

Zhi Lu · Xiaoquan Zhang ·  
Jian Ma · Caifu Tang *Editors*

# Forest Carbon Practices and Low Carbon Development in China



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# Preface

## **Forests of Multi-benefits: Dual Implication in the Context of Low Carbon Development**

The Copenhagen Climate Summit held towards the end of 2009 aroused heated discussion around the world regarding global climate change. Although the Summit didn't reach a legally binding intergovernmental agreement, it attracted people's attention to climate change and concluded more consensus of action. Global climate change is an undeniable fact, the main cause of which is attributed to greenhouse gas (GHG) emitted from the consumption of fossil fuel during industrial activities. According to Assessment Report 5 (AR5, released in 2013) of the Intergovernmental Panel on Climate Change (IPCC), global climate change is even worse than we thought in the past. Between 1880 and 2012, the average temperature of global land and sea surface is on a trend of linear increase and is up by 0.85 °C; between 2003 and 2012, annual average temperature is up by 0.78 °C based on that of 1850–1900; between 1901 and 2010, global sea level went up about 0.19 m, during which the average rising rate reached 2.0 mm per year between 1971 and 2010, and 3.2 mm per year between 1993 and 2010. Most regions witnessed shrinking snow cover, particularly in spring and summer. In the past 40 years, the amount of snow in the Northern Hemisphere diminishes monthly (excluding November and December), which is prominent during 1980s.

The consequence of global warming can't be estimated precisely for the time being, and its complexity and uncertainty may well exceed our existing knowledge boundary. Globally speaking, climate change is taking effect, such as increased desertification, change of raindrop pattern, rise of sea level and frequent drastic weather, which will deal major impact on the environment and ecosystem that human beings and animals rely upon for living. According to AR4 of IPCC, if future global temperature rise goes up by 2–3 °C compared to that of 1750 (before the Industrial Revolution), significant changes will happen to 25–40% of the existing structure and function of ecosystem on the earth. According to AR5 of IPCC, the temperature rise of 4 °C can't be avoided if no effective action is taken.

In the past century, China's climate change was in sync with global trend. China is among the countries that suffer from the impact of climate change, particularly in the northern and western part of China. Generally speaking, there are already some negative changes related to climate in China, for example, worsened and more frequent drastic weather incidents, increase in instability of agricultural production; prominent shrinking of icebergs; affected biodiversity; daunting water resources. In the recent 50 years, the amount of rainfall remains generally unchanged, but its spatial pattern has changed significantly.

Low carbon transformation is also the needed option for China's sustainable economic growth. While improving energy efficiency and promoting renewable energy, protecting biodiversity and ecology is also a key measure for combating climate change. Biodiversity is the fundamental component to a sound ecosystem of the earth in terms of species, ecosystem and genes. Ecosystem possesses dual implication of mitigation and adaptation with respect to climate change. The services provided by ecosystem, including direct product provision of food, oxygen, drug and fibre, and regulating function such as climate, flood, disease and water resource, as well as our cultural and spiritual enjoyment on the basis of the nature, are the basic security guarantee for our living. A complete, sound and diversified ecosystem can better sustain and prosper in the face of climate change. Therefore, protecting a sound ecosystem is one of the fundamental approaches to mitigating the negative impact of climate change and adapting to it. In addition, forests, grasslands and wetlands all have the capacities to absorb carbon dioxide (CO<sub>2</sub>) in the ecosystem; as a result, there is expanding forest coverage for the benefit of CO<sub>2</sub> absorption on the earth is an effective measure for carbon reduction and carbon rebalance. In fact, 20–30% of global carbon emission is caused by deforestation and loss of vegetation coverage. Thus, protecting biodiversity and conserving the nature and ecosystem are even more crucial in the context of climate change.

