The investigation of the differences between allocation and actual emission of provinces is conducted from two dimensions, one is the absolute gap between these two data, namely “allocation - actual emission” in 2012; the other is the proportion between both data, namely “allocation / actual emission” in 2012. The differences between allocation and actual emission in different regions can be categorized into three ranges as follows:

Range I (large deficit): “allocation / actual emission<0.8” or “allocation - actual emission <-500 million $tCO_2$ ”

Range II (moderate difference): “allocation / actual emission=0.8 to 1.2” and “-500 million $tCO_2$<allocation - actual emission<500 million $tCO_2$”

Range III (largh surplus): “allocation / actual emission>1.2” or “allocation-actual emission>500 million $tCO_2$”

**②. Simulation decomposition results and discussion**

On account of the multiple choices that may exist in the decomposition process, the simulation only considers the differences of decomposition aggregate and thus sets three simulation decomposition schemes: the first is to directly decompose national total carbon emissions in 2012; the second is to decompose national carbon emissions increment between 2010 and 2012, and the decomposition result of each

province will be the sum of its actual emission in 2010 plus increment decomposition result; the third is a mixed decomposition aggregate which includes “part of storage”(5% emissions in 2010) and increment between 2010 and 2012”, and the decomposition result of every province will be the sum of storage after adjustment plus mixed decomposition result. For these three schemes, the weight coefficients of population, per capita GDP and carbon productivity indicators are 0.3, 0.2 and 0.5 respectively, indicating that equity and efficiency will be attached equal importance. For the formula that calculate the allocation coeffcient under the per capita GDP indicator, we use national average per capita GDP in 2012 as the national target per capita GDP, and corresponding allocation coefficient is calculated as the proportion of the gap between per capita GDP of each province in 2010 and the target per capita GDP in the sum of all provinces.. The main idea is that some relatively developed regions (like Beijing and Shanghai) have basically entered the post-industrial development stage, and these regions should set aside some space for carbon emissions and allocate it to the regions that remain in the burgeoning stage of industrialization or in the medium-term of industrialization. That is to say, in the carbon emissions decomposition corresponding to per capita GDP indicator, relatively developed regions such as Beijing and Shanghai are allowed to have negative allocation value. For the decomposition of sub-target corresponding to carbon productivity indicator , the decomposition process will be based on the proportion of carbon productivity of each province to the aggregate of all provinces (Formula 4-14), with the consideration of spurring the development of regions featuring high carbon productivity and promoting the low-carbon restructuring of overall economy.

(1) The General distribution of the difference betweenprovincial allocation and actual emission

Under three simulation schemes, the differences between allocation and actual emission for all provinces and municipalities can be seen at Table 4-8. For the first scheme, there are lots of provinces and cities lie in the range of large differences between allocation and actual emission. Range I has 11 and Range III 14, so the number of region with moderate difference is only 5. For the second scheme, the number of province with large difference drops sharply, and 25 provinces lie within range II (moderate difference), the number of provinces lying in range I and range III is 1 and 4 respectively. For the third scheme, despite the decline in number of provinces with moderate diffenence between allocation and actual emission, the majority of provinces remain in range II, with 3 in range I and 6 in range III.

The results above show that differences in emissions of reference year of all provinces should be taken into account when carrying out regional decomposition of national aggregate. Because the distribution of storage carbon emission (base year, 2010) in all provinces does not match the priciple of both equity and efficiency, and the adjustment process of emission storage distribution needs some time, the allocation and actual emission are fairly different. It is relatively advisable to

"promote storage adjustment through increment adjustment" for the regional decomposition of national carbon emission control target. Only considering decomposition of the carbon emission increment(as the second simulation scheme, though the result is optimal from the view of quantities of provinces in range II (moderate difference), it should also be reviewed whether increment can really mobilize the storage adjustment in the future. Taking into account the peak value of carbon emissions that may reached in 2030 or even earlier and drawing on the study results from different research institutes[17], China's carbon emission peak from energy consumption will reach 11 billion to 12 billion tons of $CO_2$. According to total energy consumption and its structural, China's carbon emissions have arrived at 10 billion tons of $CO_2$, so there is little space for future carbon emissions increment. Only allocate the increment will not enable the regional decomposition of national carbon emission control target in line with the principle of both equity and efficiency. Therefore, the third scheme that decomposes "part of storage plus increment" will be more recommendable.

From the specific provinces (municipalities) list of range I, II, and III, some provinces belong to the same range under all three decomposition schemes. For example, Inner Mongolia all along belongs to range I, implying a large deficit; Jilin, Heilongjiang, Henan, Shanxi and Xinjiang all belong to range II, indicating moderate difference; Jiangxi, Hainan, Yunnan and Qinghai all belong to range III, which means large surplus. This shows that Inner Mongolia's development pattern from 2010 to 2012 has relatively more demand for carbon emission space than other regions, while Jiangxi , Hainan, Yunan and Qinghai are comparatively low carbon.

| | decomposition aggregrate | Range I | Range II | Range III |
|---|---|---|---|---|
| Scheme I | National total carbon emissions in 2012 | 11<br>Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Shanghai, Jiangsu, Zhejiang, Shandong, | 5<br>Jilin, Heilongjiang, Henan, Shaaxi, Xinjiang | 14<br>Anhui, Fujian, Jiangxi, Hubei, Hunan, Guangxi, Hainan, Chongqing, Sichuan, Guizhou, Yunan, Gansu, Qinghai, Ningxia[14] |

17 Wangyi: *To Suggest That "the 13th Five-year Plan" Formulate and Implement the Control Target for Total Carbon Emissions*
http://finance.ifeng.com/a/20150314/13552971_0.shtml

| | | | | |
|---|---|---|---|---|
| Scheme II | National carbon emissions increment from 2010 to 2012 | 1<br>Inner Mongolia | 25<br>Beijing, Tianjin, Hebei, Shanxi, Liaoning, Jilin, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Chongqing, Sichuan, Guizhou, Shaanxi, Gansu, Ningxia, Xinjiang | 4<br>Jiangxi, Hainan, Yunnan, Qinghai |
| Scheme III | National carbon emissions increment from 2010 to 2012 + 5% * national total carbon emissions in 2012 | 3<br>Inner Mongolia, Jiangsu, Shandong | 27<br>Beijing, Tianjin, Hebei, Shanxi, Liaoning, Jilin, Heilongjiang, Shanghai, Zhejiang, Anhui, Fujian, Henan, Hubei, Hunan, Guangdong, Chongqing, Sichuan, Guizhou, Shaanxi, Ningxia, Xinjiang | 6<br>Jiangxi, Guangxi, Hainan, Yunan, Gansu, Qinghai |

Table 4-8 The difference between allocation and actual emission of all provinces for 3 simulation schemes in 2012

Note：The weight coefficient corresponding to population, per capita GDP and carbon productivity targets are 0.3, 0.2 and 0.5 respectively, representing equal consideration of both equity and efficiency.

(2) The Difference between allocation and actual emission in sample provinces

10 sample provinces are selected to represent both “Eastern, Middle and Western regions” and “south and north regions”, and their difference between allocation and actual emission are analyzed.(Table2). With the increase of decomposed carbon emissions aggregrate, regions whose allocation declines include Beijing, Shanghai, Shandong and Guangdong. Among these four provinces, Beijing and Shanghai enjoy rather high per capita GDP which are among the highest throughout the country and is well above national average, so the two municipalities should set aside some space for other provinces while considering the fairness in development level. Besides, per capita carbon emission of Beijing and Shanghai is also higher than national average, so their allocated space is squeezed. Meanwhile, the carbon productivity of both cities is higher than national average, and Beijing’s productivity is even 30% higher than Shanghai, so compared with Shanghai, Beijing, is in relative vantage point (figure4-7). Shandong province and Guangdong province have similar per capita GDP which is about the same asnational average, but carbon productivity of Shandong is only near

national level and that of Guangdong province is only next to Beijing which is relatively high, and per capita emissions level of Shandong is also 70% more than that of Guangdong, so Guangdong can get larger space than Shandong.

The carbon emission space obtained through decomposition of the other 6 provinces gradually increase with enlarging decomposition aggregrate, for Jilin, Jiangxi, Hubei, Yunnan, Qinghai and Ningxia feature relatively low per capita GDP. On top of that, per capita carbon emissions level of these provinces remain low besides Ningxia, what's more, Jiangxi and Hubei have fairly highcarbon productivity level, so there is relatively large space for carbon emissions in these regions.

| provinces | Actual carbon emissions in 2012 (100 million tons) | Simulation scheme I | | | Simulation scheme II | | | Simulation scheme III | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Allocation carbon emissions in 2012 (100 million tons) | Differences | | Allocation in 2012 (100 million tons) | Differences | | Allocation in 2012 (100 million tons) | Differences | |
| | | | allocation-actual | allocation/actual | | allocation-actual | allocation/actual | | allocation-actual | allocation/actual |
| Beijing | 1.471 | 0.650 | -0.821 | 44% | 1.460 | -0.012 | 99% | 1.419 | -0.052 | 96% |
| Jilin | 1.964 | 2.282 | 0.319 | 116% | 1.920 | -0.044 | 98% | 1.938 | -0.026 | 99% |
| Shanghai | 2.106 | 0.079 | -2.208 | 4% | 2.156 | 0.050 | 102% | 2.052 | -0.054 | 97% |
| Jiangxi | 1.270 | 3.880 | 2.611 | 306% | 1.578 | 0.308 | 124% | 1.693 | 0.423 | 133% |
| Shandong | 7.775 | 2.998 | -4.777 | 39% | 7.474 | -0.301 | 96% | 7.251 | -0.525 | 93% |
| Hubei | 2.559 | 3.515 | 0.956 | 137% | 2.564 | 0.006 | 100% | 2.612 | 0.053 | 102% |
| Guangdong | 4.783 | 3.912 | -0.871 | 82% | 5.051 | 0.268 | 106% | 4.994 | 0.211 | 104% |
| Yunnan | 1.493 | 3.602 | 2.109 | 241% | 1.810 | 0.318 | 121% | 1.900 | 0.407 | 127% |
| Qinghai | 0.4717 | 2.340 | 1.923 | 562% | 0.511 | 0.094 | 123% | 0.602 | 0.186 | 145% |
| Ningxia | 1.084 | 1.496 | 0.413 | 138% | 1.059 | -0.025 | 98% | 1.081 | -0.003 | 100% |

Table4-9 The differences between decomposition value and actual value under three schemes of some provinces in 2012

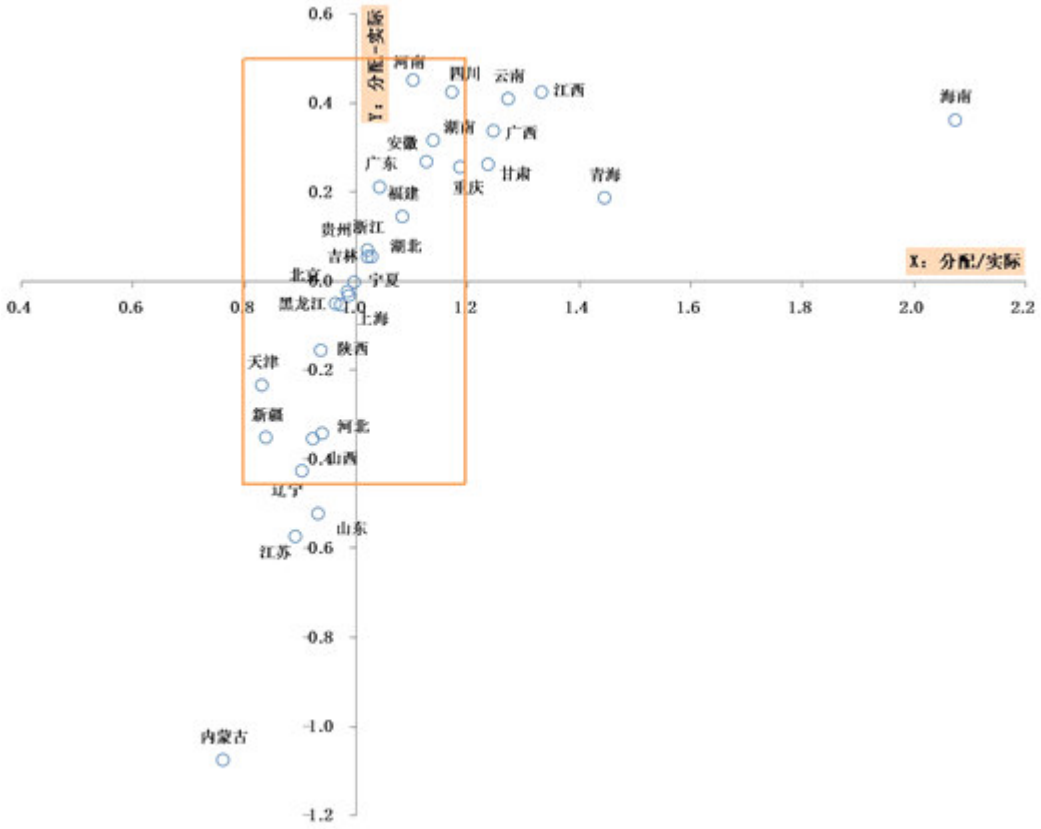



figure4-6 The spread of differences between allocation and actual emission (W1=0.3, W2=0.2, W3=0.5)

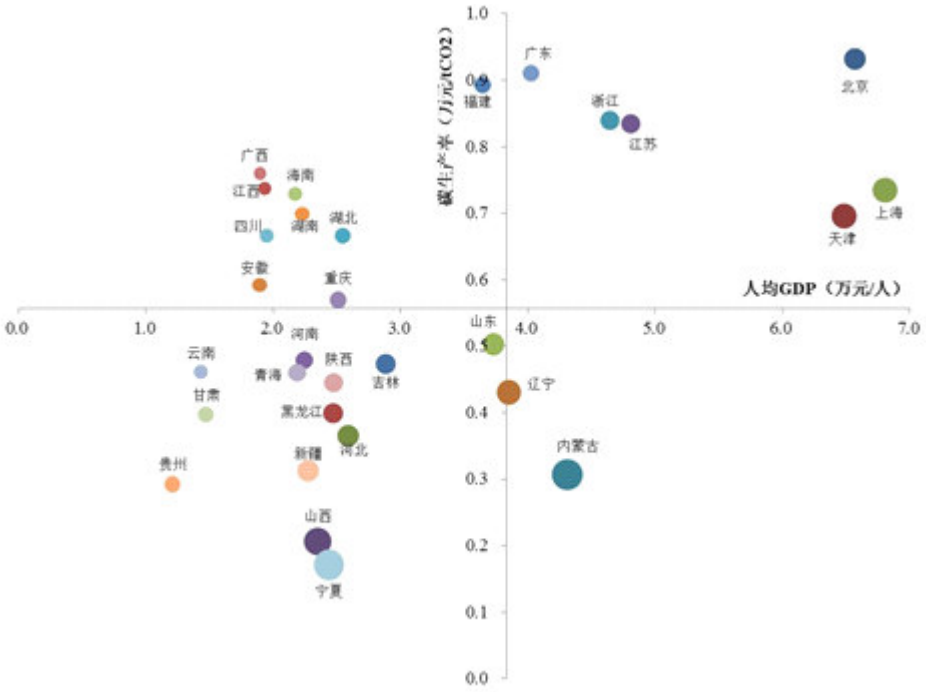



figure4-7 Comparison of per capita GDP, carbon productivity and per capita carbon

emissions of all provinces

Note: The vertical axis of this figure is carbon productivity, and its intersecting point with horizontal axis is national average level of 5.57 thousand yuan/tCO2 in 2010;The horizontal axis of this figure is per capita GDP, and its intersecting point with vertical axis is national average level of 38.33 thousand yuan per person; The circle size represents the ammount of per capita carbon emissions, and the larger the circle is, the more the carbon emissions are.

The weight coefficient of indicators (i.e. population, per capita GDP and carbon productivity) and the selection of calculation formula for regional allocation coefficient will have a tremendous bearing on the decomposition results. For instance, when adjusting weight coefficient and emphasizing the efficiency more, provinces with relatively high carbon productivity (like Beijing, Guangdong and Jiangxi) will gain larger carbon emissionspace for , while the space of provinces with relatively low-carbon productivity (like Ningxia and Guizhou) tends to be squeezed. However, when equity is more stressed, provinces with low per capita carbon emission or low per capita GDP (such as Guizhou, Yunnan and Gansu) will enjoy larger space. The final choice will be determined by the policy orientation of central government and the consultation among all local governments.

## 3.4 Conclusion

The regional decomposition method of total carbon emissions control target combines top-down decomposition process with a bottom-up process of parameters and calculation formula determination. This method also takes into account local practical situation to ensure fairness and China's national policy orientation to ensure more development benefits within the limited space for carbon emissions, not leaving out the effects of national strategy implementation on local carbon emission which is specific national practical conditions.

The idea of "summation" reflected in this method, contributes to simplicity and clearance of the decomposition process, which also results in little demand for data, thus this decomposition methodology is relatively applicable under the circumstances that there are relatively scanty of detailed and accurate data in China. The results of simulation decomposition also indicate that when allocate "incremental emission" or "incremental plus some storage emission" employing this method, there are relatively few differences between allocation and actual emission in all provinces, showing that this method can be used as the discussion basis of actual decomposition process.

# Section 4 Suggestions for Regional Decomposition Mechanism of Carbon Emission Control Target duringthe 13th Five-Year Plan Period

## 4.1 Implementing “double control” of both intensity and total carbon emissions

### 4.1.1 The comparison between two controll mechanism of carbon intensity and total carbon emission

Both intensity control and total emission control are effective methods for controlling carbon emissions. The former mainly focuses on decreasing the intensity of carbon emissions to a specific target, while the latter requires total carbon emissions do not surpass a specific value. Both control mechanisms are able to promote low-carbon development, but there exist some differences between them, including:

**①. Differences in target orientation**

The method of intensity control takes carbon emissions per unit of GDP as the control target, and accordingly the target is oriented to reducing carbon emissions per unit of GDP, which means that importance has been attached to “the quality of economic development”. In other words, it aims at improving carbon productivity. Developing countries have great potential for economic development. In particular, the increase of total energy consumption and total carbon emissions will be inevitably followed by the industrialization process and urbanization process. To follow a low carbon development path they need to improve the quality of economic and social development, so the intensity carbon target gains more popularity among developing countries.

The method of controlling total emission pays more attention to the absolute emission cap, and it may even achieve the decline of total carbon emission at the cost of economic growth. Developed countries have entered into post- industrialization process with high proportion of the tertiary industry, and their carbon productivity has ranked fairly high throughout the world, indicating that there is relatively limited space for further improving carbon productivity. The requirements for low-carbon development in their development stages are to take low-carbon way as the new economic growth opportunities, decoupling economic growth and carbon emissions, and thus controlling and gradually lowering the total carbon emissions, so the total emission control gains more popularity among developed countries.

**②. Differences in the requirements for data statistics**

There are differences in requirements for data statistics betweenintensity control and total emission control when decomposing the national target to regions. Adopting intensity target requires that all regions provide scientific and accurate data of carbon emissions and GDP that are in line with national aggregate; however, employing total carbon emission control only requires scientific and accurate data of carbon emission of whole country and all regions..

These two kinds of carbon emission control targets will have more differences in terms of the requirements for data when conducting regional decomposition. The regional decomposition of intensity control targets needs a number of indicators. For example, the decomposition methods put forward in this research demands 9 indicators in the reference year, including per capita fossil energy consumption, per capita carbon dioxide emissions, GDP proportion to national total, per capita energy production, strategic orientation of regional development, development rate of regional economy, per capita GDP, the proportion of the tertiary industry and carbon emissions per unit of GDP. However, the method for regional decomposition of total carbon emission target raised by this study only requires three indicators in the reference year, namely population, per capita GDP and carbon productivity.

**③. Differences in constraint force**

There are also differences between two kinds of carbon emission control targets in terms of constraint force. Adopting the total emission target intensifies the constraints on carbon emissions, thus providing more power in facilitating the reform of the government, adjustment of economic structure, energy mix and innovation in technology. However, intensity targetmeans less constraint force because the target canbe reached by means of enlarging denominator, i.e. producing more GDP. When there is lack of accurate data, it will be easy for local governments and enterprises to achieve the intensity target through data frauds. As a result, for the regions with relatively great potential of development, there must be due attention to demand of GDP growth which should be incorporated into the target range.

**④. Differences in relations between regional and national target**

If intensity target is used, regional targets and national target may not be coordinated, because the targets decomposed to all regional governments are the decline target of carbon emissions intensity. Relevant mathematical formula can indicate that on the one hand, it cannot be ensured that all regions' targets of carbon intensity decline can be strictly in line with national target. On the other hand, it could happen that all regions have achieved their targets but national target is unaccomplished at the final check. Therefore, further research is needed to address the problem of coordination between national target and regional targets during regional decomposition of national intensity target.

### 4.1.2 The situation for carbon emission control in China

Firstly, “the 13th Five-Year Plan Period” is the final period of achieving 40-45% decline of carbon emissions intensity than 2005 by 2020, which objectively requires that China to insist on the carbon emission intensity control. In 2009, China put forward this target before COP15 in Copenhagen, and “the 13th Five-Year Plan” is the final five years to achieve this target. As a responsible country with notable amount of carbon emissions, China should continue with the carbon emissions intensity control during these five years and guarantee the achievement of the carbon emissions intensity reduction target.

Secondly, “the 13th Five-Year Plan” is crucial period of building up a moderately prosperous society in an all-round way, which gives top priority to development for China. Therefore, equal attention should be paid to carbon emission control and economic growth and it is more rational to adopt the carbon intensity target. The 18th CPC National Congress raised the development targets that per capita income in 2020 should be doubled compared with 2010 and that moderately prosperous society should be built up in a comprehensive way, demanding for the maintenance of moderate-to-high speed economic growth during “the 13th Five-Year Plan” period. China is still in the primary stage of Socialism and development is still the most important task, so both carbon emission control and economic growth should be taken into consideration when taking to the path of low-carbon development. In short, to implement carbon emissions intensity control will be more advisable.

Thirdly, China is confronted with tremendous pressure in global climate change negotiation. “China’s National Determined Contribution[18]” and “China-Us Climate Change Joint Communique” have pushed forward that China will do its utmost to reach the peak of carbon emissions by 2030, so “the 13th Five-Year Plan” should explore the measures for total carbon emission control. China’s total carbon emissions have leaped to the first throughout the world, so China is under great pressure in the negotiation. The international society holds relatively high expectations for China to achieve the peak of carbon emissions as early as possible. “China’s National Determined Contribution” raised that China will reach the peak of carbon emission and will try every way to make it happen in advance. It is necessary for China to step into the stage of total carbon emission control and total carbon emissions control should be explored and implemented during “the 13th Five-Year Plan” period.

Fourthly, China has made it clear to control total energy consumption, so it is more necessary to explore the way to establish the mechanism to control total carbon emissions. President Xi Jinping puts forward that “China should unswervingly implement the control on total energy consumption” in his discuss on energy revolution. It is generally thought that total energy consumption has positive correlation with economic and social development. In current development stage, the economic and social constant development inevitably demands for further increase of total energy consumption. To carry out the control on total carbon [15]emissions can

[18] Intended Nationally Determined Contribution, “INDC” in short.

guide energy conservation, improve energy efficiency, and optimize energy mix, thus contributiing to China's sustainable development, so it should be explored more actively.

Fifthly, national economic and social development has entered into "new normal", and it is easier for the implementation of total carbon emission control. China's economic growth rate has been changed from high speed to moderate-to-high speed, which means the growth rate of China's total energy consumption and carbon emissions is likely to drop sharply. Besides, the optimized adjustment of economic structure will further lower the energy consumption and carbon emissionsgrowth. The macro economic and social development which is in the stage of "new normal" provides relatively sound and healthy environment for the implementation of control on total carbon emission to make it easier.

Sixthly, there is unbalanced development among different regions in China, so there should not be single scheme for controlling carbon emissions. The underdeveloped regions have both great potential for development and heavy tasks, and some relatively developed regions should lower their GDP growth. The underdeveloped regions in middle and western China are always accompanied by relatively high energy consumption and carbon emissions growth; but relatively developed regions in eastern China should actively carry forward the idea of green and low-carbon development in next move. Under the influences of optimized adjustment of industrial structure and lower GDP growth, some regions will even reach or approach the peak of total carbon emission during "the 13th Five-Year Plan" period. Against this backdrop, all regions cannot have the single scheme for controlling carbon emissions, but should determine their appropriate control methods tailored to local development stage and development features.

### 4.1.3 Brief summary

Based on the comparison between intensity control and aggregate control as well as the judgment of the situation of carbon emission control that China will face during "the 13th Five-Year Plan" period, "double control" featuring both intensity control and total carbon emissions control should be carried out. (1) At national level: intensity control remains dominant with total emission control as auxiliary; that is, to guarantee the achievement of national carbon intensity reduction target, while taking total emission control as guiding target. (2) At regional level: some regions are selected (with the standard of per capita GDP for example) to give priority to total carbon emission control and combine intensity control to check the control targets of carbon emissions; other regions put intensity control first and their intensity targets will be checked by central government.

## 4.2 The determination of national "double control" target and the initial ideas of its regional decomposition

### 4.2.1 The determination of national "double control" target carbon emissions should combine both top-down and bottom-top process

①. **Prediction for GDP growth rate**. National and regional carbon emissions intensity and total carbon emission is obviously related to GDP growth rate, so national and regional GDP growth targets in the future should be coordinated. The judgment for national GDP growth rate during "the 13th Five-Year Plan" should be coordinated with regional GDP growth rate expectations during that period submitted beforehand. In other words, regional GDP growth rate should meet national GDP growth rate target after accounting.

②. **Carbon intensity and total carbon emission targets**. To achieve the target of reducing carbon emissions intensity by 40%-45% than 2005 in 2020 means that national decline target in carbon emissions intensity in 2020 has been set. Referring to national GDP growth rate, total carbon emissions in 2020 can also be determined.

### 4.2.2 Decomposition process of national intensity and total carbon emissions target is as follows

①. Take the year of 2015 as the reference year, and decompose national intensity and total carbon emission targets to all regions at the same time employing the regional decomposition methods for intensity target and total emission target mentioned above.

②. Regional governments combines the carbon intensity target acquired through decomposition with their GDP growth rate checked by central government, and calculate the total carbon emission control target s, which will be compared with that total carbon emission control target acquired through regional decomposition, and the lower total carbon emissions target will be the final control target.

③. For the provinces and cites adopting total emission control target, the total carbon emission control target will be finally determined in accordance with the lower value; for the provinces and cites adopting intensity control, they will calculate the decline target of carbon intensity according to the lower carbon emissions value and the checked GDP growth rate and make it the final intensity control target.

## 4.3 Problems that should be noticed during regional decomposition

### 4.3.1 Problems with regards to data quality should be solved as soon as possible.

To implement carbon emission control and regional decomposition, including both intensity control and total emission control, it is needed real and effective data. There is relatively weak basis for statistical data in China, so it is necessary to further strengthen data statistics and improve its quality.

In particular, the decomposition process should take accurate statistics , such as population, GDP and energy consumption data. At present, there are huge differences between the statistical data of all regions and those of the whole country, especially the data of total energy consumption and its structure. Therefore, there should be coordination between local and national statistics and measures to solve this problem as soon as possible, thus providing solid data for the regional decomposition of carbon intensity and total emission targets.

On top of that, there remain some problems in terms of datastatistics, including: the statistical cycle lags behind, especially the data of energy and carbon emissions; data comparison from the third party is in great demand and there is little transparency in the process of data dissemination; the caliber adjustment of influences should also be put into statistics, such as the rectified data of population and economy census.

### 4.3.2 To issue relevant supporting measures

The formulation and decomposition of national carbon emission control target need to intensify coordination with other targets. Carbon emission control target is directly related to energy conservation target, non-fossil fuel development target and environment-protection target, and its achievement demands for the support from the fields of energy conservation, non-fossil fuel development and ecological protection. In particular, with the ever-growing importance of carbon emissions control target, energy conservation, non-fossil fuel development, forest carbon sinks and ecological environment should be closely connected with carbon emission control as well as the long-term low carbon development targets, such as ensure carbon emissions reaches peak in 2030.

When setting and allocating total carbon emissions target to regions, corresponding policies should be issued. On the one hand, owing to regional differences, to allocate the control total carbon emission targets to all regions will inevitably lead to the situation that some regions get surplus while some regions are in deficit. That will bring about pressure to the results of allocation accepted by regions and even the decomposition process, which needs supporting flexible measures to help these regions to achieve their target, including adjusting of the design of carbon trade system to allow these regions to trade, and establishing the system of borrowing in advance or storage. On the other hand, the checking policies should be updated, which means that it is necessary to formulate and issue assessment policies on total carbon emissions, coordinate carbon trade policies and trade among governments that may exist in the future, and adjust relevant content about assessing carbon emissions

of regions.

# Chapter 5 Study on the Framework of Carbon Emission Control Policies

After the target of energy conservation and consumption reduction was set forth in "the 11th Five-Year Plan" as an binding target, the target on the reduction of carbon emission per unit of GDP was also set forth in "the 12th Five-Year Plan" for the first time. In order to ensure the realization of the relevant targets, a series of policies and measures has been rolled out by central and local governments in the past few years, which effectively promoted the smooth development of combating climate change and the reduction of carbon emission intensity. Due to the implementation of relevant polices, better results have been achieved though there are still many problems to be solved. In the future, we should put more attention on the setting of overall target and working thought for combating climate change during "the 13th Five-Year Plan", and further study the implement approaches and supporting measures for the carbon emission control.