It has been noted that China's biodiversity is faced with severe risk, which is even worse given the impact of climate change. Same as the global situation, China's biodiversity trend is deteriorating. In the recent 100–200 years, more than 10 mammals had already gone extinct in China, plus that more than 20 animals are on the verge of extinction. In particular, in the past half a century, under the aggregated effect of population growth, over-exploitation and over-utilization of resource and habitat, environmental pollution and intrusion of external species, ecosystem is becoming worse and worse. Protecting and recovering habitat may help to slow down the loss of biodiversity and reverse the trend.

With the recovery of habitat, vegetation cover may, while growing, absorb GHG and store it within the organism in the soil to create a certain amount of carbon absorption. This is what is known as carbon sink. Forest carbon may absorb GHG while promoting biodiversity protection.

In fact, forests have always been absorbing GHG and generating carbon sink. The only thing is that such fundamental eco-service provided by the ecosystem is being ignored all the time. It comes into view because it can be traded. The emergence of market trade in carbon shows that the eco-service value from carbon absorption of forests is recognized by market. Back in 2005, the public couldn't

believe the notion that ‘the air can be traded’, but now forest carbon becomes one of the three main contents of all provinces in the policies of coping with climate change. Forest carbon is also demystified.

However, the forest carbon market is different from carbon trading in the energy and industrial sector; in that, it is quite small and the demand is very limited. In particular, with regard to Clean Development Mechanism (CDM), due to protracted negotiation in climate change and inborn deficiency in non-permanence and leakage, CDM market has low demand on forest carbon, while project development standard is strict and cost is high. Only a few forest carbon projects from China have been successfully registered in CDM. So far, only five projects have registered successfully in this regard. Meanwhile, there are not much forest carbon projects in voluntary markets. However, for the purpose of public interest, there is a rapid growth of corporate and individual funding for carbon sink projects of public interest, so as to support the restoration of forest vegetation cover for achieving carbon neutral. There is specialized public offering fund engaged in the operation.

The reason why forest carbon is favoured greatly by the public is because it can bring multiple benefits. Investing in forest carbon can simultaneously expand the habitat of wild fauna and flora and protect biodiversity, and the communities in remote areas can also benefit from forests. Forest carbon brings more value than singular carbon. Therefore, in the future, forest carbon will also enjoy greater prospect in China’s carbon market. The key to China’s future carbon sink market is to draw upon the experiences and lessons learned from the development of international forest carbon market, promote multi-benefit forest carbon standard and formulate carbon sink standard that is in line with China’s actual condition.

This book invites experienced experts and frontline practitioners in China’s carbon trading and forest carbon sector to make analysis and prediction of China’s carbon market and the future of forest carbon market. It also reviews and analyses CDM projects, international voluntary market projects, domestic voluntary market projects and carbon sink projects of public interest. These real cases of carbon sink projects will help the public and decision makers to make proper judgement of the development space of forest carbon projects, so as to make better use of forest carbon to achieve a balance between conserving the ecology and combating climate change.

By the end of 2012, the first commitment period of the Kyoto Protocol finished. Global carbon market underwent significant changes. Meanwhile, China’s carbon market will also start from pilots and gradually become a reality. We hope that the development experience and lessons learned from China’s forest carbon projects in the past 7 years will provide guidance for the development of China’s future carbon market and forest carbon. The book pools together cases of forest carbon projects that are most relevant in China, which we also hope could guide the direction of forest carbon projects. In 2015, after a difficult negotiation, the Paris Agreement was reached with milestone relevance. Low carbon and green development become a common choice of the international community; in particular, China becomes the most important player in green development and global effort in combating climate change. The output of China’s experience will be even more important. For this

purpose, with the joint efforts of Peking University Press and Springer and Nature, we update several chapters of this book in 2017 and publish a translated version in English.

From drafting to release, the Beijing Shanshui Conservation Center and the Nature Conservancy of US offer great support in the organization, compiling and review process. The authors work diligently on several revisions. Fangyi Yang and Shi Xiangying from the Beijing Shanshui Conservation Center have done great coordination, and Prof. Huang Wei from Peking University Press contributes a lot in terms of compilation, to whom we wish to express our sincere appreciation. Our special thanks also to Prof. Huang Wei from PUP and Prof. Huang Mengchu from Springer and Nature for their time and efforts devoted to the update and translation of the English version of the book.

Beijing, China  
Beijing, China  
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Chengdu, China  
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Zhi Lu  
Xiaoquan Zhang  
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To the original version of this book, the following translator information has been added in the copyright page: “The translator of this book is Yue Meng”.



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# China's Low-Carbon Transformation and Emergence of Domestic Carbon Market



Guoqiang Qian, Xiaochen Huang, Han Lai and Xiang Zou

## Executive Summary

Climate change is a hot topic globally. United Nations (UN) and member states reached a cooperative framework for combating climate change by reaching such legal agreements the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreement. The Paris Agreement identifies the objective and blueprint for global low-carbon development and heralds the arrival of the global low-carbon era. Implementing the Paris Agreement and practically promoting low-carbon green development have become a major task for all countries. Currently, some major countries have formulated a series of objectives and action plans to cope with climate change. Fighting against climate change and boosting low-carbon green development are regarded key measures for increasing job opportunities and creating economic growth opportunities.

Carbon trading mechanism is a policy tool created on the basis of carbon pricing theory. This mechanism has become an important approach for many countries and regions in implementing greenhouse gas (GHG) emission reduction and combating climate change. Global carbon trading market features multilayered and diversified structure and content. Voluntary emission reduction market stands out in the global carbon trading arena and shifts to a rapid growth period, thanks to its distinctive advantage in promoting the public interest. Since the Kyoto Protocol takes effect, global carbon trading has made a great stride. The global carbon market is affected

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by policy uncertainty around the world and weak market demand, and the Kyoto Protocol-based global carbon market is lost in the quagmire. Entering 2012, the market encountered decreasing trading price and trade volume of products. However, with the Paris Agreement comes into view, the global carbon market is coming back, with more and more countries and regions promoting the establishment of a domestic carbon trading market. The future of carbon trading is bright.

Achieving low-carbon and green development and low-carbon transformation is an integral part of China's ecological civilization. It is the necessary choice for China's sustainable economic and social development. China formulates national plan and work plan to cope with climate change, conducts low-carbon pilot and incorporate "green development" in the economic and social development plan, establishes founding principle, specific targets, key areas, policy measures and steps in combating climate change, and gradually creates and improves a management regime and work mechanism for climate change.

Currently, local carbon market is operating as had been expected. It uses the market mechanism to achieve China's action objective of controlling GHG emission at a lower cost, and lays a solid foundation for the gradual establishment of a unified carbon market. By drawing upon the experience and lessons learned from 7 carbon emission trading pilots, the national carbon market started in 2017, with related development work already underway in an orderly fashion.

Forest carbon plays an irreplaceable role in mitigating global climate change and improving ecology and environment. It enjoys a broader prospect as long as it receives policy support. Currently, China's forestry project serves two major purposes, one is being used as an offset product in mandatory carbon market; the other is being used as carbon-neutral product in voluntary emission reduction trade.

## **1 Political Process of Combating Climate Change Globally and Low-Carbon Development**

### ***1.1 Process of World Climate Politics***

#### **(I) Global climate change and attribution**

In order to scientifically assess the cause, impact, and countermeasures for climate change, as mandated by the United Nations (UN), the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) jointly set up the Intergovernmental Panel on Climate Change (IPCC) in 1988. The purpose is to, on the basis of comprehensiveness, objectivity, openness and transparency, assess and understand the relation between anthropogenic activity and climate change, the potential impact of climate change and scientific and technological and social and economic information that are relevant to the scientific basis of adapting to and mitigating climate change.