## Section 1 Progress of Existing Policies

### 1.1 Initial establishment of policy system for low-carbon development

Since 2006, China has strengthened the policy system designing around energy conservation and emission reduction and climate change. During the period of "the 11th Five-Year Plan", relevant policy systems of climate change have been established, and work on climate change has been brought into the overall layout of national economic and social development. China has enacted and implemented the *National Program on Climate Change*, which brings forward guiding thought, main areas and key tasks clearly at national level. There are 31 provinces (autonomous regions and municipalities) have formulated plan on climate change and established relevant policy system on climate change. During the period of "the 12th Five-Year Plan", the laws and regulation system to address climate change has been further improved and enhanced. Furthermore, the legislative process on climate change is accelerating. China has issued a series of special policies including *the National Strategy for Climate Adaptation*, *the Work Plan for Controlling Greenhouse Gas Emissions during "the 12th Five-Year Plan" Period*, *China's Policy and Action on Climate Change*, *Action Plan of Industry Addressing Climate Change (2012-2020), Action Points of Forestry Addressing Climate Change*, *China's Science and Technology Actions on Climate Change*, and *the National Plan on Climate Change (2014-2020)*. Several provinces are also active in compiling medium-and long-term plan on climate change

and climate adaptation at provincial level.

As of now, the low-carbon policy has basically covered all low-carbon development areas, which has significant impacts on carbon emission intensity. In accordance with the degree of government involvement, relevant policies on low-carbon development can be divided into 3 categories, that is, regulatory policy, incentive policy and voluntary policy[16]. The standard for the classification of policies is as following: (specific categories of policy shown in Table 5-1)

Regulatory policy: It is based on government forces, which controls and guides the behaviors of the target groups. The basis of reaching the functions relies on compulsory actions of government, and it is mainly delivered through the controlling or regulating method.

Incentive policy: It mainly relies on the market mechanism, which guides choices of target groups by levying the impact on costs and revenue, so as to achieve the policy targets. Incentive policy tries to make an equal marginal costs of energy conservation and carbon emission reduction among enterprises. It is not only promoting the effective allocation of social resources, but also encouraging enterprises to strengthen the development and application of low-carbon technologies.

Voluntary policy: It is few linked with the involvement of governments and usually operated by social groups in a voluntary basis, so as to achieve the desired policy targets. The precondition of voluntary policy is that the conception of voluntary supply can be widespread among enterprises in their management and personal values.

Table 5-1 Categorization of low-carbon policy

| Regulatory Policy | Incentive Policy | Voluntary policy |
|---|---|---|
| Establishing Carbon Intensity Reduction Target Responsibility System | Arranging Financial Fund to Support Energy Conservation Reconstruction | Energy Conservation Labels |
| Strengthening Energy Conservation Target Responsibility Evaluation | Providing Financial Funds to Clean Energy Utilization and Low-Carbon Energy | Energy Performance Contracting |
| Energy Consumption Control | Providing Financial Fund to Support Strategic Emerging Industries | Voluntary Exchange |

[16] On the relevant policies and measures on climate change and low-carbon related policies and measures, there is no unified classification method. For example, the World Bank (2002) has divided the environmental and resource management policies into 4 categories, namely environmental regulation, market usage, market creatation and public participation. While American environmental economist professor Tietenberg classified environmental policy tools into the command control tools, market-based tools, and informative tools.

| | | |
|---|---|---|
| Phasing Out Outdated Production Capacity | Carbon Emission Permit exchange | Capacity Building |
| Strictly Setting up Admittance of Industry | Building Low-Carbon Communities and Low-Carbon Pilots | |
| Relevant Laws and Regulations | | |
| Energy Conservation Technology Promotion Catalog | | |
| Relevant Schemes, Programs and Opinions | | |

## 1.2 Preliminary formation of management mechanism for low-carbon development

During the period of "the 11th Five-Year Plan", China has established and improved the management mechanism and working mechanism on climate change. It consists of climate change leading group, the National Development and Reform Commission, the relevant departments, local governments and local industries. In 2007, China established the National Leading Group on Climate Change, which is responsible for formulating major strategies, policies and guidelines. In 2008, the National Development and Reform Commission set up the Department of Climate Change, which is responsible for overall planning, coordinating and managing climate related work as well as implementing the strategies, policies and guidelines formulated by the National Leading Group on Climate Change. In 2010, China set up the coordination and liaison office within the National Leading Group on Climate Change, which strengthens the coordination between different departments. In addition, China established the Committee of Experts on Climate Change. During the period of "the 12th Five-Year Plan", all the provinces (autonomous regions and municipalities) have set up the leading agencies on climate change headed by the chief executive of governments as well as the division and coordination mechanism of different departments, with a purpose to implement the deployment work on climate change across China. Furthermore, some cities have set up special offices dealing with climate change or low-carbon development.

## 1.3 Continuous reinforcement of regulatory system for low-carbon development

Since 2006, China has strengthened the relevant system designing on energy conversation, emission reduction and climate change. During the period of "the 11th Five-Year Plan", in the outlines of the national economic and social development plan, China has put forward clearly the target of “energy intensity” for the first time. In addition, China has established a top-down energy intensity management system, and takes the energy consumption per unit of GDP as the binding target for the evaluation of performance of various provinces and cities. Furthermore, China has implemented the system of checking, examining and evaluation of the annual energy conservation target. In "the 12th Five-Year Plan" period, China proposed the dual binding targets of “energy intensity” and “carbon emission” intensity. Taking Beijing and other provinces as pilot areas, China implemented the total energy consumption control, which further perfected the responsibility and evaluation mechanism of energy conservation and carbon emission. Moreover, in recent years, China has continuously reinforced some operational systems, which proves a benefit for energy conservation and carbon reduction, such as the censorship of fixed assets energy conservation evaluation, energy performance contracting and carbon emission trading.

## 1.4 Preliminary establishment of statistics and accounting system for low-carbon development

During the period of "the 11th Five-Year Plan", China has made great progress in energy related statistics as well as greenhouse gas accounting. In terms of energy related statistics, China issued *the Implement Plan and Measures for Monitoring and Evaluation of Energy Conservation and Emission Reduction* and further improved the energy consumption accounting system. In addition, all provinces also continuously strengthened the institutional arrangement and personnel allocation on energy statistic and establish the relevant institution. In terms of greenhouse gas emissions accounting, China completed the national greenhouse gas emissions inventory for year 2005 and the second national communication, and established the national greenhouse gas inventory database. Moreover, China issued *the Provincial Greenhouse Gas Emissions Inventory Guideline (trial)*, and started compiling the provincial greenhouse gas inventories.

In "the 12th Five-Year Plan" period, the greenhouse gas statistics and accounting system was basically established. China issued *the Notice on the Implementation of Climate Change Statistics*, and set up a leading group to address climate change statistics. The National Development and Reform Commission (NDRC) checked and accepted the greenhouse gas emissions inventories of 31 provinces (autonomous regions and municipalities) for year 2005 and 2010. China released greenhouse gas

emissions accounting methodologies and guidelines for industry sectors such as steel, cement, nonferrous metals, etc..

## 1.5 Preliminary establishment of supporting policy framework for low-carbon pilots and demonstration

Since "the 11th Five-Year Plan", China has issued a series of pilot and demonstration policies in many aspects and carried out a wide range of low-carbon pilots and demonstration, such as the establishment of low-carbon province and city pilots, low-carbon park and community pilots, carbon emission trading pilots, and low-carbon product pilots. In terms of low-carbon province and city pilots, the National Development and Reform Commission approved a total 6 low-carbon pilot provinces and 36 low-carbon pilot cities in 2010 and 2012. All the pilot areas formulated their own pilot program, and the majority of pilot cities compiled local greenhouse gas emissions inventory. In addition, some pilot areas also arranged for special funds to support the pilot program and the relevant infrastructure constructions. In terms of low-carbon park pilots, the Ministry of Industry and Information and the National Reform and Development Commission jointly issued *the Notice on the Organization of National Low-Carbon Industry Park Pilots*, and formulated the corresponding evaluation index system and the supporting policies. As of now, the evaluation of the first 55 pilot industry parks has been completed and the implementation plans of these pilots are prepared. In terms of low-carbon community pilots the National Development and Reform Commission issued *the Notice on the Implementation of low-carbon Community Pilots*, and formulated *the Low-Carbon Community Pilot Construction Guideline* as well as *the Low-Carbon Community Pilot Evaluation Index System,* which focus on the carbon emissions accounting methods and the construction of relevant laws and regulations for the pilots. In terms of carbon emissions trading pilots, China selected two provinces and five cities as pilots to carry out the carbon emissions trading scheme. The pilot areas actively explored to establish their own carbon emissions trading system, including the formulation of local laws and regulations, the decision of total control targets and coverage areas, the establishment of greenhouse gas measurement, reporting and verification (MRV) system and the establishment of trading systems and rules as well as the market monitory and regulatory system. By doing these, China completed the preliminary establishment of a comprehensive policy system for carbon emission trading pilots. In terms of other pilots and demonstration, *the Issuance of the Interim Measures to Certificate and Manage Low-Carbon Products* and *the Notice on the Promotion of Test and Demonstration of Carbon Capture, Utilization and Storage* are published, which forms the basis of further promotion of low-carbon development.

## Section 2 Main Problems of Existing Policies

China's existing carbon policies are mainly regulatory policies, with the administrative approaches occupying the dominant position. With an apparent characteristic of “top-down” designing, regulatory policies is still needed to be strengthened in terms of their strategic, scientific and effective feature. The main problems of existing low-carbon policies can be summarized as below.

### 2.1 Main problems on regulatory policies

Firstly, the binding force of regulatory policies is weak. In spite of the continuous promotion of climate change legislation and the establishment of series of carbon emissions control targets, but generally speaking, China’s current work on greenhouse gas emissions control is still lack of clear law support, and there are no specific regulations and standards for carbon emissions control. Besides, other important low-carbon development systems such as information disclosure system and monitoring and regulatory system are still been established. Therefore, it is difficult for regulatory policy to play its fundamental role of constraints.

Secondly, the flexibility of regulatory policy is low. Although the regulatory policy has its advantage of high pertinence, easy operation and able to be managed, it is often lack of flexibility, which is easy to lead to policy failure. Constrained by the high management cost, the regulatory policy is often weak in taking account of the difference of marginal costs and carbon mitigation potential among different enterprises. In the implementation of regulatory policies, different enterprises are always required to follow same standards for energy conservation and emission reduction, which is easy to lead to the unbalance allocation of market resources.

Thirdly, the implementation effect of regulatory policy is not good enough. At present, regulatory polics are mainly devoted to the supervision of large energy-consuming enterprises and high energy-intensive industries, which can easily lead to the lack of incentive for enterprises that have the ability to go beyond the controlling standards. At the same time, there is still a lack of evaluation mechanism for the implementation effect of such policies. The overlap of policy functions and lack of communication between different departments can be easily found during the implementation of such policies, which means that the effectiveness, efficiency and strength of policies could not be guaranteed.

### 2.2 Main problems of incentive policies

Firstly, the market incentive of incentive policies is weak. China's current economic incentive policies are mainly based on government subsidies as well as

taxes and fees adjustment. It fails in fully mobilizing the market players and social forces, which affects the rational allocation of resources. In addition, the current policies are set up mainly in accordance with measures or actions rather than the effectiveness of policies. The lack of pre-evaluation and post-evaluation not only affects the effects of implementation of policies, but also increases the implementation cost of them.

Secondly, the pricing mechanism is far from perfect. This is mainly reflected in the imperfection of resources pricing mechanism. For example, the price of energy resource products is still mainly controlled by the government, so it can not truly reflect the relationship between supply and demand and the scarcity of resources, and cannot internalization of external cost of resource development. As a result, it is difficult to stimulate the development of low-carbon technology and measures effectively.

Thirdly, the sustained investment mechanism has not yet been established. The sustainable financial supporting mechanism with long-term effect for the development of low-carbon technology, low-carbon projects and low-carbon work has not yet formed at all levels of government departments, financial institutions and social subjects.

Fourthly, supporting mechanism is incomplete. Since the absence of effective evaluation mechanisms for the implementation of such policies, a phenomenon of "free ride" (enterprises do not actively take action but can obtain short-term benefits) can be easily found. In addition, there are several problems of incentive policies such as that the policy target is limited, the market is inflexible, and the application process is complex and the supervision is absent, which would easily lead to the weak implementation of policy.

## 2.3 Main problems of voluntary policies

Firstly, the participation of public and business enterprise is low. At present, the publicity and education on energy conservation and carbon emission reduction in China are mainly pushed forward by the government, but with low participation of enterprises and social subjects. In addition, the understanding of energy conservation and carbon emission reduction is often biased. These problems will therefore affected the implementation effect of this kind of policy.

Secondly, the supervision mechanism is not sufficient. The implementation of policy easily go awry due to some problems such as the lack of appropriate public participation and supervision, the lack of third party certification and evaluation as well as the weakness of relevant professional ability.

Thirdly, the supporting mechanism is incomplete. The stimulating mechanisms in

accordance with voluntary policies rely heavily on financial subsidies and tax deduction. However, due to the complex application process as well as the lack of associated guarantee, financing, insurance and other risk sharing mechanism, the willingness of participation of enterprises would be easily reduced.

# Section 3 Overall Policy Framework for Carbon Emission Control in "the 13th Five-Year Plan"

## 3.1 Overall consideration of the designing of carbon emission control policies

During "the 13th Five-Year Plan" period, the spirit of the 18th CPC National Congress and the 18th CPC Central Committee Third Plenary Session as well as Chinese 18th CPC Central Committee fourth Plenary Session should be fully followed up, and the challenges and opportunities faced by China when entering into a "new normal" economic and social development period should be fully grasped. The promotion of low-carbon transition of industry, energy and consumption should be regarded as the core. It should be strengthened to increase the guiding force of comprehensive policies and the exploration of innovative and targeted policies in accordance with policy orientation and function area, in order to further optimize the policy guidance and system design, and finally establish a long-term-effect mechanism and policy framework for low-carbon development that promoted by government, driven by market, initiated by enterprises, interacted by society and participated by public.

**To achieve the whole-process promotion of low-carbon development**. The standard and requirement of low-carbon development should be incorporated into the whole process of economic transition and urban construction. A diversified and multi-level low-carbon policy system should be established to achieve the source control on new facility construction and project development, achieve the policy guiding on the whole process of low-carbon operation and management of industrial projects, and guarantee the coordination and integration of economic transition, urbanization and low-carbon development.

**To cover all fields of economic and social development.** On the basis of improvement of carbon emissions inventory and with the focus on key industries, key projects, key facilities and key technologies and products, the policy design should be gradually improved in all aspects including standard and specification, technical innovation, identification and accreditation, etc.

**To strengthen the coordination of energy and environmental policies**. By

focusing on the incompatibility and inconsistence between the work on low-carbon, clean energy development, energy conservation, emission reduction and environmental pollution control, the top-level design of cooperative policies should be enhanced to address the problems of environmental protection and low carbon development together.

**To emphasize the suitability of regional characteristics**. The innovative pathway for top-down policy design should be explored to build the low-carbon governance and policy system consistent with local circumstances, by taking the provincial government as the main body and combining the economic stage of different regions with their own resource endowment and emission characteristics.

**To encourage the wide participation of whole society.** The low carbon policies should cover all aspects of social subjects and provide guidance and support in all process covering the awareness rising on low-carbon development, system designing with full public participation, balanced allocation of low-carbon benefit, and the supervision and management of low-carbon development, in order to encourage the active participation of the government, enterprises, non-governmental organizations, media and public.

## 3.2 General thought of the improvement of carbon emission control policies

**To strengthen the top-level design and build the forcing mechanism for low-carbon transition.** In order to achieve the carbon emission peaking target as early as possible, the carbon emissions control targets should be set by stage, by region and by sector. The requirement for the low-carbon development should be integrated into the whole process of economic and social development to force the low-carbon transition of development mode, so as to ensure the overall advance of economic restructuring, urbanization and low-carbon development.

**To enhance the systemic designing and ensure the full coverage of low-carbon development in economic and social system**. With the national carbon emissions control requirements as the goal, the government should ensure that the related policies should cover all regions and sectors. At the same time, the carbon emissions policy designing should be targeted, sequential and pointed according to the development characteristics and emission potential in different regions and sectors.

**To improve the collaborative designing and achieve the co-benefit of low carbon development**. The co-benefit of low-carbon development on energy conservation, emission reduction and environmental pollution control should be exerted. The coordination of different targets and collaborative design of relevant policies should be taken into consideration, so that the low-carbon development can

become an important driving force to solve the problems of resources, ecology and environment.

**With regard to three kinds of policies, i.e. regulation policies, incentive policies and voluntary policies, the specific thoughts on policy designing are as followings**. Firstly, to continue taking the advantage of regulatory policies. We should continue to take advantages of the regulatory policy tool on the reduction of sectoral carbon emission and the elimination of energy-intensive projects, in order to strengthen the control of energy-intensive and carbon-intensive industries. At the same time, we should improve the flexibility of regulatory policies, and take into consideration of regional circumstance in designing the regulatory policies such as the target responsibility evaluation system, the energy conservation evaluation and verification scheme, the technical standards on energy conservation retrofit, etc. Secondly, to improve and strengthen incentive policies. We should promote the market reformation actively, and particularly, enhance the marketization degree of energy supply system, change the long-term price distortions of resource products and build a market that can reflect the carbon price. At the same time, we should strengthen the effectiveness of financing and taxation policies, the combination of public funds and private capital, as well as the construction of carbon emission trading market. Thirdly, to improve voluntary policies in an innovative way. We should strengthen the disclosure of governmental information on energy conservation and emission reduction, promote the participation degree and supervision role of public and non-governmental organizations (NGOs), actively cultivate and support the third-party certification evaluation institutions and improve the relevant sectoral standards and behavior norms.

# Section 4 Policy recommendations on Carbon Emission Control in "The 13th Five-Year Plan" period

## 4.1 To improve the legal, standard and planning system for low-carbon development

**Firstly, to enhance the legislation on low-carbon development and relevant laws and regulations.** The legislation process on the basic law of climate change should be speeded up. *The Law of People's Republic of China on Climate Change* shall be formulated and issued as quickly as possible to explicit and consolidate the strategic position of low-carbon development. Simultaneously, the enforcement regulation, operation mechanism and supervision program of relevant laws on low-carbon development should be strengthened to embody the orientation of low-carbon development.

**Secondly, to establish medium and long-term planning and indicator system guided by low-carbon development for the whole society.** The planning for low-carbon development should be further strengthened by putting the low-carbon development as an important pathway to transform development mode and embodying it into the planning system for national economy and social development. The concept of "Low-carbon development", together with the concept of "resource conservation" and "friendly environment", should be considered as the strategic concept and goals at the national level. In the process of compiling the overall planning of national economy and social development, regional planning and specialized planning at all levels, the governments should make clear their specific considerations, major targets, main tasks and policy advices for the low-carbon development, and take the achievement of low-carbon development indicator as the key basis to assess political achievement of governments at all levels.

**Thirdly, to establish the standard system covering whole all sectors, areas and processes.** Great efforts should be made to improve the evaluation standard and mechanism for the carbon emission from source-type projects, and formulate strict admittance standard on energy consumption and carbon emission. The national compulsory standard of carbon emission on all kinds of key engineering projects and industry projects should be formulated to strictly control the new projects in industries with high energy consumption, high carbon emission and excess capacity. The product standard, labelling and certification system of carbon emission should be improved to establish the evaluation criterion and specification on low-carbon design, low carbon technology and low carbon product with wide applicability and international advanced level, in order to speed up the certification and promotion process for low-carbon products.

## 4.2 To improve responsibility decomposition and statistics and evaluation system on carbon emission

**Firstly, to establish top-down compulsory target responsibility and decomposition system on carbon emission**. Based on the full evaluation of achievement and potential for carbon emission control in various provinces and cities and sectors and areas, the carbon emission intensity reduction target and the total emission control target should be formulated and implemented, and the scheme for target decomposition by region and sector should be designed in a scientific and reasonable way. The practical and effective target evaluation method should be formulated and the evaluation mechanism combining rewarding and administrative accountability should be established.

**Secondly, to establish the permit system for the total carbon emission.** According to the requirement of total control on carbon emission, we should implement the permit system for greenhouse gas emissions in key sectors and key

regions, establish the permit threshold on carbon emission for energy-intensive and carbon-intensive industries such as power, steel and cement industries to control and restrain the greenhouse gas emissions from enterprises.

**Thirdly, to establish the basic statistics, accounting and reporting systems for carbon emission**. Efforts should be made to further improve the existing method of energy statistics, survey and accounting, as well as enlarge and detail the energy statistics and classification. The fundamental statistical indicator about greenhouse gas emissions should be included into the governmental statistical indicator system. The statistical system should be improved to fit for the requirement of greenhouse gas emissions accounting and cover all processes of energy combustions, industry process, agriculture, land use and change and forest and waste disposal. The greenhouse gas emissions inventories at national and provincial level should be compiled regularly. We should speed up the formulation of accounting guideline and technical specification for greenhouse gas emissions in key areas, sectors and institutions, and implement the system of key enterprises' direct reporting of energy consumption and greenhouse gas emissions.

## 4.3 To reinforce the coordination between carbon emission control and environmental protection policies

**Firstly, to formulate the joint-action mechanism on environmental protection and energy conservation and low carbon**. The coordination and cooperation among departments under national leading groups on climate change should be enhanced. The department coordination mechanism should be established to improve the work on energy conservation, climate change and environmental protection and realize the overall coordination and docking in formulating programmer, action plan, standard and targets. The collaborative supervision system on greenhouse gas and main pollutants should be established. The investigation of carbon emission sources should be involved into the pollution source investigation system based on current monitoring network system of pollutants. The specification method on greenhouse gas supervision should be formulated and the information base on carbon emission sources should be established.

**Secondly, to formulate the collaborative promotion policies on energy conservation, low carbon and environmental protection.** The policy design on collaborative control of pollutants and greenhouse gas should be enhanced. In the area of environmental protection, we should strengthen the collaborative management and control on the greenhouse gas emission and collaborative application of management approaches on greenhouse gas emission reduction on the basis of existing emission reduction policies. In the area of addressing climate change, we should give priority to the policies and measures with co-benefit of pollutant control, and implement the collaborative policies and incentive mechanisms integrating energy efficiency

improvement and carbon emission and pollutant reduction. The effort should be given to formulate the policies to improve the application of technologies with multi-effects of energy conservation, carbon emission reduction and pollutant reduction, and formulate pertinent incentive policies for technological development, innovation, popularization and application.

## 4.4 To improve the finance and taxation policies for low-carbon development

**Firstly, to improve the financial, financing and incentive policies for low-carbon development.** The investment increment and government rewarding schemes for low carbon development should be enhanced. The special funds on low-carbon development should be established and the low-carbon technology innovation and industrialization and application in key fields should be given more importance. Great efforts should be done to complete the green purchasing system and corresponding laws and regulations, to increase the loan on low-carbon projects, and encourage banks to establish the green and low-carbon loan mechanism. More efforts and supports should be given to establish the venture capital organizations for the development of low-carbon technologies and share the risks in the low-carbon technology research, development and industrialization process.

**Secondly, to improve the pricing and taxation policy related to low-carbon development.** Further efforts should be made to improve relevant energy price policies and gradually realize the market-oriented pricing for the competitive energy field. A differential pricing system for energy utilization should be established gradually to promote the microeconomic entities to reduce the use of fossil energy and increase the energy efficiency. The environment taxation and energy taxation scheme should be completed and the carbon taxation scheme should be studied to initiate. The taxation policy in the building and transportation sector should be improved to promote the development of low-carbon buildings and low-carbon transportation.

**Thirdly, to strengthen the application of PPP scheme in the low-carbon development field.** The use of PPP mode should be encouraged to attract social capital into the investment on low-carbon infrastructure construction that guided by governmental funds. Greater efforts should be made to complete the relevant laws and regulations related to PPP to guarantee the benefits of all sides involving the project development and promote the contribution of PPP on low-carbon development. The risk-prevention mechanism for the social capital investment should enhanced through the innovative mode of combining operation and cooperative development. A normalized channel for the increment of credit scale and rating of low-carbon PPP projects should be established.

## 4.5 To strengthen the construction of national carbon emission trading system

**Firstly, to conduct deeper studies on the national top-level designing of carbon emission trading scheme**. It should be enhanced to study the policy design regarding carbon emission reporting and verification, quota assignment and allocation, crediting mechanism, market adjustment and regulation, and the management of trading institution. On this basis, the relevant administrative official documents should be issued to provide the guidance for the establishment of national carbon emission trading market. In the meantime, the legalization at a higher level should be promoted so as to make clear regulations on the carbon emission reporting and verification and the punishment criteria for the failure and violation during the compliance to make sure that carbon emission trading market can be operated effectively.

**Secondly, to establish the national-level carbon emission trading market.** Based on the carbon emission trading pilots in seven provinces and cities, more efforts should be given to build up the national-level carbon emission trading market, including the establishment of national-scale carbon emission trading platform, carbon emission trading and supervision mechanism, unified registration system and third-party verification system. In addition, the supervision rule and risk prevention measures for the carbon emission trading market should be formulated, the professional institution and personnel working on the carbon market should be strengthened, and the propaganda and training of the carbon market should be enhanced.

**Thirdly, to gradually expand the carbon emission trading scheme from industry to building and public transportation sector.** Considering the inherent law and trend of urbanization in China, both production and consumption side should be involved into the general design of the carbon emission trading mechanism. For the regions dominated by service industries and with good transportation infrastructure, the carbon emission trading scheme should focus to the industry sector at the first stage, and then expand to the public transportation and large-scale building sectors, which can help link the carbon emission trading scheme with the policies on green and energy-efficient buildings and transportation.

**Fourthly, to gradually expand the carbon emission trading scheme from carbon emission sources to sink**. It should be given more importance to use market-based force to solve the issue of carbon emission control and ecology and environment protection comprehensively, by coordinating the carbon emission trading scheme with the ecology compensation scheme. The carbon emission permit should be regarded as a kind of scarce resource and the capacity of carbon sink should be regarded as a kind of benefit means. Under this condition, we could use the regional

disparity in carbon emission and sink capacity to formulate a commonly-recognized trading price, which will help produce economic-value for ecological environment and promote the paid service for ecological construction.

## 4.6 To improve the incentive policies for the low-carbon development in key areas

**Firstly, to strengthen the incentive policies on low-carbon city (town) pilots, low-carbon park pilots and low-carbon community pilots.** The comprehensive planning and guiding mechanism should be established for the ecology and environment protection, intensive-use of land resource, the low-carbon transition of industries and the low-carbon and green infrastructure, with a purpose to concentrate the economic resources into the low-carbon demonstration areas and attract leading enterprises and social funds into the construction and development of low-carbon projects. More efforts should be put to promote the construction and expansion of low-carbon industry parks and the incentive policies should be developed to promote the development of comprehensive industry parks toward the green, low-carbon and cycling development. The incentive policies should be further strengthened for the low-carbon development of service industry parks, agriculture parks and high-tech parks. The construction guidance, technical specification and incentive policies for low-carbon communities should be further improved and refined, in order to promote the low-carbon construction and retrofit of all kinds of communities, in accordance with those work relate with the urbanization and new-village construction.

**Secondly, to improve the incentive policy for low-carbon industry development.** More efforts should be given to formulate stricter policies on controlling and eliminating carbon-intensive industries, develop more low-carbon-oriented policies for the upgrade of traditional manufacturing industries and cultivate strategic new-type industries, and further strengthen the guiding policies on industry transformation that satisfy the need of low carbon development. Great efforts should be made to construct the promoting policy system for the development of low carbon industries. Such policies as incentive policies for low carbon parks and guiding list on low carbon industries should be established and completed to support the development of tertiary industry and strategic emerging industries with low energy consumption and support the low-carbon transformation and retrofit of traditional industry parks.

**Thirdly, to improve the incentive policies integrating low-carbon development and poverty alleviation.** In the poor rural regions, it should be recommended to promote the development of ecological industries such as carbon sink industry, green organic industry and ecological tourism, in order to transform the agricultural and forestry resources into economic benefits. In the poor rural regions and ecological immigrant regions, an incentive policy system integrating low-carbon

poverty alleviation and low-carbon community construction should be gradually established. It is recommended to establish the special fund for the construction of low-carbon pilots of rural communities in poor regions, and the key funding should be given to the green rural housing construction and retrofit, low-carbon traffic facility construction, renewable energy technology and product application, rural waste treatment and reuse, ecological environment construction in villages and promotion of low-carbon living style.

## 4.7 To enhance the promoting policy for technology innovation on low-carbon development

**Firstly, to formulate the technology lists and promoting policies for key low-carbon technologies**. The long-term development plan for low-carbon science and technology innovation should be formulated. It should be given priority to develop key low-carbon technologies and increase the financial input on advanced low-carbon technologies such as nuclear and renewable energy technologies, large-scale energy-conservation projects, carbon capture and storage technologies, etc. The policies encouraging microeconomic entities to participate in the low-carbon technology innovation and the technology standards for low-carbon industries and products should be formulated. China should actively take part in the international exchange and cooperation and joint researches on low-carbon technologies and build the low-carbon technology R&D system that tracks with global orientation and standards.

**Secondly, to improve the policies for the industrialization of low-carbon technologies.** The patent-protection mechanisms for the low-carbon technology transfer, R&D and industrialization should be improved and the effective transformation mechanism and patent-protection mechanism for the achievement of science and technology should be enhanced. More efforts should be given to give full support to the experimental demonstration of low-carbon technologies, improve the incentive policies for technology innovation, and actively promote the cooperative mechanism with enterprise as subject, universities and scientific research institutes as support and science-and-technology intermediate institutions as cooperation medium, and establish the low-carbon technology innovation base and industrialization incubator. The financing guarantee platform, technology insurance platform and equity investment platform that can serve all kinds of energy-saving and low-carbon enterprises should be established.

## 4.8 To improve the guiding policies for public participation into low-carbon development

**Firstly, to improve the guiding policies for low-carbon consumption in the whole society**. The propaganda and educational activities on low-carbon development should be conducted to increase the training and knowledge of general public on low-carbon development. Various activities such as Low-carbon Day and Low-carbon Museum should be conducted to promote the governments at all levels and the communities with different types to learn, publicize and practice low-carbon development. All types of low-carbon and environmental-protection propaganda activities should be done by means of family, school and community, with a purpose to form a low-carbon living style across the whole society. The scheme of carbon footprint labelling and low-carbon product certification should be continuously enhanced and the application scope of labelling should be expanded. The green government procurement policies should be further improved and the provincial and city governments should be encouraged to scientifically formulate the government procurement standard, list and guidance, giving priority to the purchase and utilization of products that meet with low-carbon certification standard under same circumstances. More efforts should be given to improve the financial subsidy policies for energy-saving, low-carbon and benefit-to-people products and clean energy products, guiding the public to formulate the habit and behavior of rational consumption and low-carbon consumption.

**Secondly, to improve the guiding policies for public participation in low-carbon development.** The information disclosure mechanism and public participation and supervision mechanism on low-carbon development should be strengthened. More efforts should be made to increase the propaganda and implementation of low-carbon related law, regulation and standard and further increase the disclosure and transparence of information about energy, low-carbon and environmental pollution. The policies on information disclosure and public participation should be improved to further increase the disclosure of information on low-carbon policy decision-making and project decision. A diversified public-participation channel should be established to encourage public to expose the phenomenon and problems against low-carbon development and enhance public's role in the policy formulation, supervision, suggestion and performance evaluation. The awarding scheme for the public and enterprises' participation into the low-carbon development should be developed.

**Thirdly, to increase the social responsibility awareness of enterprises in participating into low-carbon development.** More efforts should be given to guide enterprises to formulate and implement the low-carbon development strategy and include carbon emission reduction into the decisions on research and development,

management and market development and enhance the low-carbon culture of enterprises. More actions should be conducted to guide enterprises to make investments in low-carbon technological innovation, upgrading and personnel introduction, enhance the innovation in all process of product design, production and recycle, intensify the product certification according to international standard, and increase the low-carbon competitiveness of enterprises in international market. Enterprises should be guided to gradually establish and improve the carbon emission statistics, monitoring and evaluation system and strengthen the source control and process monitoring.

**Fourthly, to strengthen the participation of NGO into low-carbon development**. The social organization consulting committees represented by NGOs should be encouraged to establish on all governmental levels, which can make NGOs fully play the role of providing recommendations for policy making. The guiding and supporting policies for NGOs and relevant social organizations should be improved to build up the cooperation platform and mechanism among NGOs, enterprises and public, and enhance the influence of NGOs in the propagation of low-carbon knowledge, experience, technologies and policies.

## 4.9 To improve the international exchange and cooperation policies on low-carbon development

**Firstly, to establish the promoting policies for the international exchange and cooperation of low-carbon development.** The international cooperation should be enhanced with an aim of attracting foreign advanced technologies and funds. We should strengthen the exchange and dialogue with developed countries, and take part in the arrangement of global climate change activities with an active and constructive attitude. We should also actively work with developing countries to build up broader and more effective south-south cooperation channel, and pursue the development right in the negotiations on international climate, international carbon emission trading, carbon financing and low-carbon standard.

**Secondly, to speed up the establishment of relevant international mechanism and market**. More efforts should be made to actively participate in international economy, trading and financial system construction related with carbon emission trading, carbon financing and low-carbon standardization, improve the discourse right in regional and national low-carbon economy system, trading system and financial system, actively participate in the cross-regional and global carbon market construction, and effectively utilize international low-carbon resources to create a beneficial international market environment for China's low-carbon development.

**Thirdly, to improve the personnel cultivation and introduction scheme for low-carbon development.** More efforts should be given to cultivate and introduce

professional talents to work in key fields such as low-carbon technological research and development, low-carbon law and policy setting and carbon product market construction, cultivate and train the personnel familiar with international low-carbon political framework and operation mechanism, international low-carbon trading system and rules, and international low-carbon law and policies, and cultivate the professional personnel familiar with carbon fund, carbon credit, carbon auditing, carbon emission trading, carbon speculation, carbon evaluation, etc.

# Chapter 6 Cases Study On Typical Region

Since defined first low-carbon pilots in Five Provinces and Eight Cities in 2010, China has enriched with abundant experiences in low-carbon development. This chapter takes Beijing, Hebei and Yunnan provinces as typical examples, which have important demonstrating values. Beijing, as the capital, international and livable city, has devoted great efforts to low-carbon development and achieved a series of vital fruits; Hebei province, a typical industrial province that is transiting itself to low-carbon province, has also accumulated plentiful experience in low-carbon development; Yunnan province, one of the earliest low-carbon pilots, owns typical research value in low-carbon development.

## Section 1 A Case Study in Beijing

### 1.1 The current low-carbon development in Beijing

#### 1.1.1 The achievement of low-carbon development in Beijing

During “the 11th Five-Year Plan”, to restructure economy, transform development mode and promote scientific development, Beijing took energy conservation and emission reduction as the vital goal of sustainable development, to promote resource conservation, pollution prevention and treatment as well as ecological construction, setting up energy conservation and consumption reduction target of energy and water consumption per 10,000 Yuan GDP reducing 15% and 20% respectively and establishing circular economic development initiative for five consecutive years, which continuously improves environment and takes the lead in energy conservation and consumption reduction. From 2006 to 2010, Beijing has achieved 11.4% of economic growth with annual average 4.7% energy consumption; energy consumption per 10,000 Yuan GDP has dropped from 0.792 tons of coal equivalent in 2005 to 0.581 tons of coal equivalent in 2010, with a reduction rate of 26.59%; water consumption per 10,000 Yuan GDP has dropped from 49.5 $m^3$ in 2005 to 29.4 $m^3$ in 2010, with a reduction rate of 40.46%; the number of days that have

second-level weather and above in 2010 has increased 14 percentage points than that of 2005. The ecological environment and air quality have substantially improved, outperforming the target of energy conservation and emission reduction in period of "the 11th Five-Year Plan". Beijing is the only region which has accomplished annual target of energy consumption reduction for five consecutive years in China.

During the period of "the 12th Five-Year Plan", guided by the Scientific Outlook on Development, Beijing comprehensively implements the decisions on climate change initiated by the country, making great efforts to promote "dual adjustment" of industrial and energy structure, to advance "dual enhancement" of energy efficiency and forest carbon sink capacity, to vigorously implement "carbon emissions permit" trade and "two pilots" in low-carbon city, to focus on fundamental task and capacity building and to promote $CO_2$ emission control. Meanwhile, Beijing formulates target of double control on energy conservation and consumption reduction: energy consumption per 10,000 Yuan GDP should drop by 17%, and $CO_2$ emission per 10,000 Yuan GDP should drop by 18%, total energy consumption should be controlled at 90 million tons. Total energy consumption in 2014 of Beijing was 68.312 million tons of coal equivalent, a year-on-year increase of 1.6%; calculated against the comparable prices in 2010, energy consumption per 10,000 Yuan GDP was 0.3596 tons of coal equivalent, with a reduction rate of 5.29%, which exceeded 3.29 percentage points of reduction target of annual energy consumption per 10,000 Yuan GDP, outperforming annual target for four consecutive years. From 2010 to 2014, energy consumption per 10,000 Yuan GDP has dropped by 20.15%, accomplishing energy conservation target of 17% reduction during "the 12th Five-Year Plan" one year ahead; water consumption per 10,000 Yuan GDP has dropped by 20.84%, exceeding 5.84 percentage points of water consumption target during "the 12th Five-Year Plan". The power consumption of the whole city is 93.7 billion kw·h, a year-on-year increase of 2.6%; calculated against the comparable prices in 2010, power consumption per 10,000 Yuan GDP is 493.21 kw·h, with a reduction rate of 4.34%. The proportion of tertiary industry exceeds 76% for the first time in 2013. The proportion of utilizing superior clean energy exceeds 70% and the proportion of the energy consumption of tertiary industry and residents' lives exceed 60%. The distribution of energy consumption represents features of "dispersed points with wide range".

### 1.1.2 Measures of low-carbon development in Beijing

**①. The implementation of tasks and measures**

**To continuously enhance energy utilization efficiency.** "Double control" mechanism of energy consumption intensity and total energy consumption is implemented, with a focus on energy conservation in key fields, like industry, architecture, transportation and public institution.k Key tasks, like energy auditing, energy conservation and low-carbon statistics system construction, energy conservation and low-carbon standard revision, clean production of service industry

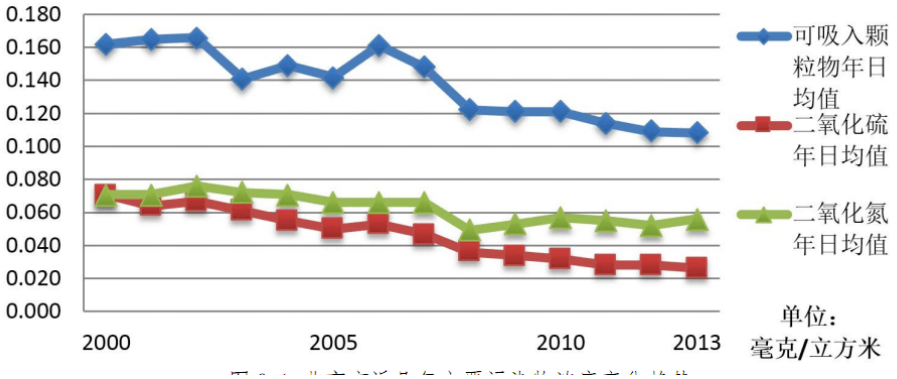
are promoted, vigorously exploring pilots, like implementing energy conservation technical improvement, energy control center construction and energy-cost trust contract management; advancing energy conservation management and government purchasing service; and cultivating energy conservation professional market to realize continuous enhancement of energy utilization efficiency and standard.

**To adjust industrial and energy structure.** Beijing has further quickened the industrial and energy structuring, to relocate 446 enterprises with heavy pollution in Shijingshan and suburbs in the northeast, like Shougang Corporation and coking plants; to shut down all the cement plants, quarry sites and clay brick plants; to realize heat supplying without coal within the Fifth Ring Road; to implement *Beijing 2013-2017 Plan for Reducing Fire Coal and Constructing Clean Energy* to significantly reduce fire coal and develop new and renewable energy with local condition in order to further optimize energy mix of Beijing. In 2014, total energy consumption of Beijing was approximately 76.8 million tons of coal equivalent, a 4.5% year-on-year increase, reducing fire coal 2.6 million tons all year around. The proportion of superior energy consumption has increased to 80% or more while the proportion of new and renewable energy has also increased to 5.2%. Based on preliminary estimates, in 2014, coal consumption gross of Beijing has dropped below 19 million tons, 2.6 million tons lower than that of 2013, and the gross will drop below 15 tons in 2015. Energy conservation has witnessed obvious effect. Until 2017, generating capacity of renewable energy will reach to 1 million kw, and fire coal gross will reduce by 13 million tons compared with year of 2012, of which the proportion of coal will drop lower than 10%.

**To enhance forest carbon sink capacity.** National ecological engineering and plain afforestation projects are comprehensively advanced, like Beijing-Tianjin Sandstorm Source Control, Three North Shelterbelt Program and Afforestation of Taihang Mountain, which create 473,500 mu of afforestation area, outperforming the annual plan of 459,500 mu; the rate of woody plant cover has reached to 57.4%, a 1.9 percentage points year-on-year increase; forest coverage rate has reached to 40%, a 1.4 percentage points year-on-year increase; qualified tending of woods area has reached 600,000 mu, accomplishing annual plan and further enhancing the forest systematic carbon sequestration capacity.

**To vigorously advance clean energy transformation.** Natural gas engineering in Beijing is continuously promoted, ranging from 300 million $m^3$ in 1998 to 9.2 billion $m^3$ in 2012, and the proportion of superior clean energy has increased to 74.6% in 2012. Since 2012 when tough fight with air pollution was started, especially the governing of PM2.5, Beijing has issued binding targets on energy conservation in districts and counties, promoting the transformation of clean energy and achieving positive effects; the 17,000 coal-fired boilers below 20 T/h has totally completed clean energy transformation (reducing 6 million tons of coal, 48,000 tons of dust emission and 68,000 tons of $SO_2$). The proportion of superior clean energy

consumption has reached at 77% while the proportion of new and renewable energy has reached at 4.5%.




可吸入颗粒物年日均值　annual average daily inhalable particles
二氧化硫年日均值　annual average daily sulfur dioxide
二氧化氮年日均值　annual average daily nitrogen dioxide
单位：毫克/立方米　Unit: mg/m$^3$

Figure 6-1　Trends of change of main pollutants concentration in recent years of Beijing

**To vigorously promote low-carbon pilots.** Beijing has been defined as national second batch of low-carbon pilot by NDRC, issuing *The Implementation Plan of Low-Carbon Pilot of Beijing* to comprehensively promote pilot construction; Beijing has also been defined as national green circulation and low-carbon transportation system pilots by Ministry of Communication; Gubeikou town of Miyun County has been evaluated as first green and low-carbon town pilot by Ministry of Finance, Ministry of Housing and Urban-rural Development and NDRC. Yongfeng new and hi-tech industrial base in Zhongguancun and Beijing Caiyu Economic Development Zone have been evaluated as national low-carbon industrial parks (first batch) by MIIT and NDRC. Meanwhile, Beijing has vigorously launched low-carbon community pilots, determining five communities, like Minan in Dongcheng District and Fenghuiyuan in Xicheng District, as first batch of low-carbon community pilots.

**②. Fundamental task and capacity building**

**To strengthen target responsibility check.** Beijing establishes working lead group on climate change and energy conservation and emission reduction; to coordinate mechanisms to operate well, municipal government holds annual meeting on energy conservation and emission reduction as well as climate change, and also arranges countermeasures; $CO_2$ emission reduction target per unit GDP is brought into both annual national economic and social development plan, and annual performance management evaluation system of county government, annual tasks are assigned accordingly; evaluation implementing rules are made and evaluation on task performance is launched.

**To perfect statistical accounting system of greenhouse gas emissions.** In the light of the requirement of *Announcement on Enhanced Statistical Working*

*Suggestions on Climate Change*, Beijing has launched a study on *Establishing Basic Statistical System of Greenhouse Gas*, the *Basic Statistical System on greenhouse gas emissions of Beijing* has taken initial shape and will enter the pilot phase; the function of standards is highlighted, formulating and implementing hundreds of (revised) plans on energy conservation and low-carbon standards; standards are made: 75% energy conservation design for new residential buildings and green building standard for new projects in cities and towns, of which the government takes the lead to energy conservation transformation on office buildings.

**To promote low-carbon products accreditation.** Certification authorities and manufacturing enterprises are encouraged to launch low-carbon products accreditation activities; campaigns on the theme of energy conservation and emission reduction as well as low-carbon accreditation are developed, to enhance the awareness of enterprises and consumers on energy conservation and emission reduction; enterprises are encouraged to carry out related accreditation of low-carbon products; consumers are guided to choose products with energy conservation and low-carbon accreditation.

**Strategic emerging industry has already taken shape.** Low-carbon technology exploitation and basic research is intensified, to create energy conservation and low-carbon creation service platform, to make a large-scale promotion of low-carbon advanced technology and products, to prepare to build technological innovation center and hi-tech industrial bases with international influence to form innovation-driven development pattern; the leading role of Zhongguancun national independent innovation demonstration area is exerted, tackling core technology and enhancing exploration and basic research; recommended catalogue and typical cases of energy conservation and low-carbon technology products are launched every year, promoting over 200 new technologies and products, such as waste heat and pressure, CCHP distributed energy resources; integration of enterprises, universities and research institutions as well as using, supplying and demanding is promoted, impulsing the cooperation among Beijing government, institutions and advanced laboratories; technological innovation center and hi-tech industrial bases with international influence are prepared to build, supporting new energy industrial development in Beijing by technology.

**To promote wide participation of the whole society.** Beijing has widely launched publicity and education on climate change and low-carbon life for residents by establishing low-carbon communities, initiating low-carbon consumption and releasing action plan of energy conservation and emission consumption; through radio, TV, network and print media, policies about energy conservation and emission reduction are popularized, and low-carbon lifestyle is initiated; it makes sure that all people participate in activities on energy conservation and emission reduction, sending low-carbon specialists to ten places including communities, government organizations, and schools, to enhance sense of urgency and responsibility on low-carbon development; series of theme activities are launched, such as “Smooth

Beijing Green Transportation", "Day of Reducing Garbage", and "Limitation on Plastics", "Limitation on Excess Packaging" to benefit citizens by energy conservation products, enhance their awareness of green consumption and form low-carbon consumption habits.

**③. Innovation-seeking on system and mechanism.**

**To establish a rudimental standard and open carbon emissions permit trading market.** System of policies and laws with legally binding "1+1+N" has basically formed, including *Decision of Developing Carbon Emissions Permit Trading Pilots under Strictly Controlling Total Carbon Emissions in Beijing*, *Management of Carbon Emissions Permit Trade of Beijing (Trial), Management of Open Market Operation of Carbon Emissions Permit Trade of Beijing (Trial), The Law of Administrative Punishment and Discretionary Power to Govern Carbon Emissions Permit Trade.* The smooth and orderly market operation has exerted wide social impact; Beijng has taken the lead to develop research on cross-regional trade of carbon emissions permit, to explore the new route to promote emission reduction with Beijing, Tianjin and Hebei coordination by market mechanism, and to ensure the sound development of carbon trading market in Beijing.

**To be the first one to implement total $CO_2$ emissions control.** In "the 12th Five-Year Plan", binding targets have been defined, like energy consumption reduction rate per 10,000 Yuan GDP, $CO_2$ emission reduction rate per 10,000 Yuan GDP and regional total energy consumption. In 2013, the Standing Committee of the National People's Congress of Beijing issued *Decision of Developing Carbon Emissions Permit Trading Pilots under Strictly Controlling Total Carbon Emissions in Beijing*, which integrated absolute capacity with relative intensity control in different industries, and focused on carbon emissions permit management mechanism with both direct and indirect emission; on the basis of energy conservation evaluation, it has been the first one to implement carbon evaluation system in fixed-asset investments project, and to strengthen source gross control; energy conservation targets are distributed to 16 districts and counties, 17 department in charge of key industries and 57 key energy-consuming units, to implement gross control of air and water pollutants; annual target evaluation of energy conservation and emission reduction is implemented, and the guiding role of target evaluation is efficiently exerted.

Chart 6-1 Green development target system in "the12th Five-Year Plan" of Beijing

| | | | |
|---|---|---|---|
| Green development target | Energy consumption reduction per 10,000 Yuan GDP (%) | 17 | binding |
| | Water consumption reduction per 10,000 Yuan GDP (%) | 15 | binding |
| | CO2 emission reduction per 10,000 Yuan GDP (%) | 18 | binding |

**To gradually improve energy conservation and emission reduction policy system.** Beijing has introduced and implemented local rules and decisions on energy conservation and water pollution prevention. Over 10 special plannings are

established and issued on energy conservation and emission reduction as well as climate change, introducing several plans on specific areas, like clean air activity and mass activity of energy conservation and emission reduction. Series of supporting documents are formulated, like contract energy management project, provisional regulation on energy conservation monitoring, energy management pilot regulation and clean production regulation, enhancing incentive standard and lowering admittance. The number of energy conservation service enterprises with national records has reached at 448 to be No.1 in the country. Contract energy management projects have produced 240,000 tons of contract energy conservation. The market has already opened in terms of energy auditing, clean production approval, carbon verifying and green finance.

**To promote government purchasing service mechanism.** 19 third-party inspecting organizations and 210 inspectors are publicly chosen and recorded. Through purchasing service methods, professional organizations were entrusted to launch third-party inspection and fourth-party selective examination of reports of key emission units, to motivate the development of low-carbon consulting service and third-party verification and consultation as well as cultivate talents of verification and consultation.

### 1.1.3 Major challenges and problems of low-carbon development in Beijing

**①. Rigid demand of energy is rapidly increasing, and it becomes harder and harder to promote energy conservation plan.**

For the past few years, Beijing has witnessed economic and social development, rapid urbanization, continuously expanded building scale and high-growth transportation gross (the number of new motor vehicles in 2014 limits at 150,000) so that the rigid demand of energy has substantially increased. With increasingly prominent contraction between energy consumption demand and limited energy supply, although Beijing can basically realize targets of energy conservation and consumption reduction every year, it still needs to be promoted by enhancing efficiency of energy utilization and strictly controlling total energy consumption in order to achieve the economic and social sustained development with limited energy consumption and lower carbon emissions.

**②. Increase of new and renewable energy consumption is relatively slow.**

With the effect of resource endowment and long-term project construction, it is difficult to increase the utilization gross of new and renewable energy. Up to the end of 2014, the proportion of new and renewable consumption hasn't completed scheduled targets, and there is still some distance from requirements of "the 12th Five-Year Plan". In next phase, Beijing needs to quicken the implementation of new and renewable energy utilization project, to further expand the renewable energy utilization, like solar energy and power generated by burning garbage.

**③. To accelerate the economic development mode transformation needs to deepen innovation of operating mode.**

Against the backdrop of accelerating the economic development mode transformation, the energy mix, energy efficiency level and terminal energy utilization efficiency of Beijing need to be deeply optimized and improved. During the period of "the 12th Five-Year Plan", related institutions in Beijing have changed their operating mode, and some achievements have been obtained such as innovating energy conservation operating pattern, simplifying process and one-stop business, but several problems still exist, like overstaffing in organizations and fussy procedures. In next phase, it is necessary to deepen innovation of energy conservation operating pattern, using technological innovation to enrich methods, institutional innovation to realize integration of departments, and interest mechanism to mobilize all parties to participate. Meanwhile, the carbon emissions permit trading mechanism is still in the starting stage, which needs us to perfectly marketize carbon emissions reduction mechanism; total energy consumption and energy type and utilization pattern have close association with air pollutant and $CO_2$ emission so that it is necessary to coordinate energy conservation and carbon reduction as well as pollution prevention and emission reduction.

**④. The supporting system on low-carbon development needs to be perfected.**

First, the urban space exploitation protection system needs to be perfected. Focusing on the future, Beijing cannot continue to depend on economic development mode of resource consumption, environment pollution and ecological damage. Most of urban centers encounter issues, like over-exploitation, surface collapse, and environment pollution. During "the 13th Five-Year Plan", Beijing should respect laws of nature in urban space exploitation; taking resource and environment restrictive factors as starting points, Beijing should scientifically regulate scale, structure, layout and time sequence of urban space exploitation, guide population and industry to concentrate toward regions with higher bearing capacity of resource and environment, forming efficiently operating space organization system and orderly implementing urban space exploitation.

Second, emission permit system needs to be perfected. The State Council has organized 11 provinces (districts and municipalities) like Tianjin, Hebei and Inner Mongolia to launch emission permit paid utilization and trading pilots since 2007, which has obtained some improvements. To further guarantee the implementation of Beijing low-carbon development plan and promote continuous reduction of major pollutants gross emission, it is important to focus on and explore emission permit paid utilization and trading pilots.

Third, environment damage compensation system needs to be perfected. To thoroughly apply the systems stipulated by new implemented *Environment Protection Act*, for example, sealing up and detention, continuous punishment by day, limiting production and suspending production for rectification, and administrative detention,

Beijing has also carried out a series of corresponding supporting measures to support *Environment Protection Act*, and punished some enterprises that violated the law. However, supporting implementation rules have not been in place as regards how to define the principle, procedure of environmental damage or damage compensation as well as how to judge or affirm damage degree for relevant compensation system; in terms of scope of damage compensations, the relevant compensation system only stipulates compensating the direct loss of environmental pollution and damage, but not about potential or indirect loss. In fact, environmental damage may lead to potential or indirect environment or human health damage.

Forth, the financial and taxation policy of energy conservation and carbon reduction needs to be perfected. On the one hand, Beijing lacks specific fund in low-carbon development. Although climate change has been included into the range of specific fund in low-carbon development, in terms of solution of climate change and implementation of plan, it still lacks specific fund in supporting low-carbon development and coping with climate change. Meanwhile, little district-level funding has been put into climate change. Next, compared with agricultural finance supporting, there is few supporting policy in energy conservation and carbon reduction in different fields.

Fifth, the statistical system of energy conservation and carbon reduction needs to be perfected. At present, with weak basic data about energy conservation and carbon reduction in Beijing, the statistics, measuring and monitoring systems of energy conservation in some industries need to be perfected. For example, as for transportation industry, most vehicles have no measuring instruments of energy consumption, which brings inconvenience to statistics of energy consumption; as for civil architecture, it cannot provide the statistics about energy consumption of architecture, including two target data: power consumption of unit area of public architecture and quantity of energy conservation in civil architecture; the lodging business and catering industry haven't provided statistics, so it is difficult to master the energy consumption; civil aviation industries should report statistics from different channels at regular intervals, which needs large investment of data statistics and labors.

## 1.2 The situation and demands of low-carbon development illustrated in "the 13th Five-Year Plan" in Beijing

### 1.2.1 To promote energy production and consumption revolution is the fundamental approach as well as key focus to build ecological civilization and realize low-carbon development.

Innovative thoughts are required in energy development strategy to drive energy production and consumption revolution. Besides, the framework of traditional energy strategy centered on assuring energy supply must be changed. Instead, energy

utilization ought to be led and coordinated given a society with ideal ecological environment, therefore, the unreasonable need of energy could be restrained, placing a rigid control over the energy totally consumed, forming a "forced" mechanism which helps radically transform economic development pattern. In addition, new and renewable energy resources ought to be vigorously explored so as to cast the energy system in a low-carbon mode. This is at the same time regarded as the core of energy production revolution, with its ultimate goal to shape a sustainable energy system constituted mainly with new and renewable energy, achieving "near zero" $CO_2$ emissions.

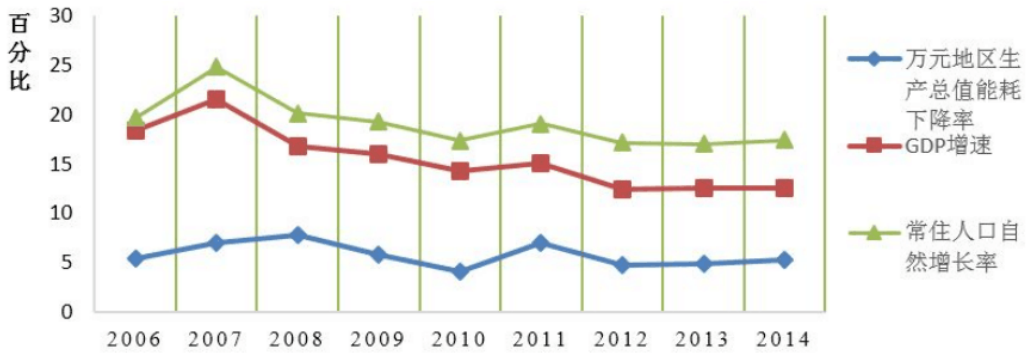
Beijing, a city short of energy resources, mainly depends on the coals with low reserve, hydroelectricity and geothermal resources. There is no industrial reserve found for exploitation and the renewable or clean energy resources such as photovoltaic energy, wind electricity and nuclear power are hardly available. Considering the low energy self-efficiency rate here, Beijing primarily relies on resources from other provinces, and it has to bring in energy reserved in its neighbors such as Shanxi, Hebei and Inner Mongolia etc. Thus, on one hand, the exploration of renewable and clean energy should be accelerated to optimize the consumption structure and on the other hand emissions of greenhouse gases should be reduced to strive for more clean and renewable energy during "the 13th Five-Year Plan" period.

### 1.2.2 "Double control principle" has achieved a lot and a control over total energy consumption will bring new choices and opportunities for low-carbon development in Beijing.

*National Outline of the 12th Five-Year Plan* put forward "a reasonable control over the energy totally consumed, a strict management of energy use, a timely development planning as well as a well-defined workable mechanism" which would chart course for energy conservation and emission reduction in Beijing. On November 12th, 2014, China and the US released *China-US Joint Announcement on Climate Change* which stipulated "China intends to achieve the peaking of $CO_2$ emissions around 2030 and to make best efforts to peak early and intends to increase the share of non-fossil fuels in primary energy consumption to around 20% by 2030." Beijing is the capital city of China and its window to the outside world where there is an increasing need for water, construction land and energy resources with a growing scale of population, industrial development as well as construction. As a city which badly needs the energy support from surrounding regions, Beijing will have to face relatively huge pressure in terms of security in energy supply and utilization efficiency for some time. A slowdown in economic development, intensified population mobility, a growing need for energy consumption as well as pollution of air and water have all to some degree made it more difficult to implement the practice of energy conservation and carbon reduction. During "the 12th Five-Year Plan" period, the obligatory target of "double control" charted course for conservation energy and reducing consumption. Thus, all parties at stake could transform the present development mode in a targeted way and innovate techniques and management

methods to reduce energy intensity and wastes, embarking on a more sustainable mode.