**Table 1** Main assessment conclusion of IPCC with respect to climate change

- 
1. During the period 1880–2012, the average surface temperature increased by 0.65–1.06 °C, showing a prominent trend of global warming
  2. Anthropogenic activity is the main cause of the increased concentration of GHG in the atmosphere. The credibility of this conclusion is over 95%
  3. Climate change subjects ocean system, the majority of land and freshwater species to higher risk of extinction, coastal and low-lying areas suffer higher ecological pressure, and food security is reduced. These severely threaten the health and security of human beings
  4. Given the current trend, if no further action is taken, the concentration of CO<sub>2</sub> in the atmosphere will exceed 750 ppm by end of the century, the average surface temperature will be 3.7–4.8 °C higher than that in the Industrialization period. This cause greater and more frequent extreme weather incidents and disaster
  5. In order to avoid the detrimental impact of climate change, temperature increase shall be controlled within 2 °C by the end of the century. By 2050, global carbon emission needs to be reduced by 40–70% on the basis of that in 2010
- 

As the most authoritative assessment agency in climate change, the IPCC, since its establishment in 1988, organizes thousands of top experts around the world to have compiled five assessment reports on climate change. The latest assessment report was finished in 2014. Its main conclusion is shown in Table 1.

With each assessment report (AR), IPCC makes a crucial contribution to the negotiation in climate change and international cooperation. For example, the AR 1 (released by IPCC in 1990) directly promotes the UN to create a negotiation committee on climate change convention, which leads up to the UNFCCC. Shortly before the COP21, IPCC released the AR 5. The up-to-date scientific evidence and assessment conclusion in this report offers strong support for reaching the Paris Agreement (Table 2).

## (II) History of the global climate regime

In order to effectively deal with the threat posed by climate change, the international community began to seek countermeasures since the 1990s. In December 1990, the UN General Assembly (UNGA) adopted Resolution 45/212, deciding to establish an intergovernmental committee on climate change under the leadership of UNGA to negotiate and draft a framework convention on climate change. On May 9, 1992, the committee adopted the UNFCCC in New York. As the first legal instrument on climate change, the Convention identifies the ultimate goal of stabilizing GHG concentration in the atmosphere on a level that can avoid climate change be disturbed by risky anthropogenic activities. It also sets out that developed countries and developing countries shall undertake “common but differentiated responsibilities” in coping with climate change.

**Table 2** IPCC assessment report and progression of climate negotiation

	<p>IPCC AR 1 (1990) The UN set up intergovernmental negotiation committee, and drafted UNFCCC</p>	<p>UNFCCC came into effect (1994) Establish a global objective of combating climate change, identify the responsibilities of main participants, lay down legal foundation the basic framework of international cooperation on climate change</p>
	<p>IPCC AR 2 (1995) Creation of the Kyoto Protocol</p>	<p>The Kyoto Protocol is approved (1997) Set quantified emission obligation for developed countries, namely, reducing GHG emission by 5% on the basis of 1990 during the first commitment period (2008–2012)</p>
	<p>IPCC AR 3 (2001) Creation of the Marrakesh Agreement</p>	<p>The Kyoto Protocol came into effect (2005) The Marrakesh Agreement creates a complete set of approach to monitoring and calculating the emission of developed countries in implementing the Kyoto Protocol, as well as measures for accomplishing the objectives and evaluation mechanism</p>
	<p>IPCC AR 4 (2007) Initiation of Bali Roadmap negotiation</p>	<p>Bali Roadmap is launched (2007) Discussion of emission reduction mechanism after the first commitment period of the Kyoto Protocol expires in 2012 Copenhagen Accord (2009) Pooling of key political consensus for a cooperation mechanism between 2012–2020 Durban Platform is launched (2011) Initiation of emission reduction negotiation for post 2020</p>
	<p>IPCC AR 5 (2014) Creation of the Paris Agreement</p>	<p>Paris Agreement (2015) Global emission reduction agreement for post 2020, key milestone of combating climate change globally, the strong signal of low-carbon transformation of global economy Marrakesh Action proclamation (2016) Reiterate that the Paris Agreement will be fully implemented, in light of the irreversible trend of climate change. A consensus is reached on a procedural matter concerning the Agreement</p>

The Kyoto Protocol in 1997 is the first emission reduction agreement of the international community that lays down a quantified target for specific developed countries. On the basis of the Convention, the Kyoto Protocol further demands developed countries, as listed in the annex to the Convention, to reduce the GHG emission by 5% on the basis of 1990 during the first commitment period of 2008–2012 and reduce it by 18% on the same basis during the second commitment period of 2013–2020. Specific quantified GHG emission indicators have been identified for each country in the Annex I (see Table 3).