At the next stage, our capital is required to enhance the capability to prevent pollution and switch roles, examining the future with a worldwide vision and planning its own work of energy conservation and carbon reduction. Beijing is undergoing an accelerated industrialization and urbanization, so the contradiction between a great demand of energy to promote economic growth and a must to stop high energy consumption for the sake of low-carbon development will exist in the long run. Therefore, based on implementing the national deploy, Beijing should take the specific situation into account and give full play to market mechanism in terms of optimizing the allocation of resources. In addition, it should comprehensively use government guidelines, policies, laws as well as regulations to attach supervision over the total emission of pollutants. Also, mandatory objectives shall be set to reduce the emission of main pollutants through setting up a preliminary goal before emission, enforcing rigid management during emission and conducting supervision after emission.




万元地区生产总值能耗下降率　　energy consumption reduction rate per 10,000 Yuan GDP

GDP 增速　　GDP growth

常住人口自然增长率　　natural growth rate of permanent resident population

Figure 6-2 The variation trend of major economic indicators of Beijing in recent years.

### 1.2.3 To build a low-carbon mode should be regarded as an important grasp for coordinated development of ecological civilization in Beijing, Tianjin and Hebei.

Given the fact that there is a huge emission of pollutants in Beijing, Tianjin, Hebei and surrounding areas with a relatively small environmental capacity, low-carbon development ought to be deemed as an important grasp in these regions. Major constituents of $CO_2$ and atmospheric contaminants basically come from the burning of coals, oil, natural gases and other fossil fuels. Both of them originate from the same source. When promoting energy conservation and consumption reduction in Beijing, synergetic development of Beijing, Tianjin, Hebei can at the same time be

considered to contribute to the low-carbon mode, extending the scope of controlling emissions. For example, we can reduce the emissions of air pollutants such as $SO_2$, NOx, PM10, PM2.5 in a proper manner. Under certain obligatory conditions of environmental capacity, Beijing, Tianjin and Hebei have to transform their development mode for further progress. Concerning resource use, ecological effect and economic benefit, high energy consumption must be turned into low energy consumption, high pollution into low pollution and low efficiency to high efficiency. Adherence to the low-carbon development is the only way for Beijing, Tianjin and Hebei to accomplish goals of reducing emissions, to solve the problem of air pollution, and to relieve ecological pressure and increase environmental capacity as well as ecological space.

### 1.2.4 The practice of carbon emissions trading pilot has steadily advanced and it will continue to play a demonstration role.

In order to adapt to climate change and further enhance the ability to deal with extreme climate events, to optimize the infrastructure and urban facilities, Beijing sticks to the principle of "insisting on government's lead, keeping the enterprises as main body, involving all the social sectors" and the guidelines from top-level design to institutional arrangements. It takes the establishment and perfection of regulations in carbon emissions trading market as well as distribution system as precursor, the improvement of reporting, supervision and certification system of greenhouse gases emission as support, the consolidation of monitoring and specifying trading rules as guarantee; the cultivation of fair and dynamic trading market as essential means, with the purpose of gradually fostering a regional carbon emissions trading market characterized by "perfected system, dynamic trading, strict supervision and sound marketing rules", promoting the reducing of greenhouse gases emissions and consequently playing its demonstration role in carrying out the nationwide carbon emissions trading.

## 1.3 SWTO analysis of Low-carbon development in "the 13th Five-Year Plan" of Beijing

### 1.3.1 The advantages of low-carbon development in "the 13th Five Year Plan" of Beijing.

**Firstly, the strong policy supports to ensure the implementing of this work**. In order to strengthen the measures to deal with climate change, build up a management framework of energy conservation and consumption reducing, implement the responsibility for energy conservation of corresponding areas, evaluate the performance of energy conservation in districts, counties as well as major energy consuming units, and to improve the standard policy system, Beijing has formulated and reformulated a series of regulatory documents. *Beijing's Implementation Measures of Law of People's Republic of China on Energy Saving*, *Beijing's*

*Suggestions of Implementing Energy Conservation Regulation for State-Funded Institutions*, *Beijing's Implementation Plan for Evaluation System of the Regional Total Energy Consumption, Beijing's Interim Measures of Encouragement on Energy Conservation and Emission Reduction, Beijing's Suggestions on Further Promoting Energy Use In a Clean, Efficient and Secure Approach, Action Plan for Energy Development Strategy* etc. are all included. Besides, it has revised the catalog on adjustment of industrial structure; specified the indicators of water and energy consuming for industrial sectors; taken the lead in building a supervision and law enforcement team in districts and counties for energy saving as well as defined clearly the responsibility for performing the energy conservation tasks and the standards for evaluation system. In addition, Beijing is the first to combine the overall control of total energy consumption and decomposition targets of energy conservation to departments and regions at different levels; to carry out the evaluation and examining regulations on energy conservation; to establish a working system of cleaner production; to introduce contracts on energy management and policies of financial incentives, which would contribute to a sound institutional environment of low-carbon development in "the 13th Five Year Plan" of Beijing.

**The second advantage is that the practice of energy saving and reducing consumption together with the governance over haze pollution can benefit the low-carbon development.** On one hand, Beijing has taken various measures to save energy and reduce consumption. From 2000 to 2014, the energy consuming per 10,000 RMB of GDP decreased from 1.3114 tons of coal equivalents to 0.3596 tons, achieving remarkable results. On the other hand, aiming at solving the haze pollution which has troubled the residents a lot, Beijing has established a coordinating agency including 13 municipal departments and 16 county level governments and it decides that in the case of heavy pollution, each district has to take actions to deal with it according to its specific conditions such as stopping production, controlling traffics, eliminating old cars and calling on joint prevention among districts. At the same time, Beijing has released several planning schemes such as *Beijing's Regulation on Prevention and Treatment of Air Pollution* and *Beijing's Emergency Plan on Heavy Air Pollution*, promoting energy conservation and consumption reduction in collaboration with harnessing haze.

**The third advantage is that the outstanding achievements in industrial re-constructuring will help form a high-grade, high precision and advanced economic structure.** On February 25$^{th}$, 2014, general secretary Xi Jinping pointed out the strategic positioning of Beijing when he inspected work of this city: "Insisting on and strengthening the capital's core functions as center of national politics, culture, international exchange and technological innovation". Beijing has to give up the "all-inclusive" economic system and distribute the functions which don't belong to the core city, turning to a high-grade, high precision and advanced economic structure. On one hand, there is still room for industrial re-constructuring in Beijing and a modernized, professional industrial system can be built through optimization,

adjustment and transformation, enhancing the economic quality and level of our capital. On the other hand, in the past many years, with steady progress of energy saving and reducing emissions, the industrial structure led by Beijing has been substantially improved, and especially the industries of high pollution, high energy consumption and high carbon emissions are disappearing from this city. During "the 13th Five-Year Plan" period, to formulate reasonable function divisions in Beijing based on the existing social sectors will contribute to distributing the redundant functions not belonging to core cities. In addition, Beijing will further strengthen its industrial connection with Tianjin and Hebei, harmoniously balancing the relationship between population, resources and environment in a wider range. Also, while dropping out of corresponding commercial activities, Beijing will upgrade its life-support services, improving the quality of service industry.

**The fourth advantage lies in that citizens have developed a strong sense of low-carbon emissions and they positively support the conduct of low-carbon pilots.** As the capital city of China, Beijing is regarded as the center of politics, economy and culture. Taking its unique identity into account, the residents here have a firm pursuit of healthy lifestyle and they are able to positively collaborate with organizations concerned to carry out the pilot project. Beijing now is synonymous with the term "a city full of haze and traffic congestion", so various measures are expected to be taken to regain more blue sky in our capital. As a result, citizens have played an important role in upgrading the infrastructure and promoting the low-carbon products. Besides, the inhabitants here show greater willingness to accept green buildings and low-carbon products, which contributes to a favorable environment for promoting low-carbon consumption.

### 1.3.2 Beijing's disadvantages in low-carbon development during "the 13th Five-Year Plan" period

**First, despite the increasing energy consumption demand driven by low-carbon development year by year, there has been certain conflict between the existing economic mode and low-carbon economy.** During "the 13th Five-Year Plan" period, Beijing's economic development will surely enter the stage of high demand. With the accelerating urbanization and modernization, the primary industry will gradually withdraw and the tertiary industry will be developed rapidly. The growing proportion of permanent residents brings about rising rigid housing demand and traffic volume. Moreover, large-scale infrastructure rebuilding projects in old urban areas pose a big challenge. All these will significantly raise the society's rigid energy demand. It is inevitable that the high carbon gas emissions register harmful rise given the repeated construction of the backward production capacity in the secondary industry for the pursuit of GDP growth. Beijing is currently in the midst of a stage of rapid development of urbanization and internationalization, its existing development pattern has great space for optimization in terms of economic high-end degree, intensity degree, and the development of negative externalization. The pursuit of low-carbon should be further advanced by the transformation of the pattern of

economic development. On the one hand, the economic high-end degree still has optimization space. Although Beijing's tertiary industry output value of 2013 presented a higher share of GDP to reach 76.85% which was for the first time above 75% , it must keep up with the low-carbon cities in western developed countries. On the other hand, the degree of intensive development still has space for optimization. Beijing led China with its bus travel rate of 48% in 2014, but in the world cities such as London, New York, Tokyo, this rate has been higher than 70%.

**Secondly, key areas of energy consumption have been changed, and the work should be turned from "promoting emission reduction by withdrawing" to "promoting emission reduction by internal optimization".** Since "the 11th Five-Year Plan" period, Beijing's energy conservation target has been met mainly through withdrawing some major producers which are characterized by high consumption and high pollution. The rate of energy consumption by traditional high-consumption industries in the total energy consumption has been dropped from 38.14% in 2006 to 19.94% in 2012. Since then, there is decreasing space for meeting energy conservation goal through eliminating high-consumption projects and even a removal of all such industries will merely achieve the energy conservation target for the coming 1-3 years. Since the year 2008, the total rate of energy consumption by the tertiary industry and households has amounted to more than 60% and these two areas have become the new major areas for energy consumption. However, the existing means and measures in conservation energy are still direct at traditional consumption pattern and new workable ways and policy systems need to be explored to deal with emerging areas. Meanwhile, as the space for promoting emission reduction by withdrawing industries has been shrinking, Beijing's industry which has been based upon fossil fuels like coal and oil, combined with its extensive energy utilization system, will restrict its future practice of reducing greenhouse gas emissions, hence a great marginal cost rise for traditional measures to advance energy conservation and emission-reducing work. Therefore, the transition from "promoting emission reduction by withdrawing" to "promoting emission reduction by internal optimization" should be moved forward in a continuous manner.

**Thirdly, new and high technology needs to break through the bottleneck, the low-carbon incentive constraint mechanism needs to be improved, and the promotion of new energy technology application needs new measures.** During "the 13th Five-Year Plan" period, vigorous promotion of new energy application technology will boost low-carbon consumption pattern development. On the one hand, the combustion efficiency of coal in our country is far lower than the world advanced level, twice the combustion of coal to achieve the same level or even lower created value within the developed countries. Therefore, the development of new energy is the necessary step for Beijing to tackle climate change. But new energy can only meet a small part of Beijing's energy demands, and production costs of using renewable energy sources such as wind power and solar energy are much higher than traditional fossil fuels such as coal before the smart power grid is established. On the other hand,

industrial development structure has been gradually optimized and upgraded, urban service functions have been significantly improved, and more advanced high and new technologies will be required to apply to daily life such as construction and transportation. The increasing public demand for low-carbon products will boost the low-carbon product trade volume. Although UNFCCC (*The United Nations Framework Convention on Climate Change*) requires that developed countries have the obligation to provide technology transfer for developing countries, in practice China can only bring in those technologies through international technology market. Existing technology is not enough to meet the estimated demand of Beijing for low-carbon consumption, and making technology breakthrough will become the key and difficult task for low-carbon work during "the 13th Five-Year Plan" period.

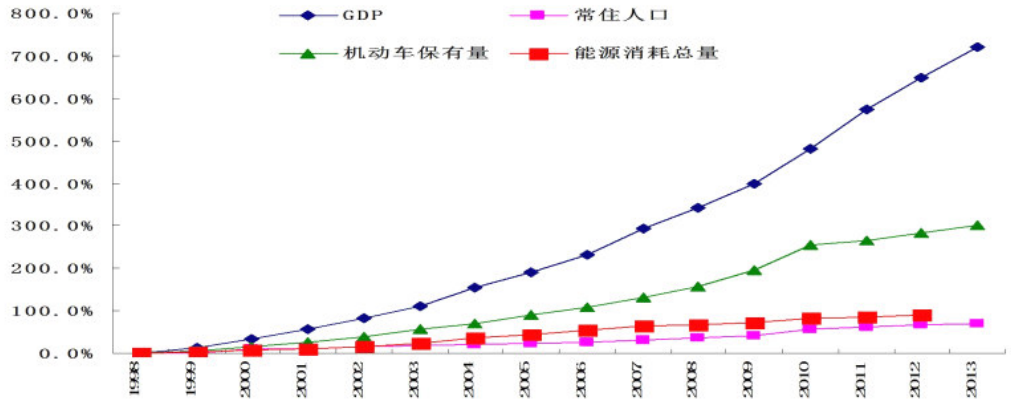
**Fourthly, high cost of energy conservation products is not acceptable under the traditional consumer's sense.** On the basis of the existing technical condition, China has produced and introduced a number of effective energy conservation products. For example, new energy conservation building materials have certain advantages such as higher technology content, lower resource consumption, longer service life, and less environmental pollution, but they are not competitive in terms of market price. And higher price which are driven up by the higher cost of energy conservation building materials production, makes it hard for energy conservation products to become the market pet. Another example is energy-saving electrical appliances. In terms of factors that affect consumers in choosing home appliance, the cost performance of energy-saving products is low. While those products are effective in energy conservation, they tend to be unacceptable given consumers' consuming habits and budgets. And in their mind, energy conservation comes after the function and price. At present, many citizens' consumption mode goes against the concept of sustainable development. Convenient consumption, excessive consumption, and luxury consumption are still widespread. The awareness of giving priority to energy conservation and environmental protection products is relatively weak, and implementation of voluntary garbage classification is very poor.

### 1.3.3 Beijing's low-carbon development opportunity during "the 13th Five-Year Plan" period

**First, Beijing's economy achieved a great leap forward, and its financial system will be more sound.**

On the one hand, the total economic volume greatly increased. In 2014, the overall economy was stable. Its GDP reached 2.133 trillion yuan, higher than two trillion for the first time and it was an increase of 7.3% over the previous year calculated at comparable prices. The investment in fixed assets reached 756.23 billion yuan, a year-on-year growth of 7.5%. Social retail sales of consumer goods reached 909.81 billion yuan, an increase of 8.6%. In 2013, the urban and rural residents' income reached 40,000 yuan and 18,000 yuan respectively, a year-on-year growth of 10.6% and 11.3% respectively. With the price taken into calculation, the urban and rural income increased by 7.1% and 7.7% respectively in real terms. By the year of

2014, the city's urban per capita disposable income had reached 43,910 yuan, an increase of 8.9% over the previous year. Rural residents' net income per capita had reached 20,226 yuan, an increase of 10.3%. As to the local public financial budget, 402.72 billion yuan of estimated income was collected, an increase of 10.1%. On the other hand, Beijing vigorously developed low-carbon economy and transformed existing industry system to more efficient, low-carbon industrial structure. The growing stronger industrial and technical foundation provided favorable conditions for the development of low-carbon economy, and there will be more opportunities to assist the overall establishment of low-carbon financial system with backward advantages. During the 12th Five-Year Plan period, service industry characterized by service-domination, innovation-driven and ecological environmental protection maintained its high-end advantages. The scale and level of modern manufacturing of new energy automobiles, electronic information, equipment manufacturing, biomedicine attained new development. Technological innovation centered in Zhongguancun national innovation demonstration zone grew more active. The development of new energy, energy conservation and environmental protection industry had been accelerated. All of above progress has become the important engine of low-carbon economy development and laid solid foundation for the low-carbon economy development characterized by low-carbon emissions industry and the low-carbon technology innovation.




常住人口　permanent resident population
机动车保有量　the holding volume of automobiles
能源消耗总量　energy consumption gross

Figure 6-3 1998—2013 Annual growth rate of four major social indicators of Beijing

[20]data source: Beijing Municipal Bureau of Statistics. http://www.bjstats.gov.cn/

**Secondly, the low-carbon development has become a national strategy, and Beijing, Tianjin and Hebei will cooperatively explore low-carbon development mode.** On the one hand, the country comprehensively considered the local work base and the representation of the pilot in the layout. It has been first determined that pilot

projects would be carried out in five provinces including Guangdong, Liaoning, Hubei, Shaanxi, Yunnan and eight cities including Tianjin, Chongqing, Shenzhen, Xiamen, Hangzhou, Nanchang, Guiyang, and Baoding. Low-carbon urban development planning would also be organized in those provinces and cities to proactively explore low-carbon urban development with local characteristics. The policy system, institutional mechanism, and the industry system and consumption pattern characterized by low-carbon will be of a great reference for Beijing in its construction of low-carbon city. On the other hand, the coordinated development of Beijing-Tianjin-Hebei has become a national development strategy under the new normal. It has been planned to jointly launch port, highway, railway, airport and other transportation facilities building, carry out the regional protection and rational utilization of water resources, major ecological construction and environmental protection projects, and actively guide the regional economic and technical cooperation among industries and enterprises. Through expanding cooperation among the projects and facilitating innovation in cooperation mode, they will work together to explore low-carbon development mode as well as develop economy.

**Thirdly, low-carbon development becomes the city's theme, and various consumer subjects actively take part.** With the implementation of the action plan for energy conservation and emission reduction for the whole city, Beijing has focused on the whole process from products supply, market circulation, to consumer behavior, built a sound low-carbon marketing services network, and fully mobilized social forces to participate. Activities to popularize scientific low-carbon knowledge have been organized through a variety of theme days, such as "energy conservation publicity week", "low-carbon campus activities", the "earth hour" and "not driving today". They popularized low-carbon knowledge, called for protecting the global climate environment, and improved the public awareness of emissions reduction. And through the mass media attention and intensive coverage, they promoted non-governmental organizations to actively raise the public awareness of protecting the environment and encouraged all kinds of organizations and groups in colleges and universities to launch low-carbon and energy conservation activities. All those have made the consuming subjects to consciously put their low-carbon environmental protection concept into practice in daily life, including broad participation in taking reusable shopping bags, controlling air conditioning temperature, no use of chopsticks, buying energy-saving products and other activities. This has not only brought concept of low-carbon consumption to Beijing residents, but also promoted the development of low-carbon consumption in Beijing.

**Fourthly, as the world is transiting to a low-carbon economy, Beijing has a mature external environment for low-carbon development.** In the background of economic globalization and global climate change, with its eyes on the international trend of western ecological cities, Beijing has actively participated in international cooperation, strived for establishing good interaction with the west low-carbon cities, launched constructive work and training to cope with the climate change, and carried

out technical cooperation projects adaptable to climate change. On the one hand, the rapid development of the international carbon trading market provides opportunities for Beijing. While absorbing the advanced experience of western cities, Beijing has combined it with the feature of regional development, and pushed its carbon financial business to the market. On the other hand, international technology transfer and cooperation adds impetus to Beijing: first, under the leadership of the Copenhagen Conference spirit, developed countries have made clean technology cooperation agreement with China; secondly, the increasingly powerful scientific research team in our country, improved research level especially Beijing's leading high-end science and technology innovation ability and strong scientific research team, will be a strong power for the research and development of advanced low-carbon technologies in the future; thirdly, Beijing's accelerated internationalization brings in new factors for energy conservation, emission reduction and low-carbon development. Green development strategy enables Beijing to be closer to the cutting edge and the top industrial and technological factors including international companies like Germany's Siemens, Japan's Panasonic, US's Johnson Controls, and closer to the smart power grid, electric vehicles and new energy technology. The introduction and transfer of these elements worldwide significantly promote Beijing's independent innovation ability for energy conservation and emission reduction and low-carbon technology, its absorption of advanced international experience and mode, and gradual development towards the domestic low-carbon innovation center and high-end manufacturing bases.

### 1.3.4 Beijing's challenge of low-carbon development during "the 13th Five-Year Plan" period

**First, the energy demand will grow in a rigid manner, and the construction sector will be a crucial area for energy conservation and emissions reduction.** According to the development trend of the world, per capita energy consumption will still be in the fast growth range before GDP per capita reaches $20,000 or $25,000. The beginning of 13$^{th}$ Five-Year Plan Period will be a period for Beijing to accelerate its urbanization and internationalization during which the increasing level of economic development, combined with a leap of per capita GDP to go beyond $16,000, will inevitably lead to further increase of energy consumption. To estimate energy consumption in terms of the sector, energy consumption peak values present an orderly alternative progress among the industry, construction, civil use, and transportation sectors. In the field of construction, the difficulty of energy conservation and emission reduction lies in winter heating. There are mainly three heating forms in Beijing: central heating, boiler room heating, and decentralized heating. Most of the existing traditional ways meet the temperature requirements through coal, therefore a significant portion of the total energy consumption in each year is for heating energy consumption, which puts forward significant pressure for energy conservation and emissions reduction work. It is expected that during "the 13th Five-Year Plan" period, the city will continue to speed up infrastructure construction and expand construction areas. The construction sector will catch up with

industry to become the fastest-growing segment of energy consumption during the 13th Five-Year Plan period, and its huge rigid demand growth will be a great challenge to energy conservation and emissions reduction.

**Secondly, the supporting science and technology innovation ability is still in the primary stage of development, and such innovation will be insufficient for the energy conservation and carbon reduction.** While depending on structural adjustment to reduce emission, Beijing still needs to fix more attention to technological progress. Making the difficulties encountered in the energy conservation and carbon reduction work as a breakthrough point, it should give full play to the leading role of scientific and technological innovation, and rely on scientific and technological progress to solve problems in each link. At present, the innovation system with the enterprise as the main body has not yet been established, and the level of marketization and industrialization is low (in the Beijing area, the enterprise R&D funds accounted for only 40%, compared with a national average of 76%). So it is not enough to support the incubation of low-carbon innovation enterprise. Potential of Zhongguancun's pilot policy still needs further development, and integrated coordination of innovation resources still needs to strengthen. The low-carbon goal setting of the 13th Five-Year Plan cannot be achieved by merely relying on the dividends brought by energy structural adjustment, rather, the shortage of driving force for low-carbon development shall be overcomed, and innovation-driven development shall be vigorously promoted.

**Thirdly, there are considerable challenges in regulating population, transforming development mode and mounting pressure of energy conservation and carbon emissions reduction.** On the one hand, in recent years, there has been a gradual slowdown of Beijing's population growth, but the population size keeps increasing. According to statistics, by the end of 2014, the Beijing resident population has reached 21,516 million, an increase of 368,000. Permanent population density per square was 1,311, an increase of 22 people per square. However, the energy conservation and carbon reduction requires strict control of population scale. Beijing has started to strengthen the appendage responsibility system, and speed up the implementation of strictly controlling population size. A large number of population not only means greater pressure of survival, but also increases the work intensity of the transportation, housing, work, water and electricity supply, and garbage disposal. Population control remains a difficult task in meeting the energy conservation and emissions reduction targets. The transformation of Beijing's development mode, on the other hand, is a comprehensive and systematic project, and the comprehensive transformation is very difficult. However, the final realization of low-carbon economy must be based on changing the overall economic development patterns and the social concepts, which can be long-term development period given the comprehensive building of industrial structure, energy efficiency, technical progress, public infrastructure, consumption and philosophy as well as other elements.

## 1.4 The low-carbon development goals during “the 13th Five-Year Plan” period.

In the Third Plenary Session of the 18th Central Committee of the Communist Party, there had been clear requirements for energy conservation, environmental protection and ecological civilization construction. In the document released by the State Council entitled “*The Opinion of Accelerating Ecological Civilization Construction*”, the overall requirements explicitly pointed to vigorously advancing green development, cycle development, and low-carbon development. Xi, the general secretary, made important instructions for the capital’s work during his visit to Beijing. In the fifth plenary session of the 11th Beijing municipal party committee, there has been systemic deployment of the adjustment of city function orientation, promoting the coordinated development of the Beijing-Tianjin-Hebei region, and vigorous facilitation of environmental governance. It can be said that Beijing has been standing in a new starting point for green and low-carbon development, and it needs to deeply grasp the internal relations and interactions among capital city construction, economic development and energy and resources utilization, and environmental quality improvement, closely stick to "two main lines" around conservation energy resources and improving environment, further strengthen the top design of energy conservation and carbon reduction work. It should pay more attention to bring into full play the decisive role of market in resource allocation, protect the ecological environment through institutionalization, and carry out the work to save energy and reduce carbon emissions so that it can achieve green and low-carbon development.

### 1.4.1 Beijing’s low-carbon development guiding concept during “the 13th Five-Year Plan” period

We need to comprehensively implement the spirit of the 18$^{th}$ CPC National Congress, the third and fourth plenary sessions of the 18$^{th}$ Central Committee of the Communist Party, especially general secretary Xi’s series of important speeches (the important speech made during his inspection in Beijing in particular) and the concept of scientific development. It will make speeding up the transformation of the mode of economic development as the main line, the construction of "humanistic, scientific and green Beijing" as the principle, adjusting the industrial structure, optimizing the energy mix and improving resource utilization efficiency as the core, the development and application of technologies for energy conservation, emission reduction and low-carbon as the drive, a low-carbon system construction and strengthening the social regulation as the guarantee. It will grasp the internal relations and interactions among capital city construction, economic development and energy and resources utilization, and environmental quality improvement to promote the second revolution of energy production and consumption. There will be chain management of the low-carbon production, low-carbon circulation, and low-carbon consumption. “Double control and Dual Reduction” mechanism that aims to controlling energy

consumption and carbon dioxide emission intensity and volume will be established in accordance with the principles of "government guidance, market driven, public participation" to strengthen the decisive role of market in resources allocation, establish overall low-carbon green production mode and life style, further the coordinated development of Beijing-Tianjin-Hebei region so that Beijing can become international first-class, harmonious and livable city, and achieve comprehensive, balanced and sustainable development of economy, society and ecological environment.

### 1.4.2 The principle of low-carbon development of Beijing during "the 13th Five-Year Plan"

To adhere to people-oriented and comprehensively coordinated development. It will comprehensively implement the outlook of scientific development, coordinate the relationship of environment protection and economic and social development, and promote the harmonious development of human and nature, focusing on building higher standard of material circumstance of lives, transforming the economic development mode, and coordinated developing inter-regional energy conservation and consumption reduction. It will also promote sound development of low-carbon industry, build green industrial structure, and realize sound ecological protection and create harmonious living environment.

To adhere to concept priority and proceed steadily and step by step. It will take low-carbon concept as preference field of low-carbon economic development, guarantee the sound operation of green production and living, and comprehensively apply methods of law, economy, technology and publicity. It will make conceptual innovation driven by innovation in technology, standard, system, mechanism and management, steadily promote technological progress in energy conservation, implement environment protection mechanism and gradually cultivate green living mode.

To implement collaboration and total control. It will take energy conservation and emission reduction as focal point and lower the energy consumption per unit of GDP; it will take key energy utilization area as breakthrough and deepen the energy conservation and emission reduction project; it will develop the construction of low-carbon economy pilots, and gradually build systematic circumstances in energy conservation and climate change for the whole society.

To adhere to innovation driven and technical leading approach. It will fully exert the leading and basic impact of science progress and technological innovation, highly focusing on the importance of science innovation, drawing western advanced technology to intensify independent R&D of new energy technology. It will use technological innovation to protect low-carbon development, lower the technological cost of low-carbon products and gradually replace high-carbon technology with low-carbon technology to enhance carbon productivity.

### 1.4.3 The targets of low-carbon development of Beijing during "the 13th Five-Year Plan"

**Targets of energy conservation and consumption reduction:** Until 2020, the total energy consumption of Beijing will be controlled within 86 million tons of coal equivalent (recent statistical caliber); energy consumption per 10,000 Yuan GDP will reduce 20% compared with 2015 (GDP fixed price in 2010), energy consumption per 10,000 Yuan GDP will be around 0.35 tons of coal equivalent; total carbon emission will be controlled within 26 million tons of $CO_2$ and carbon emissions per 10,000 Yuan GDP will be expected to 0.105 tons of $CO_2$; energy consumption per capita will reach 3.5 tons of coal equivalent per person.

**Target of low-carbon energy:** Until 2020, the proportion for superior energy will be over 90% of total energy consumption; the proportion of renewable energy will approach to 15%.

**Target of low-carbon economic development:** Until 2020, the proportion of tertiary industry will be expected to reach at over 90%, and the proportion of producer services will increase to 85% of service industry.