**Table 3** Quantified national GHG emission indicators of Annex I countries

Parties	Quantified limit or emission reduction indicators (2008–2012) (base year or baseline percentage)	Quantified limit or emission reduction indicators (2013–2020) (base year or baseline percentage)
Australia	108	99.5
Austria	92	80
Belarus		88
Belgium	92	80
Bulgaria	92	80
Croatia	95	80
Cyprus		80
Czech Republic	92	80
Denmark	92	80
Estonia	92	80
The European Union	92	80
Finland	92	80
France	92	80
Germany	92	80
Greece	92	80
Hungary	94	80
Iceland	110	80
Ireland	92	80
Italy	92	80
Kazakhstan		95
Latvia	92	80
Liechtenstein	92	84
Lithuania	92	80
Luxemburg	92	80
Malta		80
Monaco	92	78

(continued)



**Table 3** (continued)

Parties	Quantified limit or emission reduction indicators (2008–2012) (base year or baseline percentage)	Quantified limit or emission reduction indicators (2013–2020) (base year or baseline percentage)
The Netherlands	92	80
Norway	101	84
Poland	94	80
Portugal	92	80
Romania	92	80
Slovakia	92	80
Slovenia	92	80
Spain	92	80
Sweden	92	80
Switzerland	92	84.2
Ukraine	100	76
UK	92	80
Canada	94	
Japan	94	
New Zealand	100	
Russia	100	

The Kyoto Protocol is an active attempt of global emission reduction mechanism. Since it has a bearing on economic transition and clean energy alternative, plus that it touches upon energy security, competitiveness protection, and profound economic and social factors, countries are prudent in controlling GHG emission. As the first commitment approaches, the international community initiated negotiation on “post Kyoto Protocol” emission reduction. Since there are numerous conflicts among several vested parties within developed countries, between developed and developing countries and even within developing countries, the negotiation is met with difficulties. The negotiation on the second commitment period of the Kyoto Protocol started in 2005 and protracted until the Paris Agreement in 2015, lasting for a decade.<sup>1</sup> Climate change becomes a global hot topic in this process.

In order to pool political consensus, the UN Secretary-General hosted several leadership summits on climate change. More than 160 heads of state and government leaders attended the COP15 Copenhagen in 2009 and the UN Climate Change Conference Paris 2015 (COP21). After a decade of heated negotiation, major countries begin to realize that promoting technology innovation and embracing energy

<sup>1</sup>With respect to the Paris Agreement, including the historical background, process, main achievement and comment of climate change negotiation, please refer to *From Copenhagen to Paris—Change and Development of Global Climate Regime* (Tsinghua University Press), co-authored by Zhu Songli and Gao Xiang.

transition and green low-carbon growth is the trend. Any delay in this regard will not only endanger our future, but also lose opportunities and advantages in new economic transition. This major change of mind finally contributes to the political foundation of the Paris Agreement.