**Target of ecological environment protection:** Until 2020, forest coverage will increase to 48% and forest stocks will reach at over 17.2 million $m^3$; water consumption per 10,000 GDP will be less than 8 $m^3$; city green coverage rate will reach at over 55%; annual average daily inhalable particle will be less than 0.90 mg/$m^3$; sewage treatment capacity will be no less than 4.3 million $m^2$/D and sewage treatment rate will reach at over 93%.

| Name | Energy consumption reduction rate of per unit GDP during "the 13th Five-Year Plan" | Total energy consumption control targets at the end of "the 13th Five-Year Plan" (10,000 tons of coal equivalent) |
|---|---|---|
| Dongcheng District | 18% | 300 |
| Xicheng District | 18% | 420 |
| Chaoyang District | 19% | 1270 |
| Haidian District | 19% | 930 |
| Fengtai District | 19% | 560 |
| Shijingshan District | 30% | 470 |
| Mentougou District | 17% | 100 |
| Fangshan District | 21% | 1120 |

| | | |
|---|---|---|
| Tongzhou District | 19% | 400 |
| Shunyi District | 21% | 1100 |
| Changping District | 20% | 340 |
| Daxing District (Beijing ETDZ included) | 20% | 420 |
| Pinggu District | 17% | 120 |
| Huairou District | 17% | 120 |
| Miyun County | 16% | 110 |
| Yanqing County | 16% | 60 |

Chart 6-2 Districts and counties energy conservation goal decomposition solution during "the 13th Five-Year Plan"

Note: solutions based on *Districts and counties energy conservation goal decomposition solution during the 12th Five-Year Plan* and the target completed situation of districts and counties in 2013 and 2014.

## 1.5 The path choices of low-carbon development of Beijing during "the 13th Five-Year Plan"

To compile urban low-carbon development scheme should fully consider the variability of our regional development, not only implementing the general requirement of low-carbon development, but also considering the regional actual situation. The second chapter in this report pointed out that if we take low-carbon city as green city, high-carbon city as gray city, low-carbon industry as green industry and high-carbon industry as black industry, there are four combinations during industrialization and urbanization: green city+green industry; gray city+green industry; green city+black industry; gray city+black industry. Based on the actual situation of Beijing, strategic positioning of main functional area and the future regional development orientation, it is suggested that Beijing choose "green city+green industry" as low-carbon development path during "the 13th Five-Year Plan".

### 1.5.1 Key areas of low-carbon development of Beijing during "the 13th Five-Year Plan"

**①. To intensify the main functional area positioning, and optimize the city space development pattern.**

To implement main functional area strategy. Beijing shall comprehensively implement main functional area planning and perfect the supporting policies

associated with finance, investment, industry, land, population and environment (low-carbon target) and performance evaluation system with different focuses. It shall promote main functional area positioning in districts and counties, and advance multi-planning of economic and social development, urban and rural development, land utilization and ecological environment protection. It shall consider climate coordinated with urban low-carbon development strategy, beautification construction, ecological civilization construction and sustained development strategy, making overall consideration of urbanization, urban population density, space arrangement and pension, which associate with vulnerability of climate change. The planning formation and vital project arrangement in districts and counties should accord with main functional area positioning. It shall implement differential market evaluation policy for industrial projects of different main functional areas, define the evaluation standard of low-carbon development industry and prevent limited development industries, like high energy consumption or heavy pollution enterprises. It shall construct green and low-carbon space system in districts and counties, and properly increase living space, ecological land, and protect and expand the ecological space, like grassland, water area and wet lands.

To promote green urbanization construction. It shall implement *The Opinion of Accelerating Ecological Civilization Construction* and *National New Urbanization Planning (2014-2020)* issued by the State Council. According to the bearing capacity of resource and environment, it shall build scientific urbanization macroscopic arrangement of suburban districts and counties, and enhance the regional bearing capacity and promote the coordinated development of districts and counties under administration. It shall intensify the energy conservation concept in the process of urbanization, energetically developing green architecture, low-carbon and convenient transportation system, and promoting green eco-living zone construction. It shall launch green urban pilots, ensure all the counties and towns equipped with sewage and garbage treatment capacity and enhance the levels of construction, operation and management.

To improve beautiful rural construction. It shall perfect village planning in county territory and intensify scientificity and constraining force of planning. It shall energetically develop agricultural circular economy, manage agriculture pollution and promote agri-products quality and safety. It shall rely on rural ecological resource, properly developing rural low-carbon leisure tourism without damaging eco-environment. It shall enhance rural cultural and ideological progress, taking environment renovat and low-carbon development as key points and make solid progress in creating civilized and green villages and small towns.

**②. To develop coordination of energy conservation and emission reduction, and to comprehensively promote energy conservation and emission reduction in key fields.**

To actively promote comprehensive development of Beijing, Tianjin and Hebei

province. It shall deeply explore the direct supply pilots of clean power, like nuclear power and photovoltaic outside Beijing, building inter-regional carbon emissions permit trading market, steadily linking with national carbon emissions permit trading markets, striving to be the mode of comprehensive development of Beijing, Tianjin and Hebei province in developing ecological environment protection. It shall improve regional energy conservation and carbon reduction management system, implementing "treble control" mechanism of energy consumption intensity, carbon emissions intensity and total energy consumption. Beijing and Tianjin improve and implement carbon emissions gross control, matured prefectural-level city in Hebei province promote carbon emissions gross control and build regional carbon emissions permit trading market. It shall gradually unify the energy conservation and low-carbon standard in Beijing, Tianjin and Hebei province, promoting the system of pacemaker by efficiency. It shall encourage the all-round cooperation of technology and capital of regional energy conservation and environmental protection in energy conservation and environment protection enterprises, and cultivate a group of leading enterprises.

To adhere to the public institutions taking lead in energy conservation. On the basis of comprehensively implementing *Regulation of Energy Conservation in Public Institutions*, it shall achieve energy consumption per unit area of public institutions in 2020 dropping 25% against 2015: the first type is government. Governments shall comprehensively launch energy conservation transformation projects, taking the lead in promoting green administration and procurement, continuously initiating energy conservation diagnosis and transformation in governments of city level. According to the guiding suggestions of energy conservation in governments of districts and counties, governments of districts and counties shall launch the energy consumption survey, comprehensively initiating all-round energy conservation transformation in enclosure structure of government office buildings, heating, air conditioning, office equipment and illuminating system. It shall speed up the transformation of energy conservation heat metering and systematic energy conservation and advance governments to take the lead in charging in accordance with heat metering. The second type is school. It shall formulate *The Plan of Energy Conservation and Emission Reduction in Schools of Beijing Education System during "the 13th Five-Year Plan"*, accelerating energy conservation transformation of key energy utilization systems, like enclosure structure, network computer room and refectory, comprehensively promoting online real-time monitoring of energy consumption in municipal schools, and comprehensively establishing energy monitoring platform of heat and power utilization in municipal schools at the interim period of "the 13th Five-Year Plan" and building the conservation-oriented schools. The; third type is hospital. It shall launch the energy conservation diagnosis and transformation of air conditioning, illuminating and heating systems in the hospitals, reasonably allocating and using medical resource, space and equipment, achieving automatic operation control of spotlights, landscape lights and electrical equipment in public area and building energy conservation demonstration hospital.

To advance energy conservation of public buildings. First is to formulate new standard of building energy conservation. The energy conservation standard of new buildings will be enhanced by 30% on the former basis, strengthening the supervision and management of new projects, intensifying supervision of design standard of building energy conservation as well as construction inspection rules in designing and constructing. Second is to accelerate transformation of existing buildings. It shall accelerate transformation of existing non-energy conservation buildings and energy utilization equipment, with a synchronous implementation of transformation of existing buildings, heat metering and systematic energy conservation. Third is to popularize similar energy conservation technical products. It shall launch energy conservation diagnosis and transformation of air conditioning, illuminating, elevator and electrical machine, carrying out demonstration projects of replacing counter spotlight with LED and developing energy conservation transformation of secondary light source. It shall popularize efficient kitchen utensils across the city, and make efforts to reduce over 30% kitchen energy utilization in 2020 than that of 2015. Meanwhile, it shall gradually develop combined supply and property management of cooling, heating and power, heat pump and ice storage in centralized zone of hotels and restaurants, , encouraging logistics enterprises to purchase energy conservation and environment protection vehicles, such as establishing green fleets. It shall launch energy conservation transformation of air conditioning and enclosure structure for logistics enterprises equipped with refrigerator and fresh-keeping storehouse and make efforts to reduce 2 million tons of fire coal for energy consumption of public buildings in 2020.

To promote development of low-carbon transportation. First is to give priority to develop public transit system. It shall develop high-capacity rapid rail transportation, improve public transit system with rail transportation as mainstay and ground public transportation as subject, build many ground rails to release the pressure of congestion areas, adopt transportation arrangement according to time and grade, strengthen low-carbon drive training of drivers and enhance density of branch network in centralized areas; second is to develop smart transportation system. It shall further optimize transit signal system and traffic guidance service system, do research on operation of line guiding system in rush hours, properly abolishing stops to release congestion and enhance efficiency of transportation; third is to create comfortable slow traffic system. It shall bring bicycles to traffic plan across the city, improve connection and changing system between bicycles and public transportation, and encourage and support bicycle lease development in key areas relied on subway stations and public transit hubs; fourth is to expand scale of electric taxi for residents; fifth is to demonstrate application of public transportation, environmental sanitation and new energy automobiles of governments. In 2020, at the premise of increasing over 1.5 million automobiles, vehicle-use fuel gross will drop by 8% than that of 2012, with 1,000 km of rail transportation operating distance. It shall make efforts to control holding volume of automobiles within 5.6 million with proportion of transit trips in

centralized areas reaching at 75%.

To deeply launch industrial consumption reduction initiatives. First is to quit and transform backward facilities in industrial enterprises. It shall obsolete backward producing process and equipment with heavy pollution, implement energy conservation technical transformation, for example, combined heat and power generation, waste heat and pressure power generation, electric machine systematic energy conservation and industrial boiler energy conservation; second is to strengthen energy-use monitoring of industrial enterprises and to realize over 5,000 tons of coal equivalent of comprehensive energy consumption represented on industrial data platform in 2020; third is to improve management rules of energy conservation goals for key energy consumption enterprises. It shall strengthen the implementation of energy conservation goals and responsibilities for key energy consumption enterprises, improving energy reporting system of key energy consumption enterprises and launching energy auditing and energy conservation plan. It shall advance energy conservation technical transformation for enterprises, enhance energy efficiency, implement energy conservation goals and responsibilities and respectively formulate energy consumption reduction target of industrial added value in 100 key energy-use enterprises, to develop evaluation of performance of key energy-use enterprises, build scientific and effective evaluation system, implement specially-assigned person with management of different areas and promote cleaning production. To 2020, clean transformation of fire coal equipment in 19 industrial parks over municipal level will be accomplished with 800,000 tons of unexploited coal, complete clean transformation of fire coal equipment for industrial enterprises above designated size and implement capacity control of cement industry with 2 million tons of unexploited coal.

**③. To strengthen efforts to natural ecological system and environment protection and improve air quality with multi-methods.**

To fully take advantage of forest resources and continuously enhance carbon sink. It shall continuously implement a series of vital ecological engineering, such as wild wood protection, returning the grain plots to forestry, coordinated management of Beijing-Tianjin sources of sandstorms; it shall continuously strengthen forest resource protection and carbon sink afforestation; it shall formulate management of supervision of Beijing forest resources, further intensify biodiversity protection, govern from sources and enhance joint control and prevention within regions, and supervise punishment to sanction the forest carbon sink damage; it shall improve forest barrier of Beijing and deeply launch green afforestation; it shall implement protective farming and enhance the carbon sink of farmlands and grasslands.

To strictly control blowing of dust and sand from source management. Although Beijing has formulated environmental protection standard for construction sites, many of them witness heavy blowing dust and sand. On the basis of implementing environment protection standard, it shall strengthen green construction management

and build margin system of dust blowing prevention, install video surveillance in designed size of construction sites across the city. It shall build law enforcement procuratorial group and adopt advanced monitoring technology combined with aerial and ground monitoring. It shall manage blowing dust across the city and bring illegal acts of blowing dust in construction sites to credit management system of enterprises, and limit biding permit for the severe conditions. It shall increase the area of machine cleaning, launch city greening and manage bare ground. To 2020, the new process of road cleaning coverage will reach at over 90% and the dosage of using reuse water to wash road will be 500,000 $m^3$ per day, and to realize protective farming and biological coverage as well as manage bare farmlands.

To vigorously address climate change. It shall enhance the capacity of adopting climate change for city infrastructure. It shall promote feasibility study of climate for city space arrangement and vital projects. It shall launch the evaluation of the impact of climate change on city safety operation, and scientific stipulation of adaptive plans and measures. It shall enhance the emergency capacity in extreme climate. It shall formulate contingency plan for handling different types of climate disasters in municipalities and districts and perfect monitoring climate covering the whole city and warning system of natural disaster. It shall analyze law of extreme climate, pre-estimate risks and losses of climate disaster in different areas and optimal configuration of various disaster alleviation resources. It shall enhance the capacity of medical and public health systems to adapt to climate change. It shall develop the research on rules of spreading epidemics and prevention under the condition of climate change, gradually perfect the monitoring network, and enhance the rapid response and contingency disposal capacity to public health emergency.

**④. To explore new path of low-carbon energy application and form regional low-carbon industrial chain.**

To build low-carbon energy development mode. It shall take “Frugal, Superior, Clean” as the core to accelerate technical innovation, enhance energy efficiency, promote energy development mode transformation toward low-carbon, and to provide powerful guarantee and support for constantly perfecting ecological environment quality, controlling greenhouse gas emissions and accelerating *Green Beijing* construction.

To build external supply system of clean and superior energy. During “the 13th Five-Year Plan”, Beijing should make efforts to reducing fire coal gross to 10 million tons, dropping 18 million tons compared with 2012, the share of coal in energy consumption will drop from 25.4% to 10%, natural gas supply will reach 30 billion $m^3$ to enhance oil quality and the share for renewable energy will reach 15%, which will lay solid material foundation for low-carbon economic development.

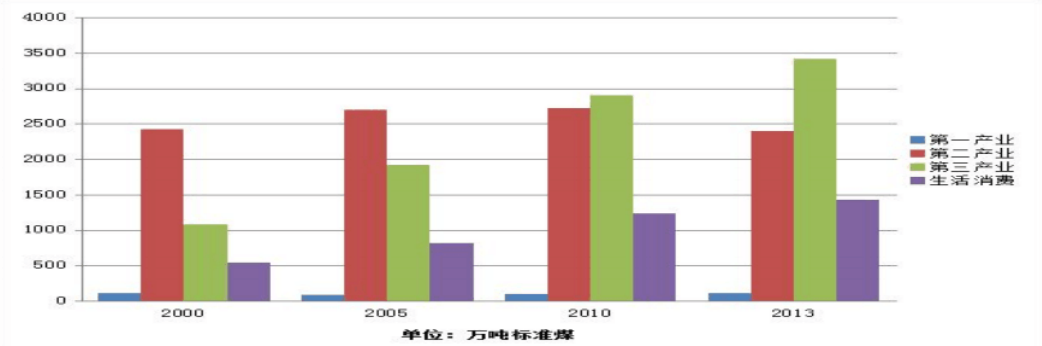
To build wind power generation equipment with high technology and efficiency. It shall encourage to properly develop wind power generation in regions with

abundant resources. It shall make efforts to obtain 600,000 kw of installed capacity of wind-driven power in 2020. Our wind-driven power equipment has realized the development of power per unit from ten million to megawatt. Beijing should develop regional advantage, fully using renewable resources, like wind and solar power, building wind power generation plant and photovoltaic power generation equipment in northern and northwestern parts of the city and removing key large industrial parks out of area under administration in order to specially supply for certain plants.

To create new types of low-carbon clean energy utilization. It shall complete clean energy transformation of 137 fire coal boilers in six districts and realize the gold of no fire coal boilers; to 2020, it shall complete clean energy transformation of fire coal boilers with 20 T/h or below in outskirts or key towns to realize reduction of fire coal in outskirts; it shall improve price policy of agricultural and forest biomass power-generation, financing biomass exploration and making a breakthrough to extract liquid fuel from non-grain biomass, like cassava and forgo; it shall popularize solar-powered illumination and solar water heater, constructing solar power generation pilots, and heat-collecting utilization areas of solar power will reach 23 million $m^2$; it shall strengthen evaluation and exploration of geothermal energy, the heat pump heating areas will be 150-180 million $m^2$ in 2020.

**⑤. To improve industrial structure adjustment and process and form demonstration effects of low-carbon industry in the capital.**

To transform traditional industry. It shall apply evaluation threshold to restrain unreasonable growth of energy consumption of traditional industry from the source. The total energy consumption in Beijing has gradually increased while the growth rate of tertiary industry is much higher than that of the first and second industry. It shall build industrial system featured with low-carbon emissions, largely develop modern service industry with knowledge, technology and management-intensive, cultivate and develop strategic emerging industry, like new energy, new material, energy conservation and environment protection, biomedicine, information network and high-end manufacturing industry so as to obsolete high energy consumption and emission industry, strengthen eliminating outdated capacity and develop alternative and follow-up industry.




第一产业　primary industry
第二产业　secondary industry

第三产业　tertiary industry
生活消费　living consumption
单位：万吨标准煤　　unit: 10,000 tons of standard coal

Figure 6-4　The recent variation trend of total energy consumption according to different industries of Beijing

To promote high-end industrial development. During "the 13th Five-Year Plan", Beijing should take energy efficiency enhancement as core, to deeply advance economic restructuring, speed up industrial structure upgrading and internal optimization, further establish the development strategy of high-end industry, primarily developing modern manufacturing, high and new technology industry and modern service industry, advancing high-end, effective and low energy consumption industry, launching low-carbon economic parks pilots and realizing the transformation of economic growth and development mode.

To cultivate strategic innovation emerging industry. The development of innovative enterprises will inject great impetus to low-carbon industry, which will be the breakthrough of optimizing industrial structure, constantly strengthen the support of technological R&D and industrialization of strategic innovation emerging industry. The vital technical infrastructure construction should be steadily promoted, implementing knowledge and technological innovation projects, tackling important technology, initiate venture investment of emerging industry, release industrial investment fund and enhance innovation capacity of SMEs.

To gradually improve modern service industry construction. To develop modern service industry including financing, cultural creativity, convention, consult and logistics, promote the combination of cultural creativity industry and capital market and build trade platform; to cultivate low-carbon economic service industry, like energy conservation and environment protection and carbon trade service industry; to advance development of service industry, like health care, physical fitness and community service.

To support the development of high-grade, precision and advanced manufacturing. To continuously support the development of dominance manufacturing, like electronic information industry, equipment manufacturing industry, automobile industry and bio-pharmaceutical industry, to take Zhongguancun technology park as core to increase the proportion of high and new technological manufacturing, like mobile communication, computer and network, integrated circuit, electro-optic display, biological industry and new energy; to focus on developing industrial high-end process, like R&D design, brand construction and products marketing.

To comprehensive upgrade cluster economies. To bring carbon emissions intensity per 10,000 GDP and carbon sink into evaluation target of low-carbon

industrial park; to launch pilots of low-carbon economic parks in emerging areas, like Lize business zone, future science and technology city and CBD expansion to the east. To take cluster economies as core, industrial structure upgrade innovation as key points and energy conservation and environment protection technical system as support in order to realize the coordination development of parks in economic and environmental benefits.

**⑥. To develop energy conservation and environment protection industry and advance the application of energy conservation and low-carbon technical products**

To widely popularize mature technology. To develop utilization and popularization of energy conservation new technology and low emission technology in fields of architecture, transportation and civilian products, adopt mature technology with larger market space, like solar and photovoltaic power generation, solar thermal utilization, wind power and new energy automobiles, and to speed up the R&D and demonstration operation of EV automobiles and industrialization of hybrid electric vehicles.

To vigorously explore frontier technology. To vigorously explore new technology R&D in carbon capture and carbon neutrality and blaze emerging industrial clusters featured with low-carbon economy; to realize the technological breakthrough of non-fossil energy, like advanced nuclear energy, hydrogen energy and fuel battery, enhance the clean energy supply and reduce excessive reliance on fossil energy.

To speed up the tax reform of resources. To constantly perfect export rebate system, adjust purchase tax of automobiles and favorable subsidy for energy conservation electric automobiles; to pave ways for low-carbon products stepping into market through subsidizing, tax deduction and exemption, loan with low interest and proportionality price policies; to implement favorable import tax policies for energy conservation and low-carbon products.

**⑦. To enhance awareness of health protection and popularize low-carbon living mode**

To conduct basic research on impact of climate change on human health. To deeply recognize the relationship of meteorological factor, extreme climate and epidemics, improve the research and warning level of medical meteorology, implement sustained prevention and control plan and provide abundant and authoritative disease monitoring, evaluating, forecasting and warning for the whole society.

To advance nationwide green lifestyle. To promote residential energy conservation transformation, comprehensive launch enclosure transformation of old residential buildings, strengthen the subsidy for popularizing energy conservation and environment protection products, and popularize energy conservation air conditioning,

refrigerator and lights into households. To forbidden high energy consumption fire coal boilers while to encourage residents to use energy conservation gas cooking appliances, energy conservation lights and low energy consumption electric boiling. To advocate green travel and purchase low emission vehicles and hybrid electric vehicles. To launch energy conservation education activities and cultivate awareness of purchase high energy efficiency appliances.

### 1.5.2 Major projects in low-carbon development during "the 13th Five-Year Plan".

**①. Reversed transmission of pressure will be strengthened, a control of the total amount of carbon emissions and carbon emissions intensity will be forced, and obligatory targets will be implemented.**

To make a breakthrough in energy-supply-oriented traditional energy strategy, regulate energy demand in light of constructing ecological civilization, and conduct an intelligent and scientific management during the whole process of energy production, transmission, transport and consumption. To further strengthen the synergistic effect of the evaluation of energy and carbon dioxide emission, and conduct a source control of the unreasonable growth of their consumption. To make a forbidden list of projects with a high degree of pollution, such as steel and iron, cement, carbon coke and nonferrous metallurgy, and stop constructing labor-intensive manufacturing projects. Meanwhile, to conduct an overall control of industries with high energy consumption and high pollution emission, with cement production capacity dropped to 3 million tons by 2020 and refinery capacity within 6 million tons. In this way, to strive to adjust small-sized polluting enterprises which have stepped out of such sectors as building materials, chemical engineering, casting and furniture making, so as to carry out the Environmental evaluation and Approval System featuring, in which the new projects motivates the old ones to achieve balanced emissions of pollutants.

Environmental protection standard conforming to the pattern of low-carbon development in Beijing will be formulated. In 2014, Beijing Municipality released the standards for using low-sulfur coal and its products, requiring a real-time supervision to be executed according to the environmental standards. To speed up the amendment and release of emission standard of air pollutants regarding sectors such as building materials, petrochemical and auto-manufacturing, strictly carry out emission standard and regulation of volatile organic compound, ramify standards as regards resistance to heat, freezing, pressure and humidity of the underground pipes. To continuously reduce coal-burning plants, strive to control the proportion of coal consumption in the total energy consumption below 5% by 2020. To optimize the energy consumption structure in Beijing, develop new energies and renewable energies, including exploring pilots of clean electric power such as nuclear power and photo-voltaic outside Beijing so as to optimize its external power consumption structure.

**②. Effective links will be established between the full implementation of Super Efficient Plan and the leading indicators of carbon-dioxide emission intensity, and the reform of low-carbon management mode will be carried out to bring the SEP into force.**

To establish the leading role institution in terms of key industries and major energy-consumption products, organize energy efficiency benchmark activities, carry out projects of energy conservation modification and strive to reach the leading level in China in key industries/areas and major consumer goods. To enhance the guiding role of the leading indicators of carbon-dioxide emission intensity, including perfecting its mechanism, strengthening the guiding role of market mechanism to reduce redundant carbon-dioxide emissions, and raising the energy-efficiency level through energy conservation and low-carbon consumption. To make a comprehensive energy plan for Beijing. To be specific, to make such a plan by combing the city's overall urban planning revision and the ecological protection in Beijing-Tianjin-Hebei Region. To implement a linkage mechanism among energy efficiency, the standard of carbon-dioxide emissions, and product catalog, and give play the leading role of reversed transmission of the pressure. At the same time, to strive to develop new industries featuring clean energy and low energy consumption, and cultivate a professional management team. In this respect, to carry out information-based engineering combining energy measurement, monitoring and energy control, form a report as regards carbon-dioxide emissions of the major industries, and establish an verifying system by a third party.

**③. A security system for low-carbon development will be perfected.**

First, improve policies and regulations. To make development and implementation plans of energy-conservation in areas of constructing, industries and transportation for the 13th Five-Year Plan; to introduce *Detailed Rules for the Implementation on Speeding up the Development of energy conservation and Environmental Protection Industry*, *Guidance on energy conservation Management for Major Energy-consumption Enterprises*; update every two year *Details on New Technology and New Products of Energy Conservation and Emission Reduction in Beijing*; formulate *The Annual Report on the Process of Energy Conservation and Greenhouse Gases Emission in Beijing* in terms of the target set for carbon emissions reduction in order to monitor its progress of energy conservation and carbon emissions reduction; establish gradually a multistage targets system including low-carbon city, low-carbon industrial parks and low-carbon industries to form a demonstration effect.

Second, to strengthen the evaluation and responsibility system on energy conservation and low-carbon consumption. To establish a responsibility system for low-carbon development during the tenure of the official leaders, and perfect the evaluation and accountability system on energy conservation and carbon emissions reduction. To be specific, to hold a lifelong accountability of those who are against the scientific outlook on development and cause severe destruction to the resources and

ecology environment. Under such situation, they will not be transferred to important positions, nor will they be promoted. Even those having been transferred will be hold responsible. To set the targets of carbon emissions reduction during the 13th Five-Year Plan, and decompose these targets to each county, sector, key parks (such as high-end districts and industrial parks) and key enterprises based on the principle of complete coverage; establish a management mechanism on the overall amount of carbon emissions, and formulate *A List of carbon emissions During "the 13th Five-Year Plan""in Beijing*; make clear the overall target of carbon emissions reduction, and form a statistical system and monitoring system on the limitation of greenhouse gases emissions such as carbon-dioxide.

Third, comprehensively promote low-carbon market mechanism. To advance the mechanisms regarding contract energy management, products of energy conservation and low-carbon, organic certification, and energy efficiency labeling management. In this respect, to enrich our policies on low-carbon economy, give play to the role of market in allocating resources, construct a trading market relating to carbon emissions permits, amount of energy conservation and emission permit, and motivate the enterprises to conduct a voluntary action for carbon emissions. To improve investment and financing policies, set up a carbon trust led by the Beijing Municipal Government, and attract investments from the whole society, especially the small-and-medium-sized enterprises as well as private flows. Besides, to perfect the mechanism for ecological compensation based on the existing mechanisms for forest and water source ecological compensation. In addition, to launch a pilot project on the trading market of water rights, and make it more standardized. Multiple parties and social forces will be involved to promote the the third party governance on environmental pollution.

Fourth, to carry forward low-carbon concept. To conduct a demonstration on the promotion of new energy conservation technology and the use of energy conservation products; to improve the training mechanism of energy conservation managers, in particular the education and training of those in key energy-consuming enterprises; to further carry out the selecting activity of role modes of energy conservation, and reward the excellent institutions, enterprises, communities, schools and individuals for their energy conservation and carbon reduction throughout the whole city of Beijing.

## Section 2 A Case Study in Hebei Province

### 2.1 The current low-carbon development in Hebei province

Located in the southeast of the Northern China, enclosing Beijing and Tianjin with Bohai Sea to its east, Hebei Province is vast in territory and abundant in resources. It is not only a big province in economics, industries and energy consumption, but also the backyard garden for the development of the integration of

the Beijing-Tianjin-Hebei Region. In 2014, Hebei's GDP reached 2942.12 billion yuan, an increase of 6.5% compared with last year. Its per capita GDP was 40783.99 yuan, and its economic aggregate ranked the 6th in China. Meanwhile, Hebei is also a big energy-consumption province, with its total amount of energy consumption topping the list around the country.

During "the 11th Five-Year Plan", Hebei achieved the targets of energy conservation and carbon reduction on schedule, with energy consumption per unit of GDP decreased by 20%, chemical oxygen demand and sulfur dioxide emissions dropped by over 15% compared with 2005. During "the 12th Five-Year Plan", Hebei announced the overall targets for energy conservation and carbon reduction, that is, energy consumption of GDP worth 10000 yuan should be reduced by 18% compared with 2010, and 34.5% compared with 2005; chemical oxygen demand and total emissions of ammonia and nitrogen should be controlled within 1.255 million tons and 1.475 million tons respectively, a decrease of 12.7% and 13.9% respectively compared with 1.438 million tons and 1.713 million tons in 2010. In 2014, the energy consumption per unit GDP dropped by 7.19% compared with the previous year, exceeding the annual objective with 4.19 percentage point; the emissions of chemical oxygen demand, ammonia and nitrogen, sulfur dioxide and nitrogen dioxide reduced by 3.16%, 4.08%, 7.38% and 8.47% respectively, all exceeding the annual objectives. It is projected that the targets of energy conservation and carbon emissions reduction set forth in "the 12th Five-Year Plan" can be basically met.

Remarkable achievements have been accomplished in low-carbon development in Hebei province. First, the innovation level of low-carbon technology have been improved. Technology import and technology research and development have been promoted in some advanced manufacturing industries with their own characteristics and advantages such as manufacturing industries of new energy products and energy equipment, energy conservation technology industry, automobile and manufacturing industry, electronic information and new materials industries, which have broken the technology bottleneck. Second, low-carbon industrial system has been perfected. Industrial conversion has been promoted. Hebei province has upgraded its industrial structure according to the requirement of "developing a batch, transforming a batch and weeding out a batch" in the course of promoting industrial projects. Hi-tech industry has been cultivated. Hebei has identified eight key areas, including biological and chemical industry, electronic information, new materials, advanced manufacturing, advanced energy, environmental protection and comprehensive utilization of resources. It has also advanced the development of modern service industry, including the establishment of financing worth 200 million for attracting the development of culture industry, financing worth 100 million for rewarding its development, and financing worth 100 million for supporting the development of modern logistics industry. Meanwhile, policies to support low-carbon development have also been strengthened. Third, energy mix has been optimized. One the one hand, in fossil energy consumption, Hebei has resorted to industrial boiler and changed coal

to gas in heating boiler. It has also carried out the gratification engineering, namely, changing oil to gas in buses and taxis. On the other hand, it has been committed to the development of non-fossil energy, raising the proportion of new energies. Fourth, infrastructure in low-carbon cities has been improved. For example, Hebei has implemented "energy conservation Renovation Project for Buildings", and promoted "Urban Central Heating Project" and "Project of Popularization of Energy Conservation in the Rural Areas". At the same time, a batch of demonstration projects featuring a high level of green building have been advanced to carry out the construction of eco-cities. Fifth, a low-carbon life style has been in its initial shaping. Hebei, in this regard, has practiced "Transportation energy conservation Project" for citizens going out, carried out "Carbon Sequestration Project", and conducted "Low-carbon Community" demonstration activities. Sixth, carbon emissions intensity has been on the decrease. Seen from the energy intensity target of Hebei province, it shows that carbon emissions per unit GDP has been on the decrease in recent years. Major measures taken by Hebei province in low-carbon development:

### 2.1.1 Industrial structure adjustment

Industrial structure has been adjusted to accelerate low-carbon development and curb the trend of heavy economy for the optimization of the industrial structure. In recent years, Hebei has issued several policy documents such as *Rejuvenation Program of Service Industry in Hebei Province* (2006), *Special Plan for High-tech Industry During the 11th Five-Year Plan in Hebei Province* (2007), *Guidance on Accelerating the Construction of Modern Industry System in Hebei Province* (2009), *Implementation Program on Optimizing Environmental Development in 2012 by the Administrative Bureau for Industry and Commerce in Hebei Province* (2014), and *Notifications on Using Price Regulation to Promote Industrial Structure and Other Related Issues* (2014). It has put forward specific measures in promoting market evaluation, tax management, financial support and elements supply, etc. In order to push forward the upgrading of industrial structure. At the same time, some other regulations such as *Regulation of New Energy Development and Utilization in Hebei Province* (2009), *Energy Development Plans During the 12th Five-Year Plan in Hebei Province* (2009) and *Development Plans of New Energy Industries During the 12th Five-Year Plan in Hebei Province* (2010) have been introduced to optimize energy mix. Besides, 8 projects including solar energy, hydro-energy, wind power and biomass energy have been put into effect to quicken new energy development.

### 2.1.2 Reduction of energy consumption and carbon emissions

The *Decision by the Hebei Provincial Government on Strengthening Energy Conservation* (2006) calls for the elimination of backward production facilities, especially outdated facilities and products in energy-intensive industries such as steel, chemical, building materials, and power. The "Suggestions on Implementing a Stronger Reduction of Backward Production Facilities" (Hebei, 2010, No. 52) proposed specific tasks, responsibility distributions and supporting measures in washing out backward production facilities in the focused industries in 2010 and has

taken focused actions in this regard. Here are the major accomplishments made in the 12th Five-Year: Firstly, the system of rewards and penalties have been improved with an enhanced accountability system; Secondly, the development of key technologies and the relief of technical bottlenecks have been promoted to simultaneously decrease energy consumption and carbon emissions, and 500 energy conservation construction projects were implemented every year forming an energy conservation capacity equivalent to 3 million tons of coal equivalent; Thirdly, the "Double 30" demonstration project of energy conservation and emission reduction remained to be enforced, and the Thousand-enterprise Energy-conservation Project was implemented, emphasizing on key enterprises and industries to guarantee and strengthen current results; Fourthly, emission of greenhouse gases was under effective control, and a system of green gas emission monitoring has been established; Fifthly, pollutant emission has been considerably reduced, and control has been implemented on chemical oxygen demand and total emission of sulfur dioxide, ammonia nitrogen and nitrogen oxides to strictly limit environmental admittance; Sixthly, construction and promotion of low-carbon key projects, demonstration projects of circular economy, demonstration bases of recycling, and demonstration projects of low-carbon industry have been carried out.

### 2.1.3 Vigorous development of circular economy

Firstly, in the field of production, circular production has been practiced. The promotion and application of new technology and facilities that suit circular economy standards have been accelerated to achieve cleaner production. Meanwhile, national and provincial experimental units such as the Caofeidian Demonstration Zone and the circular economy demonstrative city of Handan have been paid special attention. Secondly, in the field of consumption, recycling has been practiced. To vigorously promote an environment-friendly, energy-conserving lifestyle and consumption style; to improve energy efficiency in buildings, lessened the use of disposables in the service industry, restrained excessive packaging and extravagant spending, and expanded the use of renewable, biodegradable packaging material to reduce waste. To strengthen the management and recycling of kitchen waste. Thirdly, to promote the industrialization of resource recycling. To enhance the renewable resources recovery system and the classified garbage recycling system, in order to decrease the quantity of garbage, as well as make it less harmful and more useful to the environment. In addition, to focus on the construction of the five "Urban Mining" demonstrative bases to experiment recycling and harmless treatment of urban waste materials.

### 2.1.4 Promotions in resource conservation and comprehensive utilization

To adhere to the core principle of improving resource efficiency, to strengthen the protection and intensive utilization of natural resources such as land, water and minerals. Firstly,to promote intensive and economical use of land resources. The most stringent land conservation system has been implemented, accountability strengthened, strict land use regulations enforced, and projects and annual plans firmly controlled. Also, to improve the market-oriented allocation of land resources, as well as the

standards of intensive and economical land use. Land investment intensity and productivity have been on the rise. Secondly, to further conserve water resources. Specific measures include implementation of the urban-rural unified water management system, reform of the water price, establishment of the regulatory system in water function zones, raising comprehensive high quality rate of water function zones in major lakes and rivers, promotion of rational utilization of surface water and the water-conserving irrigation techniques, all for the purpose of establishing a water-conservation society. Thirdly, to emphasize on rational exploitation of mineral resources, by mean of centralized mineral resource management and regulating exploitation, cracking down excessive exploitation and abandonment of unwanted exploited minerals. In this regard, mining and multipurpose utilization techniques featuring pathogenic ore, associated ore, tailings and low grade ore have been popularized to increase extraction and recovery ratio. Meanwhile, to carry out projects of land rehabilitation to recover subsidence areas and exhausted areas to preserve the environment of mines.

### 2.1.5 Emergency measures to control air pollution

Facing the worsening pollution in recent years, and in response to the "Ten Measures of Air Pollution Control" and "Measures of Air Pollution Control in the Beijing-Tianjin-Hebei Area" issued by the State Council, Hebei province has stepped up efforts to control air pollution. For example, Baoding, Hebei has carried out the "6S" project which implements the "6S" (Sort, Systematic Arrangement, Shine, Standardize, Sustain, Safety) management mode of modern enterprises into urban environmental protection. Baoding has developed the "Plan of the 6S Project of Urban Management in Baoding" and "Evaluation of the Environmental Renovation in Baoding". Moreover, it has mobilized all forces from government offices, institutions to enterprises and communities and the individual, generating passion, motivation and citizen consciousness in every citizen to work together in protecting the city's environment. Emphasis is laid on key communities, industries, enterprises and neighborhoods. In the meantime, to focus on the implementation of five critical tasks, which are: Central heating and gas supply through combined heat and power (CHP); intensified air pollution control; strengthened management of vehicle emission; technological transformation of enterprises and the advancement of technological innovation; improvement of energy mix, and increase in the supply and expansion of clean energy such as natural gas, liquefied petroleum gas, SNG, as well as solar and wind power, to gradually increase the proportion of clean energy utilization in cities.

### 2.1.6 Strengthening environmental protection

Encircling the overall objective of "Building a Green Screen in the Beijing and Tianjin Areas; Restoring the Beautiful Mountains in Hebei", Hebei has successively issued the *Regulations on Voluntary Forestation in Hebei*, *Regulations on Deforestation in Hebei*, *Directive Opinion on the Vigorous Development of Under-forest Economy*, *Administrative Measures on Forestation Project Funds (Trial)*, and the *12$^{th}$ Five-year Plan in Environmental Protection in Hebei Province*, aiming to

expand forestation and the forest carbon sink. Here are the main measures taken: Firstly, protection and construction of forest and grass vegetation have been reinforced. Key national afforestation projects and soil and water conservation projects have been implemented. On one hand, better measures are taken for forest entry prohibition and forest conservation; on the other hand, forestation is greatly encouraged to improve forest coverage. Secondly, efforts on natural ecosystem protection have been strengthened. Ecological function regionalization has been implemented, and space management concerning important ecological function areas such as the water resource conservation areas, soil and water conservation areas, drinking water resource conservation areas, nature conservation areas, the coastline, and wetlands. Thirdly, to implement projects of boiler improvement, of efficiency power plant construction, of desulfurization, denitrification and dust precipitation, of the construction and transformation of sewage treatment and refuse processing plants, of pollution control of toxic heavy metals, of the comprehensive utilization of solid waste, of environmental monitoring and of executive construction. All these projects contribute to the common goal of environmental protection. However, Hebei, as an important energy-consuming province, still faces great pressures. In 2013, the energy intensity per unit of GDP is equal to 1.573 tons of coal equivalent and ranks the 8$^{th}$ in 31 provinces nationwide, meaning that Hebei still faces double pressures in economic growth and low-carbon transition. In the 13$^{th}$ Five-year Plan, Hebei needs to strengthen its efforts in energy conservation and emission reduction with a special focus on industrial and energy mix optimization. Hebei needs to continuously improve innovation in low-carbon technologies, decrease carbon emissions, and adhere to a sustainable strategy in both economic and social development and environmental conservation.

## 2.2 SWOT analysis on the low-carbon development in Hebei province

The low-carbon development will not only bring Hebei province with opportunities and advantages but also challenges and disadvantages. I will make a SWOT analysis on its inner environment.

### 2.2.1 Opportunities and advantages of low-carbon development in Hebei province

**①. Advantageous geographical location**

Hebei province, the hinterland of China's third growth pole "economic circle formed by Beijng, Tianjin, Hebei and coastal areas around the Bohai sea", forms an well-known "golden triangle" with Beijing and Tianjin, which can effectively benefit from the development of Beijing and Tianjin.

**②. Coordinated development of Beijing, Tianjin and Hebei**

At present, the regional cooperation and governance among regions focus on municipalities and counties and the administrative bulwark between provinces hinders

the real regional cooperation. The central government locates the first national-level and trans-provincial cooperation and governance project to Beijing, Tianjin and Hebei, which no doubt will bring unprecedented opportunities to the coordinated development to the areas. For Hebei province, this strategy is a hard-won opportunity for adjusting industrial structure, optimizing industrial layout and transforming development mode and is significant for constructing a modern industrial system featuring green development, cycle development and low-carbon development.

**③. Resources endowment**

Hebei province is located between the northwest plateau and the North China plain and a place where cold temperature zone and warm temperature zone, meadow grassland and savanna are interlocked. Its diverse and abundant natural resources are the basis for improving energy mix, developing low-carbon economy and maintaining ecological environment.

**④. Solid foundation of early development**

To alleviate the contradiction between economic development and environmental protection, promote the low-carbon and green development of social economies and strive for building an energy conservation and environmental friendly society, Hebei province has actively boost energy conservation and emission reduction, vigorously developed circular economies and constantly made breakthroughs since the implementation of "Double Thirty" engineering in 2007. Baoding municipality in Hebei province was the first "low-carbon project city" designated jointly by the Ministry of Housing and WWF in 2008 and was listed on the first bunch of low-carbon pilot provinces by the National Development and Reform Commission in 2010. The Caofeidian international eco-city, with "ecological science and development" and "innovation" as the main concept, has became one of the four-type low-carbon ecological cities in the world. In the aspect of low-carbon development, Baoding has made fruitful results in terms of developing low-carbon industries, consumption, construction, traffic and ecological carbon sink and accumulated precious practical experiences and results.

### 2.2.2 Threats and challenges facing Hebei province

**①. Severe air pollution**

Hebei province belongs to the Beijing-Tianjin-Hebei area which is heavily stricken by haze. On the list of the monthly "Top 10 polluted cities" issued by the Ministry of Environmental Protection in 2013 and 2014, the proportion of polluted cites in Hebei province exceeds 50% with 5 to 7 cities on the list every month. The industrial structure in Hebei province is unreasonable. The "high pollution, high emission" industries such as steel and iron, construction materials, petrochemical industries and electric power are centralized, among which the output of iron and crude steel is over 1/4 of the national output. The energy mix is unreasonable either. The energy consumption ranks second nationally with per unit GDP 60% higher than

the national level.

Table 6-3 list of the monthly “Top 10 polluted cities”

| Month | Ranking of the top ten polluted cities | Proportion of Hebei province |
|---|---|---|
| 1 | Xingtai, Shijiazhuang, Baoding, Handan, Langfang, Hengshui, Jinan, Tangshang, Beijing, Zhengzhou | 70% |
| 5 | Shijiazhuang, Tangshang, Xingtai, Handan, Jinan, Baoding, Zhengzhou, Beijing, Hengshui, Tianjin | 60% |
| 6 | Tangshang, Shijiazhuang, Xingtai, Handan, Baoding, Hengshui, Jinan, Tianjin, Zhengzhou, Taiyuan | 60% |
| 7 | Tangshan, Handan, Shijiazhuang, Jinan, Xingtai, Tianjin, Baoding, Lanzhou, Zhengzhou, Henshui | 50% |
| 8 | Xingtai, Tangshan, Shijiazhuang, Jinan, Handan, Tianjin, Hengshui, Xi’an, | 70% |
| 9 | Xingtai, Shijiazhuang, Tangshan, Handan, Jinan, Hengshui, Baoding, Langfang, Tianjin, Xi’an | 70% |
| 10 | Shijiazhuang, Xingtai, Baoding, Handan, Tangshan, Jinan, Harbin, Hengshui, Xi’an, Wuhan | 60% |
| 11 | Shijiazhaung, Baoding, Xingtai, Tangshang, Handan, Jinan, Taiyuan, Langfang, Urumchi, Hengshui | 70% |

(Resources are from the website of the Ministry of Environmental Protection of People’s Republic of China)

In January 2014, People’s Daily issued through its official Weibo a list of the PM2.5 rankings of 74 cities around China issued by Greenpeace in 2013, what makes us surprised is that the first six cities are all from Hebei province, and 7 cities are from Hebei province in the top 10. The serious air pollution is closely connected to people’ health and livelihood, therefore, the arduous task to solve this problem is high on the agenda of Hebei province.

Table 6-4 Rank of PM2.5 among the Top 10 polluted cities around China in 2013

| Rank | Name of the city | Annual concentration of PM2.5 (micrograms per cubic meter) | Daily concentration of PM2.5 (micrograms per cubic meter) |
|---|---|---|---|
| 1 | Xingtai | 155.2 | 688 |
| 2 | Shijiazhuang | 148.5 | 676 |
| 3 | Baoding | 127.9 | 675 |
| 4 | Handan | 127.8 | 662 |
| 5 | Hengshui | 120.6 | 712 |
| 6 | Tangshan | 114.2 | 497 |
| 7 | Jinan | 114 | 490 |
| 8 | Langfang | 113.8 | 772 |

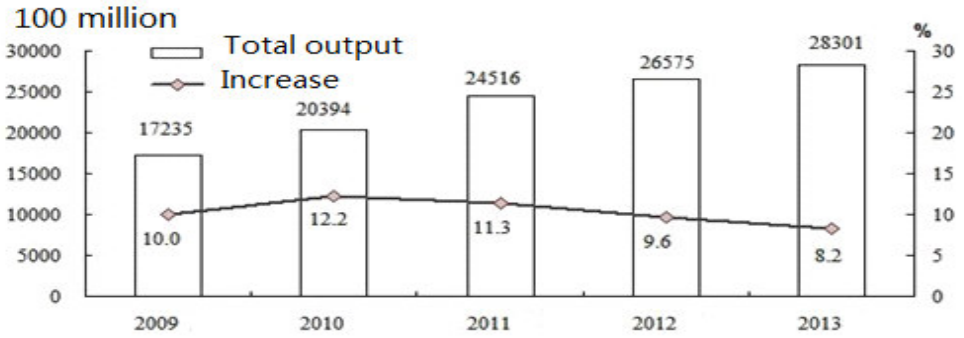
| | | | |
|---|---|---|---|
| 9 | Xi'an | 104.2 | 598 |
| 10 | Zhengzhou | 102.4 | 422 |

(Resources are from the statistics issued by Greenpeace on January 10, 2014)

**②. Heavy development task**

First, the economic growth in Hebei province is getting slow and slightly decreasing. In terms of development speed, the overall economic growth in Hebei province has continuously decreased since 2010, as listed below:

Figure 1 2009—2013 total output and growth rate




The resources listed in table 6-5 are from the public report on the national economy and social development of Hebei province in 2013.

Table 6-5 comparison of main indexes between Hebei, Beijing, Tianjin and the annual national level

| | Per capita of GDP (10000 yuan) | annual public finance (yuan) | Income of rural and urban residents | | Urbanization rate |
|---|---|---|---|---|---|
| | | | urban per capita disposable income (yuan) | Rural per capita net income (yuan) | |
| National level | 3.84 | 8656 | 24565 | 7917 | 52.6 |
| Beijing | 8.71 | 16019 | 36469 | 16476 | 86.2 |
| Tianjin | 9.12 | 12455 | 29626 | 13571 | 62.1 |
| Hebei | 3.65 | 4774 | 20543 | 8081 | 46.8 |

(resources are from the statistics of national economy and social development of China, Beijing, Tianjin and Baoding in Hebei province in 2012)

Second, Hebei is an underdeveloped province around the capital. Statistics in 2012 shows that the per capita of GDP in Hebei province is 95.1% of the national level, 41.9% of Beijing and 40% of Tianjin; Hebei is 55.2% of the national level, 29.8% of Beijing and 38.3% of Tianjin in terms of annual public finance; it is 83.6% of the national level, 56.3% of Beijing and 69.3% of Tianjin in terms of urban per capita disposable income; it is 102.1% of the national level, 49% of Beijing and

59.5% of Tianjin in terms of rural per capita net income; and it is 9.8% lower than the national level, 39.4% lower than Beijing and 15.3% lower than Tianjin in terms of urbanization rate.

Because of the low economic and social development, Hebei faces a big challenge to accelerate its economic development, improve the income for rural and urban residents, increase public finance and boost urbanization.

**③. Difficult restructuring**

Although the new energy is in use in Hebei province, its industrial restructuring is still sluggish. Over the past few years, the proportion of the tertiary industry added value in the GDP is lower than the expected goal; the proportion of heavy industry in industry continues to increase; the number of high energy consumption and high emission industries increases rapidly; and the extensive traditional industry is still not fundamentally changed. At present, the industrial coal consumption in industries like printing, machine manufacturing, paper making, construction materials, casting and chemical engineering is large. Besides, manufacturing low-carbon products does not contribute to its industrial low-carbonization. Hebei benefits from its low-carbon products, it produces products such as solar power equipment, wind power equipment, energy storage equipment and energy-saving lamps and has formed a complete industrial chain, which makes it a manufacturing base for new energy and energy equipment in north of China. However, the new-energy and energy equipment manufacturing consumes a large amount energy and generates pollution during the process of making clean energy product and energy-conserving products, such as the wire production of Tianwei Group and the fine silicon of Yinli Group. Those two Groups consumes a large amount of energy during production and have become the biggest emitters of volatile organic compounds. The most family analogy to this phenomenon is “provide consumers with low-carbon products, keep high-carbon with itself”.

**④. Weak independent innovation**

Although Hebei has made some achievements in low-carbon technology, it’s still weak in independent innovation, which is shown in the following two aspects: on one hand, the research and development of low-carbon technology has domestic structural differences. Hebei has advanced technologies in manufacturing clean energy equipment using solar power and wind power which supports the new energy and energy equipment manufacturing base, but its research and development and application in reducing automobile exhaust emissions, saving energy in construction, elevator and household appliance are obvious behind Shenzhen, Shanghai and Hangzhou. For example, as a base for manufacturing automobiles, Baoding is backward in terms of developing and applying exhaust emission reduction technology, which is bad for the long-term development of automobile manufacturing. On the other hand, its research and development in low-carbon technology falls behind the international level. Compared with the developed countries internationally, there is a

great gap both in energy development, supply, conversion, transmission, and disposition and in technical field such as industrial production and terminal consumption, which are the reasons that the energy efficiency in Hebei is lower than that of developed countries. Hebei is in a stage of large scale infrastructure construction in field of traffic and construction, therefore, its use of low-efficiency technology will result in technology lock-in effect that may last for a long time, which brings huge pressure on low energy consumption and carbon emission reduction.

**⑤. Imperfect regional coordination mechanism**

First, there is not a long-term and coefficient security mechanism for low-carbon development. The reason is that the policy and mechanism is imperfect. The imperfect economic policy in terms of price, tax and finance which are conducive to energy conservation and emission reduction and the imperfect mechanism of encouragement and constraints based on the market lead to the lack of motivation for innovation and emission reduction in enterprises. Because China still does not levy a tax on pollution (carbon emission tax), popularize and standardize carbon trading mechanism, form a uniform and standard environment compensation system, Hebei is still in an earlier stage of using fiscal and financial policy tools to support low-carbon growth field. Its imperfect law system and insufficient use of economic techniques hinders the establishment of a long-term and coefficient security mechanism of low-carbon development. Second, the carbon emission control between regions is uncoordinated. There are conflicts in the coordination of low-carbon development between municipalities in Hebei province. A lot of regions are still in a state of high energy consumption and high-carbon emission. Third, there is a lack of close cooperation mechanism between regions. Affected by the pursuit of "Each administers in his own way", Beijing, Tianjin and Hebei have their own interest goals in terms of low-carbon development and pollution control and lack close cooperation, which is not conducive to the governance and control of carbon emission and air pollution, thus making Hebei province suffers from heavily polluted air even though it has a relatively low energy and carbon emission intensity.

## 2.3 The 13th low-carbon development goal

The GRP in Hebei province reaches to 2830.14 billion with per capita GDP of 38651.39 in 2013. The total energy consumption stands at 361.732 thousand tons coal equivalent with per unit GDP energy consumption stands at 1.573 tons stand coal per 10000 yuan. Therefore, we can see that Hebei is under huge pressure of carbon emission.

According to the national carbon emission goal and combing the its actual conditions, Hebei has set the low-carbon development goals, as listed below.

**①. Improve energy utilization efficiency and largely decrease the intensity of greenhouse gas emissions.**

By the end of 2020, it will reduce the energy consumption and carbon emission per unit GDP by 55% from the 2005 level, among which 45% by the end of 2016, 50% by the end of 2018 and 55% by the end of 2020.

**②. Optimize energy consumption structure and actively develop new energy**

It will vigorously develop new energy, continue to optimize energy mix and try to increase the proportion of clean energy. It will reduce the proportion of coal in the primary energy consumption to under 75% and that of the non-fossil energy to 10%.

**③. Vigorously implement tree planting and forestation**

It will increase the forest area and stock volume by 25,37 thousand mu and 0.026 billion cubic meters respectively by the end of 2020 from the 2010 level, forest coverage rate to 35% and forest stock volume to over 0.17 billion cubic meters.

**④. Reinforce water resources optimization**

It will reinforce farmland water-conservation construction and actively implement the seed project. It will increase the effective irrigation area to 85 million mu and irrigation water utilization coefficient to over 0.70 and decrease the added water consumption in industry by 50% from the 2010 level by the end of 2020.

**⑤. Perfect the laws, regulations and standards for energy conservation**

It will establish a perfect policy system for low-carbon development, low-carbon industry, low-carbon technology support, low-carbon clean energy and statistical accounting of low-carbon emission. With the low-carbon concept deep in people's mind, people will form a low-carbon life style.

## 2.4 Implementation mechanism and concrete measures of "13th Five Year Plan" low-carbon development in Hebei province

### 2.4.1 .1mplementation mechanism

**①. Establish compound mechanisms with government guidance, market driving and public participation.**

Low-carbon development is a systematic project involving a wide range of social benefits, which must rely on the common efforts of the government, the market and the society. Consequently, we need to establish a set of compound mechanisms with government guidance, market driving and public participation. In the mechanisms, the government holds a dominant position, responsible for drawing up low-carbon development plans and strategies, enhancing the laws and regulations on low-carbon development and providing low-carbon development policy systems. And the market works as a driving force, responsible for forming competition mechanism, price mechanism and financing mechanism which are conducive to low-carbon development to promote the optimization and development of low-carbon trading

market; besides, we need to improve public participation mechanism and promote low-carbon development through motivating the enthusiasm of public participation by promotion and activities.

**②. Perfect the responsibility mechanisms of low-carbon target implementation in Hebei**

The realization of low-carbon target of Hebei depends on the joint efforts of governments in all levels, the society and enterprises. Therefore, it is great significance to establish responsibility decomposition mechanism of low-carbon target. We need to decompose the low-carbon target responsibility into all regions, units and individuals and establish an accountability system. In the meanwhile, all the regions and units need to strengthen the promotion of low-carbon development and implement low-carbon responsibility in the process of production and life. First, we need to improve the awareness to the importance of low-carbon development of governments, especially the grass-root governments, transform economic and social development ideas and bring government actions into low-carbon development. Second, we need to improve the awareness to the importance of low-carbon development of departments of high-carbon emission and change their attitude and behavior. Third, we need to improve public's awareness to the importance of low-carbon development and change their attitude and behavior. Low-carbon development is a behavior related to people's daily life. Only when the whole society reach consensus on low-carbon development and internalize it in their actions and daily lives, can low-carbon development thrive and endow lasting vitality. Therefore, we need to carry out the national action of energy conservation and emission reduction in a deep-going way and pay attention to all the sections including family communities, the youth, enterprises, schools, military barracks, the rural, government agencies, science and technology, science popularization and media, giving full play to departments of radio, film and television, the departments of culture and education, the news media and related social communities, strengthening daily promotion and public supervision, advocating civilized, thrifty, green, low-carbon production mode and consumption patterns, actively creating a good social atmosphere of energy conservation and emission reduction to make low-carbon development become social consensus and form resultant forces of low-carbon development.

**③. Advance multi-channel input mechanisms of low-carbon development**

Adequate funds are the prerequisite to the realization of low-carbon development. To realize low-carbon development, we need to establish multi-level and multi-channel financing mechanisms, among which the public financing mechanism is an important guarantee for low-carbon development. Hebei province does valid exploration on private fund investing on low-carbon development with guidance of utilizing financial fund, for a long time in the future, financial investment and financial subsidies will become important leverages levering huge injection of funds and promoting low-carbon development. To do this, we need to strengthen our support in public investment budget, special funds for energy conservation and

emission reduction to key projects and capacity building, and continue to arrange the state-owned capital budget expenditures to support enterprises to implement energy conservation projects. We should perfect the mechanism of “reward replace subsidy” and “promote governance, promote high-coefficient energy-saving products and contract energy management by means of financial subsidies and strengthen the guiding function of financial funds. While bringing financial investment into full play, we also need to exert the decisive action of the market and financing function of multi-level capital market and lead commercial financial institutions, corporate entities and social funds to join in energy conservation activities to provide an adequate fund guarantee for the low-carbon development in Hebei.

**④. Improve "Trinity" policy support system of low-carbon development**

We need to promote low-carbon development by price policy, fiscal and taxation policy and financial policy. First, in terms of price policy, we need to deepen the price reform for resource products, straighten out the price relations between resource products, such as coal, electricity, oil, gas, water and mineral, and build price forming mechanism fully reflecting the supply and demand of market, resource scarcity level and the cost of environmental damage. Second, in terms of financial policy, in addition to the means of financial investment and financial subsidies, we need to advance government procurement policy of low-carbon and energy-saving products, enlarge government procurement scope of environmental labeling products and promote the constant improvement of government procurement system on energy-saving and environmental protection services. We especially need to suppress extensive management by taxation and promote the function of low-carbon development. We could encourage the development and consumption behavior of energy-saving and low-carbon industry through implementing taxation preference policy of energy-saving and emission reduction supporting by the state, change the situation of low tax burden on resource products by accelerating resource tax reform, promote energy consumption through the improvement of the consumption tax and the fuel tax, and properly begin collecting carbon tax, narrow the production cost gap between low-carbon industry and high energy consumption industry and promote the low-carbon industrial development by accelerating legislation of environmental protection tax. Third, in terms of financial policy, we need to encourage innovation in financial product and service, establish corporate energy conservation and environment protection level rating, corporate credit rating and loan linkage mechanism, embed the low-carbon green index into credit and loan index comprehensive evaluation system, enhance the weight of low-carbon green index in evaluation system and actively improve and refine financial service in the field of energy conservation and environmental protection. In the meanwhile, we should encourage enterprises to actively participate in the emission permits trade of carbon and promote the development of low-carbon industry by financial market of carbon trade.

**⑤. Improve long-term system safeguard mechanisms of low-carbon**

**development.**

The safeguard mechanisms are as follows. First, for pollution emission behavior, we must charge from the current administrative management mode of collecting pollution fee to legal safeguard of levying environment protection taxes according to the principle of "The one who pollutes ecological environment pays".

Second, we should enhance damage and compensation system, ecological restoration system and accountability system according to the principle of "The one who destroys ecological environment repairs"

Third, we should advance ecological compensation mechanism on key ecological function areas and promote regional horizontal ecological compensation system according to the principle of "The one who benefits compensates".

Fourth, we need to strengthen low-carbon development supervision and regulation system construction.

**⑥. Improve regional cooperation mechanisms of low-carbon development**

First, take good governance as guidance on the level of value. We should devote to forming a governance pattern of multi-entities within the region, weave an interactive and cooperative governance network, strengthen initiative and inner-drive on policy coordination, establish a good partnership based on cooperative attitude, coordinating consciousness and win-win spirit, set up the goal of collective action and form a common vision plan and development strategy, to reach the consensus of the joint governance of Beijing-Tianjin-Hebei region.

Second, take diversified network regional cooperation mechanisms as carrier on organization structure. The establishment of the organization first requires authority, overall awareness and corresponding political status that could effectively exercise the power of the overall coordination. Then, we need to reform from temporary organization to institutional organization, establishing consultation system of significant matters, regular communication system, cooperation system of administration projects and regional convention system as soon as possible. Last, we need to bring multi-entities into the decision-making system.

Third, take the systems of coordination integration, information communication and laws and regulations as guarantee in terms of implementation mechanism. First, we need to resolve inner-region conflicts through effective coordinating mechanism, coordinate the relationship of interests, enhance confidence in each other and take joint action on the basis of consensus. Then, we need to perfect laws and regulations system to form anti-local protectionism rules, concerted action rules of local governments and the overall advancement rules of social governance. At the same, we need to reinforce top-level design, enact and revise relevant laws and regulations then further improve information communication mechanism. In addition to regular

communication and coordination, dialogue and negotiations, we could consider relying on the technology to establish overall inner-region information monitoring system and information sharing system.

**⑦. Establish and improve the mechanism of low-carbon evaluation development**

Evaluation is an important baton with significant orientation function. If we want to integrate the low-carbon development into the evaluation mechanism, we should bring energy consumption, carbon emission and other indexes into cadre evaluation system, further improve the systems of energy conservation and emission reduction statistics, monitoring and evaluation, enhance the early warning mechanism of energy conservation and emission reduction and establish and improve the evaluation system of energy conservation and emission reduction of all industries under the premise of comprehensive consideration of the economic development level, industrial structure, energy conservation potential, environment capacity, industrial layout and other factors .We should implement the system of rewards and penalties, taking evaluation results as an important part of comprehensive evaluation of leading group and leading cadres and bring it into government performance management. With regard to exploitation-restricted regions and the ecologically fragile key counties for national poverty alleviation and development work, we should emphatically assess their situation of energy conservation and emission reduction and abolish the evaluation of their GDP. At the same time, we should give full play to the supervisory role of the news media and the entire society and promote the relevant units to implement target responsibility of energy conservation and emission reduction relying on public opinion and social supervision.

### 2.4.2 Concrete measures

**①. Form a phased development path about Hebei province undertaking Beijing industrial transformation**

The difference between Hebei and other areas is that it assumes the responsibility for Beijing's transformation in industry, urban function and service and population and so on. The major cause of serious environmental pollution in Hebei province is that it undertakes the heavy industry transformation from Beijing. This development mode can be called "gray City + Black Industry" which needs to be transformed to "Green City + Green Industry". There are three specific measures to do this: First, the Green Industrial Movement, which means that we need to systematically analyze and integrate traditional industries, actively bring in funds, talents, technologies and other scarce resources based on the principle of complementary advantages, funds, talents, technologies and other scarce resources, vigorously cultivate factor markets and promote the development of the Green Industrial Movement by optimizing Beijing's industrial transformation function and the current industrial system of Hebei province. Second, the Green City Movement, which means that we need to vigorously strengthen the low-carbon innovation and application, make great efforts in

low-carbon city, low-carbon life and low-carbon community, strengthen efforts in promoting low-carbon and green life to form a low-carbon development system centered on the Green City. Third, by improving the independent innovation capability and applying the Metropolitan circle of Beijing, Tianjin and Hebei, we can improve industrial competitiveness, cultivate core competitive advantages, and finally form a green industrial pattern and green city driven by low-carbon and "Green".

**②. Adjust and optimize industrial structure in line with the requirement of low-carbon development**

First, we should curb the growth of high energy consumption and high emission industries. We should rationally control the development scale of key industries, such as electricity, steel, cement, paper making, printing, take indexes of energy consumption intensity, total energy consumption, contaminated emission intensity and total contaminated emissions as the important basis for evaluating energy and approving environment, control major emission intensity and total emission in electricity, steel, paper, printing field, follow the strict energy and environment evaluation standards in undertaking the removal and reconstruction of the capital and industrial transfer and strictly forbid the transfer of serious contaminated industrials and backward production capacity to Hebei province without the process of energy conservation and reducing emission.

Second, continue to eliminate backward production capacity. According to national regulations and specific requirements on eliminating backward industries such as steel, cement, paper making proposed by Hebei province, we should continue to formulate an annual implementation plan on eliminating backward production capacity and carry it out step by step. First of all, we should improve the backward production capacity withdrawal mechanism and strengthen the enforcement of eliminating backward production capacity to reject Black GDP and Black profits, earnestly protect people's living environment, maintain the law enforcement means for residential health, resolutely eliminate backward production capacity, high energy consumption and high contaminated enterprises and punish those areas and enterprises who fail to fulfill the tasks of elimination according to the law. Second, we should start from the small enterprises governing high energy consumption and high emission and giant polluters to introduce the merge and acquisitions of enterprises, improve industrial concentration and enterprises scale level, enhance their level of energy conservation and form a development mode featuring high efficiency, circular utilization and intensive use of resources.

Third, promote upgrading and optimization of traditional industries. We should use high technology and advanced applicable technologies to transform and upgrade traditional industries, accelerate the deep integration of informatization and industrialization and promote enterprises' energy conservation and emission, which are the objective requirements for realizing low-carbon development and the important tasks facing Hebei province. First of all, we should strengthen our efforts in

technological transformation, focus on key projects that will play an important role in promoting industrial upgrading and support heavy contaminated enterprises to achieve the industrial upgrading goal of energy conservation and emission by transformation. Second, in the process of improving the environmental performance of energy-saving products, we should build a low-carbon green brand. During the development of new energy and energy equipment manufacturing, energy-saving products manufacturing and other low-carbon industries, we should focus on low-carbonization in industries themselves while processing low-carbon products and cultivate enterprises which possess independent innovation capability and core competitiveness in line with requirements of energy conservation and environmental protection.

Fourth, promote the development of service industries and strategic emerging industries. Combined with Hebei province regional characteristics and resources endowment, we must accelerate the development of producer services and consumer services, speed up the development of tourism, cultural and creative industries, finance and insurance, retirement and leisure industry as well as education, science and technology and healthcare, and vigorously improve the added value proportion of modern service industry in regional gross production. Hebei rovince must continue to consolidate and develop new energy and energy equipment industry, promote energy-saving environmental protection, information technology, biotechnology, new materials and new energy vehicles and other strategic emerging industries and continue to improve the proportion of strategic emerging industry in the regional gross production.

**③. Adjust energy consumption structure and improve energy efficiency**

First, adjust and optimize the energy consumption structure. On the one hand, Hebei should improve the application of solar power, wind energy, geothermal energy, and biomass energy to develop and use renewable energy. Through the continuous improvement of non-fossil proportion of clean energy in energy consumption, we can reduce disposable fossil energy, especially for fuel dependence on coal consumption and reduce the whole city's coal-fired consumption. On the other hand, strict measures must be made and implemented to desulphurization, denitrification, dust removal and smoke removal. By using these technologies and equipment, the emission of coal-fired unit consumption can be reduced and the alternative transformation into clean energy of the coal-fired heating boilers among all 35 and below steam tons per hour will be achieved. In addition, we also need to reform and improve the fuel quality, and change the fuel standard of China Ⅲ Stage into China Ⅴ Stage to reduce unit fuel consumption contaminated emissions.

Second, comprehensively promote energy-saving projects. We should focus on strengthening the industrial energy efficiency, enhancing energy conservation in construction, promoting energy-coefficient transportation, implementing public sector energy efficiency, strengthening commercial and residential energy conservation,

promoting agricultural and rural energy conservation to comprehensively promote energy conservation projects in Hebei province, therefore, emissions can be reduced by reducing energy consumption in each area. The important matter for Hebei is to promote and popularize the application of energy-saving equipment to reduce industrial energy consumption. Therefore, through the energy contract management, energy consumption can be solved, which is caused by the shortness of finance and lack of self-improve capacity. Through the promotion and popularization of energy-saving elevator, lamps, appliances, cars, architecture materials and so on, we can promote energy conservation in architecture, transportation, public institutions, commercial and civilian activities, agriculture and rural areas.

Third, promote research and application in energy-saving technology. Energy conservation is the most direct manifestation of improving energy efficiency, and it is an effective way to reduce energy consumption per unit GDP. We should promote energy-saving technology research and applications of energy-saving technologies and products. It is beneficial to realize energy conservation and improve energy efficiency. According to actual needs of low-carbon development, Hebei should emphasizes in promoting new energy technology products, energy-saving lighting technology, cogeneration technology, coal desulphurization and denitrification technology, metering residential building heating and energy-saving technology, wall materials innovation technology, Agricultural machinery energy-saving technology, biogas technology in rural areas, rural coal stove energy-saving technology, automotive technology, charging stations and other facilities, research and development and application of intelligent transportation technology. In economic and social life, we should accelerate the promotion and popularization of application of those energy-saving technologies, energy conservation equipment, energy-saving products.

**④. Improve green vegetation coverage and low-carbon sink capability**

First, accelerate forestation and improve forest coverage rate. Forest is the foundation and material guarantee for the urban landscape and the biggest Carbon Storage and Carbon-absorbing Device on the continent. (each cubic meter of forest will absorb 1.83 tons of $CO_2$ on annual and release 1.62 tons of $O_2$. The current forest reservation of Hebei province is much lower than the national and provincial per capita forest stock stock volume (national per capita is 10 cubic meter). In order to improve forest carbon sequestration capacity, Hebei province must clear forest planning objectives and accelerate forestation. By 2015, the provincial forest coverage rate should be more than 25%. By 2020, the provincial forest coverage rate should be more than 30%. By 2035, the provincial forest coverage rate should be more than 35%. And by 2050, the provincial forest coverage rate should be more than 40%, and the reservation of forest resources and storage of forest will be increased drastically.

Second, enlarge urban green area and improve green coverage rate. Urban green area also has a good function in absorbing carbon and carbon sinks. Currently, urban

green coverage rate is much lower in Hebei province, which cannot meet the demands of low-carbon development. In order to dig the potentials in carbon absorption and carbon sinks in urban green areas, Hebei province must have good plan in city design and green construction to meet the actual need of its development. First, we must increase the water-saving green area within the city, build and protect the variety of parks, leisure green land and improve urban green rate and green coverage rate. Second, we must formulate regulations on urban residential green standards, encourage residents to improve green construction, advocate the implementation of housing green and indoor green plan and fully exploit all available green space. Third, we should plant trees on both sides of the highway, railway and roads within the city. Fourth, during the process of promoting construction of urban "Five Lakes and Ten Galleries" water system, we should increase the green area along the water.

Third, create institutional mechanisms to improve the initiatives of residents to plant trees. We should establish incentives driven by government and market profitability to accelerate forestation. First, we should deepen the reform of forest classification management, adopt different management mechanisms, operation mechanisms and policy measures to public forests and commercial forests. Second, we should deepen the reform of forest right system, protect property rights of forest owners according to the law, and safeguard their legitimate rights and interests. In timber harvesting management, we should strengthen the protection on natural forest and ecological public forest, control logging, and loose management on the commercial forest harvesting. Without changing the premise of forest use, we should allow operators to log, utilize, transfer and inherit forest independently according to the provisions. Third, we should create a fair competition environment for all kinds of main forestry constructors, encourage and support a variety of public investment in forestry development and form a multi-agent, multi-level and multi-form forestation pattern.

**⑤. Promote the innovation of low-carbon technology and form the low-carbon industry cluster advantages**

First, construct a low-carbon production mode for enterprises, including low-carbonization in terms of product development, raw materials procurement, product production, production transportation, and product marketing. First is the low-carbonization in research and development stage. During the research and development period, enterprises should actively introduce the concept of low-carbon concept and technologies and implement low-carbon environmental protection concept throughout the research and development process. Second is the low-carbonization in raw material procurement. Enterprises in procurement should select low-carbon raw materials as much as possible to reduce energy consumption and emissions. Third is the low-carbonization during production process. In the production process, we should use advanced equipment and production technique featuring low energy consumption, low emission and high efficiency. At the same time, we should also focus on optimizing the production process, and improve the

ecological performance of the production process. Fourth is the low-carbonization in product transportation and sales. Low-carbon transportation requires enterprises to simplify packaging and use biodegradable and recycled packaging. And enterprises should adopt transportation equipment featuring low energy consumption and low emission. Fifth is the low-carbonization in consumption process. Low-carbon products developed by enterprises should be highly coefficient and energy-saving.

Second, enhance innovation and develop low-carbon technologies and products. Innovation is the key to enterprise development. Development of new energy industries rely on the government and also their own independent innovation. Only when enterprises are innovative enough can they continue to promote new energy development. Independent innovation is the basis for enterprise development, it should include three aspects: First, the enterprise management mode should be innovative. Because enterprises are different from each other, they should develop their own development mode according to their own conditions instead of copying from other enterprises. What they should do is to create their own mode on the basis of the successful cases. Second, technology should be innovative. Development of new energy industries must rely on technology innovation, and technological innovation is the key to the continuous improvement of energy efficiency. Moreover, the development of new energy industry is developed on the basis of technical innovation. Therefore, the company's continuous innovation is the foundation of the new energy industrial development. Third, we should strengthen and improve the cooperation mechanism of industries, schools and research in enterprises, promote the direct information exchanges between R&D department and production, encourage universities, research institutions to work together with enterprises to jointly promote technological innovation, provide enough personnel to enhance the technological innovation capability of enterprises for the sustainable development. Moreover, we should strengthen the regional cooperation and build up enterprise strategic alliance. Low-carbon economy is an emerging economic growth, but it does not mean that large-scale industrial clusters and companies will achieve this growth. Hebei province itself couldn't achieve this target, it has to develop with Beijing and Tianjin coordinately.

Third, strengthen the financial system in enterprise low-carbon technology. It mainly includes the following aspects: First, establish and improve the bank-dominated "low-carbon indirect financing" system. It requires governments to establish sustainable supporting policies and incentives to low-carbon indirect financing. Through tax relief, financial discount and other fiscal policy measures, we can reduce bank risk of running low-carbon credit and mobilize bank enthusiasm in promoting low-carbon credit. Non-commercial banks should be a pilot in supporting low-carbon industries by providing long-term stability credit and related financial services to low-carbon projects, providing basic financial support for the development of low-carbon industries, and reducing their financial risks, so as to induce commercial banks to follow interaction. Second, accelerate the construction of

“low-carbon capital markets”. On the one hand, we should establish market evaluation system on supervising domestic enterprises running into the low-carbon green functioning capital market, issuance and allotment system, environmental information disclosure system and low-carbon capital market exit system. On the other hand, we should accelerate the formation and development of low-carbon listed companies in capital market, further expand the quantity and financing scale of low-carbon enterprises in capital market, and effectively balance regional differences in the distribution of low-carbon listed companies. And at the same time, we should purify the Green Capital Markets investment environment, establish a set of delisting criteria and acquisitions delisting standards to poor and low-carbon enterprises so as to reduce the related investors’ losses, control the overall market risk, maintain the quantum balance and make low-carbon capital market operate security and stably. Third, we should take advantage of the international market cooperation to promote industrial upgrading, technological progress and economic development, actively join the low-carbon industries and international cooperation in financial field, take advantage of international capital markets to strengthen funding into low-carbon industries, which is an important part of low-carbon industry financial supporting systems. Fourth, we should vigorously develop carbon financial trading products. The product is the carrier of the interactive development of low-carbon finance, and financial institutions must use products to achieve financial functions. With the rapid expansion of the global carbon trading market scale, carbon emissions have derivative financial assets with liquidity and investment value, which has become an important financial innovation in financial sectors in recent years. Besides actively exploring the domestic carbon trading market, we should establish featured carbon financial products market. We should vigorously develop and create carbon financial trading products, including future products, option products, future products, swaps and other financial derivatives products. By strengthening the nurture and development of China's carbon emissions trading market, accelerating the development of various types of carbon financial products, improving carbon financial products system, we can realize the jointly development of low-carbon industry and low-carbon finance.

Fourth, establish and improve personnel policies in enterprise support low-carbon technology innovation. Talent is the key factor in the development of high-tech industries. In the process of new energy industrial development, enterprises should fully recognize the important role of technical personnel in the enterprises development, encourage internal staff to continuously upgrade their self-improvement so as to provide a platform for employees to enhance their abilities. Meanwhile it is important to focus on the introduction of talent, improve employment mechanisms and put hi-tech personnel in an important position, which can provide an inexhaustible motive force for the sustainable development of enterprises. First, we should strengthen cooperation with universals and enterprises and train technical personnel according to the actual need of enterprises. Located at Beijing, Tianjin and Hebei area, Hebei is surrounded by a large number of colleges and universities. The low-carbon enterprises can take advantage of this favorable condition to cooperate

with colleges and universities and train professionals according to enterprises' demands or conduct regular training to meet the different demands from different levels talent. Second, we should actively attract talent and cooperate with research institutes. In the work of introduction of talent, not only should enterprises make great efforts but the relevant government departments should offer necessary support. Enterprises can provide employees with a variety of learning and innovation platforms and create a small internal working environment for highly skilled professionals. Government departments need to develop appropriate human resources work system and appropriate personnel policies, which provide convenient conditions for the introduction of talent and supply the external environment for enterprises to retain talent.

**⑥. Strengthen regional cooperation and implement joint prevention and control**

According to the principle of "co-ordination promotion, joint prevention and control, complementary advantages, win-win cooperation", we should jointly establish regional cooperative mechanisms of low-carbon development with Beijing and Tianjin to realize the implementation of regional cooperation.

First, in terms of ecological compensation mechanism, we should promote the establishment of ecological compensation mechanism and actively seek national financial and policy support on joint prevention and control project, which should be around Beijing and Tianjin in atmospheric environment, water environment and ecological protection and other construction. We should Jointly promote the control of sandstorm source and ecological construction of "Three North" Shelterbelt, which are Northwest China, North China and Northeast China, and planting of Yanshan Mountain and Taihang Mountain. And we should strive for making water resources in Beijing and Tianjin as Hebei province pilot provinces watershed ecological compensation and establish national, provincial, municipal and county long-term compensation mechanism to protect ecological region.

Second, in terms of air pollution control, we should explore the establishment of consultation, notification, warning and linkage mechanism, promote regional air pollution cooperation and conduct comprehensive regulation on cross-regional air pollution.

Third, in terms of prevention of water pollution, we should actively coordinate and take advantage of special funds from cooperation projects in environmental management of water resources, set up water quality improvement regulations and jointly enhance monitoring, management and strengthen efforts in governing cross rivers, water environment of lakes and reservoirs.

Fourth, in terms of supervision of environmental law enforcement, we should establish joint monitoring and early warning networks in regional environmental

quality and set up linkage mechanism in regional heavy polluted emergency. Moreover, we should strengthen the cooperation in environmental protection research and the construction of monitoring capacity, and actively explore and establish the law enforcement linkage mechanism in inter-regional air, water and hazardous waste environment.

## 2.5 specificity of the low-carbon development in Hebei province

### ①. The specificity of Beijing-Tianjin-Hebei under the integration background

Hebei is in a peripheral location of the "Beijing-Tianjin-Hebei" integration and an important part of the "Beijing-Tianjin-Hebei" strategy. In February 2014, President Xi proposed 7 requirements for the coordinated development of Beijing, Tianjin and Hebei: 1, vigorously enhance top-level design and push ahead the related plans for the integrated development of capital economy circle; 2, imitatively abandon the concept of "Each administers in his own way" and work together to head for the goal of top-level design; 3, accelerate industrial connection and straighten out the industrial development chains; 4, adjust and optimize city layout and spatial structure and improve the level of urban agglomeration integration; 5, enlarge the ecological space of environmental capacity and strengthen cooperation on ecological environment protection; 6, build a modernized traffic network system; 7, push forward the market integration, resolve to break various mechanism barriers which hinder the free flow and optimization of productive factors such as capital, technique, property, talented person and labor force and boost the free flow and optimization of all factors within the regions. The strategy of the coordinated development between Beijing, Tianjin and Hebei province not only brings Hebei with historic opportunities but also challenges. As an important part of the coordinated development between Beijing, Tianjin and Hebei, Hebei has played a significant role in bearing capital function, maintaining environment, keeping ecological system and boost low-carbon development. It also faces arduous tasks in terms of energy conservation and emission reduction. At present, the pressing task for Hebei province is how to realize low-carbon development while blending in the "Beijing, Tianjin and Hebei" integration.

### ②. Regional function location

Hebei province is adjacent to the two biggest cities: Beijing and Tianjin in north China. For years, Hebei has transported a huge amount of natural, human and financial resources to Beijing and Tianjin and served as an undertaking place for the transportation of resources and the transfer of heavy industries. But because of the imperfect compensation mechanism, Hebei has transported a huge amount of resources outside with less import of resources which makes the issue of dwindling resources obvious. Therefore, how to coordinate with Beijing and Tianjin during the process of regional development and how to find its position during the process of "Beijing-Tianjin-Hebei" integration have become the very important issue.

**③. Economic development and low-carbon transformation**

Now Hebei province adopts a typically extensive development mode. The pollution is intensified while it is developing its economy. Its environment problems affect the surrounding cities, however, these issues can not be solved by Hebei itself. Besides, affected by the concept of "Each administers in his own way", Beijing, Tianjin and Hebei vary in goals in terms of low-carbon development and pollution control and lack mechanism and impetus for close cooperation.

# Section 3 Typical Case Study on Yunnan province

## 3.1 The current low-carbon development situation in Yunnan province

### 3.1.1 The working schedules and results with regards to low-carbon development in Yunnan province during the period of "the12th Five-Year Plan."

**①. Lowering the carbon emissions in key fields and rationalizing the industry structure step by step.**

Industrial restructuring is the basis of low-carbon development. Industrial restructuring in Yunnan province includes decarbonization and higher grade of industry structure. Industrial decarbonization refers that every industrial development should carry out the low-carbon policy and change the existed high-consumption production mode in order to pursue the maximization of economic profits with the least unit energy-consumption. It shows in the following aspects: low energy consumption and high output, the progress of industrial low-carbon technologies and balanced development of industries. The higher grade industrial structure is industrial structure upgrading which refers to the process about the whole industrial system transfers from a lower level to a higher level. In other words, the industrial structure upgrading is the process that the whole industrial low-carbon evolves from primary stage to advanced stage, which is also the process to realize the integration of technologies upgrading, value adding and emission reducing.

The energy conservation and emission reduction are deeply implemented in different fields especially in iron and steel industry, chemical industry, building materials industry, nonferrous industry, electricity industry, petrochemical industry, coal industry and engineering industry and so forth. This includes to carry out formulating and approval of evaluation standard for new and restricting projects, to increase the utilization efficiency of secondary energy and water, to develop energy efficiency benchmarking qualification work, to promote the level of high-tech equipment, to extend industrial chain, and to strengthen the industrial upgrading. Besides, Yunnan province has practiced appropriate technology in a gradual way and

continually increased the energy utilization efficiency. It consistently strengthened the two lines which are “energy evaluation” (fixed asset energy-saving evaluation and energy auditing) and “unit consumption” management (energy consumption per unit product) to effectively inhabit blind development and excessive growth of high energy-consumption industries. Meanwhile, in consideration to the huge driving role of high energy-consumption industries during economic development process, Yunnan province did not carry out one-size-fits-all approach. Instead, it adopts a multiple ways to gradually increase energy consumption efficiency.

**②. Eliminating backward production capacity and developing circular economy**

In state level, the development of circular economy should center on high energy efficiency and circulation utilization, Yunnan should strive to build up circular industrial system to promote the circulation in region and society level. At the same time, Yunnan province has a firm grasping on promoting typical circular economic mode and upgrades circular economic development level in key areas. Thus, it greatly spread traditional economic concept and promoted green lifestyle.

The energy production in Yunnan province should take hydropower, nuclear power, solar power, wind power, geothermal energy, sea power, biomass energy and other new energy and renewable energy as key parts and to gradually close down the outdated production facilities. Thus, Yunnan province will formulate its own energy production plan, integrate existing production resources and energy, sort out the idea of new energy and renewable energy production, broaden production mode of new energy and renewable energy, accelerate the gradual transformation of energy production mode to replace high polluted coal, oil and other resources, and vigorously develop circular economy. In recent years, Yunnan province , who has taken the state policy which encourages circular economy as great opportunity, to deepen demonstration trials for the circular economy, to strictly close down outdated production facilities according to the time limit. In 2014, the provincial finance has invested more in energy conservation, spending 90 million Yuan on promoting advanced and applicable energy-saving techniques to renovate and upgrade traditional industries. The provincial finance has also driven 1.8 billion Yuan project investments achieving energy-saving equivalent to 600 thousand tons of coal equivalent.

**③. To implement ten key projects**

During “the 12th Five-Year Period”, Yunnan province has implemented low-carbon construction projects in fields such as low-carbon energy, low-carbon transportation, low-carbon construction, low-carbon life, industrial parks, forest carbon sink, capability construction and system innovation, and invested 10.3861 billion yuan for key low-carbon development projects that driven low-carbon development in all Yunnan province, which provided a solid foundation for the implementation of specific work and make a basic platform for low-carbon development in Yunnan province.

During the period of “the 12th Five-Year Plan”, the low-carbon development in Yunnan province has been led and driven by different fields such as low-carbon energy, low-carbon transportation, low-carbon lifestyle, industrial park, forest carbon sink, capacity building and system innovation and so on, which provides a solid foundation for the implementation of the specific work and lays a basis on the low-carbon development in Yunnan province.

Yunnan key low-carbon development projects during “the 12th Five-Year Plan” period was scrolling implemented on the basis of the twelfth Five-Year Plan. With regard to low-carbon energy construction, Yunnan province has implemented wind power exploitation project, such as built a batch of new wind and power plants including Luopingshan, Dahaicaoshan, Dafengyakou, Lianhuashan, Damogufeng and Huangcaopo, added about 320 million kw of power-generating capacity, totally invested 22 billion yuan. For the solar power exploitation and photovoltaic power generation projects, Yunnan province has developed photovoltaic power generation in twelve first-level resources counties including Yongren, Binchuan, Midu and other nine counties which made more than 0.3 million kw in general scale and 10 billion yuan in total investment. For the biomass energy projects, Yunnan province has invested 3.7 billion yuan which includes 1 billion yuan in methane projects and 0.8 billion yuan in natural gas projects. With respect to energy-saving and efficiency-increasing, Yunnan province has adopted heat and pressure energy-saving projects, motor system energy-saving projects and coal-fired industrial boilers renovation projects with a total investment of 900 million yuan.

With respect to low-carbon construction, Yunnan province implemented solar power and photothermal construction integration application projects, solar power heating projects and solar power storage projects. There are 0.5 million kilo meters utilizing solar and photothermal integration. There are 1 million kilo meters solar heating and conditioner projects demonstrated in cities like Kunming and Lijiang. And the solar photovoltaics integration projects are implemented in Kunming, Chuxiong and other four cities. Up to the end of the year of 2015, the installed solar photovoltaics capacity will reach to 78000 kw. Recently, Baisharun Park, the example of green solar power construction, is the first standard green three-star construction.

With regard to industrial park construction, Yunnan province has chosen two industrial park and high-tech industrial park with high degree of industrial mutual relation and at the same time to implement the low-carbon renovation for some enterprises. It chose key fifty enterprises in high consumption industries including mining, metallurgy (including non-ferrous metal), coal, power, chemical and building material to encourage the application of low-carbon technologies and implement low-carbon renovation afterwards.

With regard to forest carbon sink, Yunnan province has completed land closure

for reforestation and adopted medium and low yielding forest renovation which centered on forest tending, and accomplished forest recovery after disasters like snow havoc and heavy drought.

**④. Accelerating to promote the construction of the urban integrated transportation energy-saving system and advancing the road network structure and improving the transport organization structure and optimize transportation organizations structure.**

Encourage to develop environment-friendly and clean energy transportation means, develop and promote alternative automobile fuels, biological diesel cars, electric vehicles and hydrogen energy automobile, speed up renovation of road and tunnel illumination and electronic toll collection system, setup traffic signals in a scientific way to realize energy-saving in traffic management. To encourage the construction of public transportation and the reducing private cars travel; encourage people to walk or by bike when raveling to reduce the unnecessary carbon emission. Meanwhile, to promote the construction of electrical vehicles and increase EV charging stations.

To be specific, to have the energy-saving technologies renovation for 212 roads and tunnels in whole province which including technology renovation for LED lighting and tunnel solar power, voltage stabilization, filtering and compensation of tunnel electric supply. To build ETC system in all highways in Yunnan to realize expressway networked toll collection and electronic toll collection. With respect to public transportation construction, Yunnan province has set two levels management platform in main district, Chenggong new district and airport district, installed GPS dispatch terminal and information collector, and buildup smart search system.

**⑤. To expand the utilization of renewable energy in a large scale and implement new construction energy-saving material**

With regards to new buildings, the supervision and management on the implementation of energy-saving standards are strengthened. In terms of state office buildings and large public buildings, the supervision and management system on energy conservation should be developed in a fast way. Restaurants have been led to an energy-saving transformation. The “green” restaurants are promoted. The promotion of green lightening has been advanced. The management of energy efficiency standard and benchmarking is developed so as to standardize the market of energy-saving products. The projects which benefit people are implemented and the high-efficiency and energy-saving products are promoted. To fully popularize low-carbon construction mode by utilizing how-carbon and energy-saving building materials, spread and apply solar power construction integration, energy-saving lighting and other energy-saving technologies and products, popularize reuse of recycled water, garbage classification, solar power utilization and energy-saving management and strengthen community greening activities.

**⑥. Develop and improve the energy-saving management and working system in public institutions.**

To pay much attention to energy consumption statistics, measurement, monitoring and evaluation work of public institutions, promote energy-saving renovation of equipment in energy-consuming units (including utilization of reuse water, energy-saving stoves, air-conditions and elevators) and fully popularize high-efficiency and energy-saving lighting; to formulate paperless office rules and enforcement regulations in Yunnan public institutions. To gradually form experiment functionality about going and trying beforehand and strengthen energy-saving management of public institutions in order to lay a solid foundation for the implementation of energy-saving work management mechanism in other industries.

Sound energy-saving management mechanism in public institutions is the good beginning, top priority and leading criterion of low-carbon development. Sound work mechanism also can lay a solid foundation for future low-carbon development. Yunnan province, by relevant construction in the past few years, has equipped with better energy-saving management and work mechanism of public institutions which play a leading role in guiding low-carbon development in Yunnan province.

### 3.1.2 The energy consumption and carbon dioxide emissions in Yunnan province

Yunnan province, by formulating "the 11th Five-Year Plan" and "the 12th Five-Year Plan"and adopting projects construction and asset-supporting measures, has made obvious fruits of low-carbon development in Yunnan province. However, Yunnan province still faces a series of problems such as energy crisis, environment crisis and sustainability of economic growth.

From the perspective of energy consumption situation, Yunnan province is still in the energy consumption increasing status, and its annual growth rate almost reaches 10% in recent years. The energy consumption amount has increased from 60.23 million tons in 2005 to 114,37 million tons in 2013. What is surprising to us is that per unit GDP energy consumption amount in Yunnan province is in the reducing status and has dropped from per unit GDP energy consumption 1,74 tons coal equivalent/ten yuan thousand in 2005 to 1.25 tons coal equivalent/ten thousand in 2013 and it predicted that Yunnan province can accomplish its goal that make per unit GDP energy consumption lower than 1.22 tons coal equivalent/ ten thousand yuan.

Energy consumption structure is another important issue in Yunnan low-carbon development. Coal, though its proportion is in the declining status, is still the primary energy consumption in Yunnan province and accounted for 50% of energy consumption. The secondary energy consumption is primary electricity whose proportion is rising continuously and shown a great growing momentum. The third energy consumption amount is oil, followed by natural gas. In these four kinds of energy consumption, the carbon emission coefficient is around 0.755 and then followed by oil whose coefficient is 0.585. The carbon emission coefficient of natural

gas is the third one among them with 0.448. The carbon emission coefficient of primary electricity is the lowest one. Now, the carbon energy consumption accounts more than 50% in energy consumption structure and primary electricity accounts for about 30% in Yunnan province.

The situation of carbon dioxide emission in Yunnan province. According to the relevant materials, the recommended value of carbon dioxide emission of National Development and Reform Commission about carbon dioxide emission is 0.67, the reference value of Institute of Energy and Economy Japan about carbon dioxide emission is 0.68 and 0.69 in Energy Information Administration of the U. S. Department of Energy. In this study, we choose the reference value 0.67 and to transfer the coal equivalent ton of energy consumption in Yunnan province to the carbon emission amount. By the above measurement method, we calculated that carbon dioxide emission amount is about 280 million tons in 2013 in Yunnan province. The carbon dioxide emission intensity in Yunnan province has been declined sharply with its strength decreased from 4.27 tons per ten thousand yuan in 2005 to 3.07 tons per ten thousand yuan in 2013, which means that the carbon dioxide emission intensity has declined 28.1%. According to this declining rate, Yunnan province will meet its binding target about making its per GDP carbon dioxide amount decreased about 40-50% in 2020 compared with that in 2005. There are two main reasons for this. Firstly, the scale effect brought by rapid economic growth in Yunnan province. In recent years, the economy in Yunnan province has developed rapidly with about 12% growth rate, which has surpassed the annual level of China. But there is no denying that the economic growth has a certain unpredictability and will be a challenge for completing indicators during “the 13th Five-Year Plan” period. Secondly, the energy structure adjustment in Yunnan province focused on the utilization of green, low-carbon and clean energy, which brought the rapid declining growth rate of per unit output value energy consumption. The continuous growth of carbon productivity shows that the utilization efficiency of carbon is increasing gradually.

## 3.2 The SWOT analysis of the low-carbon development in Yunnan province during the period of “the 11th Five-Year Plan”

**①. The strength of the low-carbon development in Yunnan province during the period of “the 13th Five-Year Plan”.**

There are broad space and momentum of low-carbon development during “the 13th Five-Year Plan”period of Yunnan province, which provide obvious strength for Yunnan province. They can be shown in the following aspects:

Firstly, by the efforts in past few years, Yunnan province has basically formed its policy supporting system of energy-saving and carbon emission and the “three systems” which includes statistics, monitoring and evaluation have been initially built and also can be scientifically applied into evaluation work related to statistics,

monitoring and evaluation systems. As for statistics system, it has a firm theoretical research basis and its basic work has been in the place, which laid a solid foundation for the follow monitoring and evaluations. As for monitoring system, it can better plays its role and to put forward regulatory opinions from different aspects and angles. The last stage is for evaluation which relies on evaluation system to carry out relevant evaluation and then make a judgment for implemented work. This can rationally summarize the weakness and shortage in low-carbon development and also can put forward requirements for future low-carbon work. In conclusion, the establish of "three systems" which include statistics, monitoring and evaluation systems will provide the scientific technical support for low-carbon development.

Secondly, the exploitation amount of renewable energy in Yunnan province still ranks top in China. In view of energy, Yunnan province boasts the energy strength that any province can compare. In the renewable energy, Yunnan owns abundant theory reserves of water power and its theory reserves of water power reached 103.64 million kw, and its economic installed capacity reached 97.95 million kw which ranks second in China. Yunnan has obvious strength in solar power and its annual annual sunshine duration is 2200 hours which means that the solar radiation is equivalent to more than 73 billion tons coal equivalent. There are more than 53% of our land whose annual annual sunshine duration amount more than 5500 million kilo-joules per square meters with better exploitation conditions. There are more than 122.91 million kw wind power energy amount and 45200 square kilometers can be utilized (annual annual wind power density is more than 50 watts per square meter), which accounts for 11.5% percent of province land. There are 28.32 million kw that can be developed and exploited. There are more than 200 kinds of woody and oil crops in Yunnan province. Among them , woody and oil seed which with 30% percent of oil account for 60% of the total woody and oil crops amount in country. The above technologies have the following advantages: abundant in quantity, few pollution and recyclability. Yunnan province can depend on these strengths to develop low-carbon energy and improve low-carbon energy productivity, which provided favorable condition for low-carbon development in Yunnan province.

Thirdly, Yunnan province has better industrial conditions and basis for developing low-carbon. In industrial layout of Yunnan province, among five pillar industries, there are three industries belong to low-carbon industry which are tobacco, biological industry and tourism. The capacity proportion of hydropower and thermal power in electricity industry has reached 66:34 and electricity generating capacity of hydropower has surpassed 50% of total electricity generating amount. The technology research and development and industrial development of hydropower, solar power and biomass energy are advanced in China and has become the third biggest hydropower producer and the biggest flat plate solar water heater production base. Low-carbon industry can get the higher production value level by its lower energy consumption. Thus, to vigorously develop low-carbon energy industry can help to reduce over energy consumption. The development of low-carbon energy industries can both

guarantee the economic growth of Yunnan province and weaken the high energy consumption in economic development, which will help Yunnan province to enhance advantages and avoid disadvantages during its low-carbon development.

Fourthly, Yunnan people have the resolution and courage to develop low-carbon industries. Yunnan province has better natural environment with blue sky and clean water and people lived here are accustomed to living and producing in this environment, which make local people have strong will for low-carbon development. In other words, the decision of developing low-carbon industries is made by Yunnan people. What they want is not only the silver and golden mountains, but also the green hills and clean waters. Thus, Yunnan province has the largest grass root base for developing low-carbon industries.

**②. The weakness analysis of low-carbon development during "the 13th Five-Year Plan"period in Yunnan province**

What we can't undeniable is that Yunnan still has some weaknesses in developing low-carbon industries during "the 13th Five-Year Plan" period due to limitation on history, geography and economic development mode.

Firstly, industrialization and urbanization in Yunnan province are in the rapid development period, and the development of heavy chemical industry, upgrading of residents consumption structure and urban infrastructure construction have increasing requirements for energy, which lead the total carbon dioxide emission amount raising day by day. As a province whose development is relatively low in western area, its economic development level has decided its strong requirements for economic growth. In order to improve people's livelihood, increase employment and promote living quality, Yunnan province faces great economic development stresses. Under the circumstances that the energy mix and energy utilization efficiency did not have fundamental changes, developing economy will inevitably bring out the increasing of energy consumption. Thus, there must be certain opposite relations between developing economy and protecting environment in many provinces like Yunnan province in western area, and then how to coordinate their relations has become the key issue faced in Yunnan low-carbon development.

Secondly, it is expected that energy consumption amount during"the 13th Five-Year Plan" period will reach 32.5663 million tons coal equivalent, which requires Yunnan to have a strict control on energy consumption amount. For now, Yunnan province lacks oil and gas and its energy consumption structure is still dominated by coal, which bring high-carbonization of economic and energy mix and has greatly influenced the implementation of low-carbon strategy in Yunnan province. However, because of limitation of technical and economic development level, Yunnan province faces a lot of difficulties in adjusting energy consumption structure.

Thirdly, there is an obvious difference between low-carbon city and low-carbon

industrial development. Yunnan province is experiencing a period of fast development of industrialization and the level of development in cities are greatly different. Few cities including Kunming are marching forward to green city and green industry mode and many cities have shown the complex features which refers to many combinations, such as gray city+green industry mode, green city+black industry mode and gray city+black industry mode. In the period of fast development of urbanization, some counties in Yunnan province, have chosen different development road due to their differences in geographic environment, economic basis and transportation conditions. But no matter which road they chose, they all should take low-carbon development as fundamental principle and better deal with the relationship between low-carbon city development and low-carbon industrial development. And on the promise of giving full consideration to macro layout, Yunnan province should plan low-carbon strategy according to a certain city, industry or business, which will increase the difficulty for assessing imbalanced development and developing low-carbon industry during t“the 13th Five-Year Plan” period in Yunnan province.

Fourthly, relevant contradictions between economic development and environment protection. The process of economic development, in itself, is the energy-consuming process and to some extent, its economic growth mode also greatly influenced low-carbon development level in this area. No matter whether it is extensive economic growth, intensive economic growth or scientific economic growth, all of these economic growth mode require consumption on energy. And then this economic development stresses bring weaknesses for low-carbon development and form low-carbon development issue behind economic growth.

Fifthly, economic development backwardness in ethnic minorities regions. Yunnan province is a region which people live and develop together and has experienced a harmonious relationship between different peoples in a long period. But what needs our attention is that some policies maybe involve short and long period interests relationships and regional interests relationships in implementing low-carbon development. If we can’t properly deal with these relationships, it will influence harmonious relationships among ethical minorities areas and bring obstacles for low-carbon development.

**③. Analysis of low-carbon development during “the 13th Five-Year Plan” in Yunnan province**

From the overall perspective of opportunity analysis for developing low-carbon industries during “the 13th Five-Year Plan” period, Yunnan has a lot of opportunities to develop low-carbon industries, these can be listed in the following aspects:

Firstly, Yunnan province is the pilot province appointed by state to implement low-carbon development and gets strong supports from country. Yunnan has listed in the first pilot provinces for developing low-carbon industry and owned many policy supporting and clear policy orientation; Through construction in the past few years,

Yunnan has its own development orientation for low-carbon development; with the rapid development of our energy structure adjustment, energy exploitation and utilization has transferred to renewable energy which made Yunnan faced new opportunities in developing renewable energy. All of these have laid a solid foundation for future low-carbon development in Yunnan province.

Secondly, many key strategies such as “Protecting Colorful Yunnan”, ecological civilization construction and “green economic province, culture strong province and bridge fort” implemented in past few years have provided a firm development platform for low-carbon development. These actions and strategies have been implemented in different sectors, departments and industries which laid a solid foundation for low-carbon development on the one hand and on the other hand, by continuously exploiting its own features, difficulties and strengths, to provide lessons and experiences for future policy and strategies making and also provide new thoughts on low-carbon development system and path innovation.

Thirdly, Yunnan province owns the largest quantity of ethical minorities and a majority of them take farming as the main production mode. They live in harmony with the nature which provide better low-carbon development environment for Yunnan province. There are more than 26 ethical groups including Yi nationality, Bai nationality and Hani nationality. These ethical groups mainly make a living by handicraft industry and agriculture, and they lead a rather simple and conservative life with low-carbon on food, clothing, housing, transportation. Thus, the calculated value of carbon footprint is very low here. All of these conditions provided a better space and opportunity for developing low-carbon economy during “the 13th Five-Year Plan” period of Yunnan province.

**④. Threats analysis of low-carbon development during “the 13th Five-Year Plan” period of Yunnan province**

What we can’t deny is that Yunnan province still faces many threats for low-carbon development during “the 13th Five-Year Plan” period of Yunnan province.

Firstly, it is hard for Yunnan province to keep its economic growth rate around at the level of 10%-12% and it is likely to decline to 7% -8% level. The slower growth rate will bring difficulties for reforming exclusive economic development mode. Due to some relationships between principles, targets and methods of low-carbon development and economic growth rate, the uncertainties of economic growth will restrict overall process of low-carbon development.

Secondly, Yunnan province now is at the hard time of energy conservation and emission reduction. In 2010, energy consumption per unit GDP in Yunnan province had reduced to 1.436 tons coal equivalent/ ten thousand yuan, but it still higher than 40% of national annual annual level. The policy and measurement to close down backward production facilities are not yet improved and incentive, constraint and exit

mechanism are not sound. Yunnan province faces a serial of contradicts and issues in asset disposal, enterprises debt, workers resettlement and employment and still confront many difficulties in closing down backward production facilities.

Thirdly, enterprises always ignore the requirements of energy conservation and emission reduction and high yield with low energy consumption that lead them lost the initiatives to save energy and reduce emission. If enterprises can't complete target of saving energy and reducing emission as expected date, it will inevitably lead to the increasing of total amount of energy consumption and then make more difficulties for accomplishing low-carbon development target during "the 13th Five-Year Plan" period of Yunnan province.

Fourthly, lifestyle has been formed by residents in Yunnan province and also has lock-in effect. People's low-carbon consumption process is a process of game between people's living standard improvement and low-carbon development. We should not only improve living standard, but also control energy consumption to make sure that all people can save energy, reduce emission and lead a low-carbon life.

Fifthly, the uncertainty of low-carbon technologies and weaker technology innovation capability of domestic enterprises. As for innovation of low-carbon technologies, the uncertainties include the following two aspects: firstly, weaker technologies innovation capability in domestic enterprises can hardly to support development mode transformation in a short period; secondly, the low-carbon technology barriers set by developed countries lead greater difficulties in introducing technologies.

Sixthly, some entrepreneurs, private entrepreneurs in particular, do not have a strong sense of social responsibility. They blindly pursue economic benefits and ignore ecological interests that cause a lot of environment issues and thus increase difficulties in low-carbon development of Yunnan province.

## 3.3 The targets and measures of low-carbon development during "the 13th Fear-Year Plan" period of Yunnan province

As for Yunnan province, according to recent development trend, we can extrapolate that at the end of t"the 13th Five-Year Plan" period, it is expected that the ten thousand yuan GDP energy consumption will reduce 20% than that of 2015 and ten thousand yuan GDP energy consumption will be around 0.9 tons coal equivalent; the carbon emission intensity will be reduced remarkably and ten thousand yuan carbon dioxide emission will reduce 22% than that of 2015 and reach around 2.0 tons ten thousand yuan. It is expected that until 2020, the energy consumption amount of Yunnan province will be increased to 1.6 billion tons coal equivalent and annual annual energy consumption will increase 6-7 million tons coal equivalent. At the same

time, the adjustment of energy consumption structure mainly refers to the reduction of fossil fuel and increasing of clean energies such as primary electricity and then reduce emission situation. The key point of energy consumption adjustment are adjusting structures and controlling proportion. During “the 13th Five-Year Plan” period, Yunnan province should add the utilization of primary electricity and reduce the utilization of fossil fuels. Yunnan province will decrease coal consumption amount less than 40% percent and increase primary electricity amount to 40% percent, which will realize adjustment of low-carbonization of energy consumption. Finally, Yunnan province will control economic growth rate around 7%-8% percent and control annual annual growth rate of carbon dioxide emission amount at 4%-6% percent, and then gradually narrow the gap between the two growth rates. Yunnan province strives to increase2.67 million hectares forestry area than that of 2005 with forest coverage reaches at 50% (according to the calculation before the year of 2003) and forestry growing stock reach at 1.83 billion cubic meters sat the end of “the 13th Five-Year Plan” period; Yunnan province has made remarkable accomplishments in low-carbon construction and become the advanced province for low-carbon construction.

The reduction of carbon emission in accordance to“the 13th Five-Year Plan”of Yunnan province requires efforts in multiple fronts:

**①. Formulate and improve supporting policies to low-carbon**

Speed up the process of formulating supporting policies to low-carbon such as fiscal policies, financial policies, and consumption policies. Regarding fiscal policies, we can utilize fiscal investment, fiscal aid, fiscal support, subsidies and so on to support investment in low-carbon corporations, approval of low-carbon projects, and evaluation mechanism of low-carbon projects. We will prioritize subsidies, governmental loans, and governmental investment towards low-carbon corporations. Taxation is a crucial way to adjust corporation behaviors. We will introduce tax cut to low-carbon corporations, projects, and research, and encourage corporations to conduct independent research and expand their business. We can also introduce carbon tax. The specific actions are as follow: calculate the yearly annual carbon consumption of all corporations of a certain industry in Yunnan province, and supervise the carbon consumption of this industry. A corporation is exempted from carbon tax if their carbon consumption are within 95% to 105% of the industry annual. For every 1% carbon consumption over 105% will entail a 1% taxation in their profit. Corporations with less than 95% of industry annual will be rewarded over time. Corporations can store their share of carbon consumption for future use as an intangible asset. They can trade carbon consumption allowance in market. This process will effectively combine carbon emission, carbon taxation, and carbon trading market, and create a mutually restrained mechanism. The hardest part of this is to determine the annual carbon consumption and the carbon emission of any particular corporation. We have to promote coefficient low-carbonization by combining tax adjustment with systematic adjustment.

Regarding financial policies, we should prioritize low-carbon projects in capital attraction and creating new projects, and provide support in loan and financing. Boost low-carbonization by attracting capital. Open up financial channels to low-carbon economic development includes taking loans from banks, joint research projects by corporations, and capital restructuring among enterprises. When conducting financing with foreign interests, we need to focus on evaluating the motivation of their action and analysis if they intent to export pollution source.

Regarding consumption policies, we will guide a low-carbon consumption pattern, and promote low-carbon consumer style, initiate low-carbon consumer behavior. As Internet develops, low-carbon consumption is progressively becoming low-carbon finance, low-carbon shopping, low-carbon production, and low-carbon order. This is a change in people's life style, and an essential part of low-carbonization.

**② .Strict control of total energy consumption**

We allow 3.25663 million tons of coal equivalent in increase of Yunnan's energy consumption during "the 13th Five-Year Plan". The total number of energy consumption allowed is 73.65338 million tons of coal equivalent. It's tough to achieve our economic growth goal with this level of energy consumption. To do that, we must insist on the following: as government, we should strictly control the evaluation mechanism of new projects; adjust energy consumption and environment protection standards; improve the summary evaluation on energy consumption and environment impact upon completion of projects. In the meantime, encourage corporation to reduce energy consumption and waste emission, and increase effort in relevant matter; we will ban corporation from production if relevant standards are not met. Considering the total energy consumption goal in "the 13th Five-Year Plan", we assign consumption number for each energy source with a focus to reduce coal consumption. As corporations, during "the 13th Five-Year Plan", corporation with high energy consumption should complete their projects of reducing energy consumption that are proposed in"the 12th Five-Year Plan". First one is to reuse excess heat and pressure. Conducting 10 of such projects every year is estimated to reduce 100 thousand tons of coal equivalent. Second one is energy conservation projects in electric system. Conduct 100 high and low voltage electrical frequency transformation every year, which is estimated to conserve 60 thousand tons of coal equivalent. The third one is to redesign coal-fueled boiler. Redesign 50 boilers with techniques like stratified combustion and replace coal-fueled boiler with new circulating fluidity bed boiler or gas-fueled boiler. This will reduce energy consumption of 100 thousand tons of coal equivalent every year. The fourth one is solar power projects. Assemble, configure, and apply 100 solar power projects every year is estimated to reduce 200 thousand tons of coal equivalent.

**③. Optimize energy mix**

To develop clean hydropower, we should speed up assembly and usage of hydropower. Increase development efforts in the midstream and downstream in Jinsha

River, and the upstream and midstream of Lancang River. Coordinate development of medium and small hydropower plants, and do well in top-level design. Increase hydropower efficiency using the bountiful hydropower resource in flood season. Strive to exceed 80 million kilowatts in hydropower by 2020. Regarding wind energy development, we should complete a number of wind energy projects in Luoping Mount, Langmu Mount, and Maying Mount during the Thirteenth Five Year Plan. Strive to exceed 8 million kilowatts in wind energy by the end of 2020.

Regarding solar power, we will promote PV and solar thermal projects in resource-rich counties like Shilin, Yongren, Binchuan, Midu, Yuanmo, Huaping, Yulong, Nanjian, Longyang, Dayao, Eryuan, and Yaoan. Strive to exceed 400 thousand kilowatts in photo-voltaic energy by 2020. Encourage the application of solar power in industry and agriculture. Open up projects like solar AC, solar power, solar powered water pump, solar green house, solar drying, and so on. Construct demonstration zone for solar power harnessing.

Regarding biomass, we should develop biomass solid fuel and biomass power generation. Conduct straw power generation in Yaoan and Luliang in central Yunnan. Develop agricultural and forestry waste gasification heating and gas supply for civil household usage, or agricultural products drying, or power generation. In cane sugar rich regions in west and southwest Yunnan, use straw power generation to supplement power in cane sugar production. Use biogas power generation in stock farming zones like Kunming, Qujing, Zhaotong, and Chuxiong. Achieve 500 thousand kilowatts generated by biomass.

**④. Speed up the restructuring in industry**

We should eliminate industries that are high energy-consumption and low yield over time. Adjust industries with high energy-consumption and high yield through technical innovation and improvement. Promote industries with low energy consumption and high yield. Provide compensations for exiting high energy consumption, low yield industries, and optimize the structure of industries.

To be specific, in electric power industry, we should use high efficiency, clean technology to upgrade present fossil-fueled power plants, and to improve its efficiency. Promote reactive local compensation and centralized compensation technology. Reduce power loss in transmission by improving reactive compensation. We should also invent brand new power solution. In fields like nonferrous metallurgy, fossil-fueled power, chemical industry, building materials, sugar, medicine, and papermaking, we should use clean production technology, such as low nitrogen combustion and desulfurization to make sure to achieve the goal of overall low-carbonization.

We should emphasize on the development of industries with low energy consumption and high yield. Take low-carbon agriculture and low-carbon tourism as

examples. In low-carbon agriculture, we need to strengthen the development of green food, organic food, and pollution-free food. Promote business models that conserve water in irrigation, conserve pesticides, and conserve fertilizer. Encourage the enthusiasm of agricultural corporations through favorable policies, and in time establish the market operation mechanism in low-carbon agriculture. This requires attention in 3 aspects. Firstly, establish clean production project in agriculture; in the process of improving agricultural clean production, we need to promote and apply slow-release fertilizer, high-concentration, long-term fertilizer, and scientific techniques of fertilization.; we need to pay attention to processing and recycling agricultural waste; we need to hold medium and large show-case projects of developing biogas. In areas with advanced development of scale breeding and in water source protection zone in the Dianchi basin, we should construct breed biogas project, and suited farming waste gathering zone, compost site and organic fertilizer factory. Promote degradable plastic mulch, and construct show-case pest management project. Secondly, construct show-case projects. Change the single-farmer production pattern, and develop urban agriculture demonstration zone. Through the industrialization of agriculture, we will not only increase agricultural production, but also provide beautiful place for urban population to relax. Construct demonstration zones for combining farming and herding, and standardized breeding. Promote growing of artificial grass, and improve related facilities. Thirdly, Promote new varieties of low-carbon and coefficient agriculture. Promote cultivating and screening for high-efficiency, low-carbon crop, and flower. Increase unit yield of crops by cost-effective manner, and reduce usage of fertilizer, increase the use efficiency of nitrogen and phosphorus. Tourism is a specialty of Yunnan province, and it create a rather high percentage of GDP. So low-carbonization of tourism will greatly drive the development of Yunnan's overall low-carbonization. In addition to promote the 6 major tourist attraction, we will focus on constructing 10 tourism-cultural industry cluster, 10 tourism cultural city, 30 Ethnic cultural demonstration county, 60 tourist town, and 100 tourism cultural village. Form a number of competitive cultural tourism market players, promote a number of potential tourism cultural projects, and create a number of well-known brands in tourism culture. We anticipate over 400 billion RMB total revenue in tourism by 2020.

**⑤. Develop low-carbon transportation, and promote low-carbon illumination**

Low-carbon transportation include both low-carbonization of transportation infrastructure and commute. To be specific, low-carbonization of transportation infrastructure means reducing carbon emission of vehicles; it mainly entails smart choice between air, water or land vehicles. Low-carbonization of commute means smart choice of ways of commute, improvement of public lighting systems, and the application of advanced transportation auxiliary facilities.

Road transport contributes to more than 90% of the total transportation in Yunnan province; this is harmful to the development of low-carbonization. We should increase

the mileage of railway and ship transportation, strengthen infrastructure construction, and shift load towards railway and ship. We should encourage public transportation, and reduce usage of private cars. We should encourage citizen to choose bicycle or on foot to reduce unnecessary carbon emission. Meanwhile, we should follow through the construction of ETC (Electronic Toll Collection); promote electric cars, and increase the number of recharge stations. We need to replace street lights in Yunnan province with solar powered and LED lights. Public lighting should use energy-saving lights, and implement "Interval Lighting". Home lighting should also change to LED lights. We should ban Incandescent light bulbs in supermarket. We should also promote energy-saving on main streets on holidays.

**⑥. Summarize experience from pilot project, and promote universal low-carbon**

Yunnan province has conducted many pilot project regarding low-carbon development, such as usage of solar power. This includes the popularization of solar water heaters, photo-voltaic and solar thermal, solar powered building, solar powered air conditioning, solar cooker, solar drying, solar powered tobacco curing and so on. Experience from these pilot projects is helpful for future low-carbon development in Yunnan province. In the meantime, we should selectively learn from foreign experience.

**⑦. Expand financing channels, and improve technical level**

In the process of achieving low-carbon, we must emphasize the need of finance, and handle it through fiscal appropriation, public fund raising, corporation investment, and citizen donations. We suggest to set a low-carbon development fund, and incorporate special development funds into budget management. Improving the technical level of low-carbon is a continuous process that should be handled in steps and from multiple fronts. Firstly, we need to improve our understanding of low-carbon technology, and treat the research and application of low-carbon technology as a strategic target. We need to provide all the necessary support such as money, policy, and talent. Secondly, we need to focus on independent research and development of key technologies, to achieve control of core energy-saving technologies. For instance, in field of solar power, we still need to import key solar thermal technologies from the West, whereas we should be conducting independent researches based on existing technologies, and achieve technological independence. Thirdly, we should learn the advanced low-carbon technology from the West, and break the technical barriers between us and the West. We should increase spending in innovative projects, and link the application of low-carbon technology to the long term development of corporations. We will create a condition in which low-carbon will boost our economy, and technology will boost our low-carbon development.

**⑧. Improve the construction of carbon sink, and use the advantages of carbon sink**

The key process of constructing carbon sink is to increase forest coverage rate. In

2020, Yunnan will complete afforestation, with 4 million hectare of mid to low yield forest reformed, and 4 million hectare of young forest tending. We achieve 58% forest coverage rate, and forest stock stock volume of 1.83 billion cubic meter. Also, in 2020, all cities in the province will have more than 35% green space, with a green coverage of more than 40%.

**⑨. Push for new type of urbanization**

Combining the theme of constructing ecological civilization, and taking a new form of urbanization that characterizes “green development, sustainable development, and low-carbon development” is a prerequisite for realizing a beautiful China with ecological civilization, and an inevitable choice given the circumstances. In the process of urbanization, we have to raise the standard of energy conservation, and conduct reasonable zoning. On the other hand, to implement a low-carbon urbanization, we must strengthen the control of energy demand. We must achieve the transformation from high-carbon to low- carbon by cultivating a culture of low-carbon consumption, low-carbon life style, low-carbon transportation, and low-carbon living space and so on. We will in time integrate the urbanization and low-carbonization in Yunnan, and achieve a revolution towards low-carbon industry and life style.(The End)