The Paris Agreement at the end of 2015 takes less than 1 year from adoption to entry into force, while the Kyoto Protocol did the same in 8 years. The Paris Agreement is the fastest treaty that enters into force in the history of the UN, highlighting that the international community has the political determination and effort to speed up low-carbon transformation. The Paris Agreement creates a global emission reduction mechanism that all countries can partake, making itself a new milestone in combating climate change. On one hand, the Paris Agreement identifies the direction and sends a strong political signal to global low-carbon transformation, in particular, it sets the long-term goal of “achieving carbon neutral by the second half of next century”, meaning that we will put an end to fossil fuel energy and move into an era of low-carbon and clean energy. On the other, the Paris Agreement sets the principle that all countries shall act without backtrack. On the basis of this principle and the evaluation mechanism of reviewing global emission reduction every 5 years, there is mechanism assurance in place for all countries to gradually improve on their action plans, so that global emission reduction efforts will be continuously going upwards.

### **(III) Future trend of global climate regime**

The Paris Agreement will completely replace the Kyoto Protocol after 2020. Its mechanism will continue and connect to the norms and mechanism under the Kyoto Protocol, with its reporting, transparent rules, and market mechanism worth special attention. After the Paris Agreement came into effect, there is still a lot of work to be done, this is because first, parties are yet to put everything in detail due to time constraint; second, there exist vague expressions in the text; in addition, parties will have a series of negotiations on its implementation and funding issues.

In essence, climate change is related to the economic competitiveness of all countries and their conflicts of interest over development space and global image. In the context of a new round of change and adjustment to the international landscape, developed countries also try to further maintain and consolidate their leading role in global regime by leading global climate change negotiation and identifying a positive global climate regime for the future. However, as the US backs out of the Paris Agreement, the EU falls short of long-term strength, and global climate order and landscape are ever changing, global climate governance is entering into a “3.0 era” that is completely different from the past. China will play an increasingly important role in the reform of global social governance mode.

Whatever the implementation outcome of the Paris Agreement, it can be expected that the international community will continue with the political process of international cooperation on combating climate change, and it will be intensified continuously. Meanwhile, as the outcome of climate change negotiation, low-carbon development concept is also widely accepted by all, and has become the main guide for countries to engage in domestic actions on coping with climate change.

## 1.2 Low-Carbon Transformation Becomes a Key Strategy of Development for All Countries

Given the impact and boost of climate change negotiation, main countries formulate a series of actions and objectives targeting climate change. Countries regard climate change and low-carbon and green development as key measures for increasing new job opportunities and creating new economic growth point, in an attempt to promote sustainable economic growth and enhancing long-term competitiveness. Table 4 lists actions of major developed and developing countries in coping with climate change and promoting low-carbon development.

**Table 4** List of emission reduction targets and measures

Countries	Emission reduction targets	Measures
EU	Reducing 40% by 2030 in comparison with 1990	Implementing the Act on 2030 Climate Change and Energy, planning to include carbon emission trading sector and non-trading sector in the framework of 2030 climate and energy. Further reforming and adjusting the operating scheme of carbon trading market
US	Reducing 26–28% by 2025 in comparison with 2005	Implementing Clean Air Act, Energy Policy Act, and Energy Independence and Security Act, improving traffic and construction efficiency and giving full play to alternative energy. All states will also take actions, especially California will take the lead in initiating carbon trading mechanism
Japan	Reducing 26% by 2030 in comparison with 2013 (25.4% in comparison with 2005)	Implementing Act on Promoting Countermeasures against Global Warming and Basic Act on Energy Policy, and formulating laws on energy conservation and emission reduction in all sectors. Starting market-oriented emission reduction and taking the lead in launching carbon market in Asia
Australia	Reducing 26–28% by 2030 in comparison with 2005	Setting up Emission Reduction Fund (ERF), giving full play to renewable energy, improving the efficiency of existing energy, and promoting “national climate adaptation strategy”. Adopting carbon trading act in 2012. Though abolished by conservative government in 2014, it may be started over again in the foreseeable future

(continued)

**Table 4** (continued)

Countries	Emission reduction targets	Measures
India	In 2030, carbon emission per unit GDP is down by 33–35% in comparison with 2005	Implementing National Environment Policy, National Action Plan on Climate Change, and Action Plan on Climate Change at State-level, setting up clean and efficient energy system, improving industrial energy efficiency. Working on the market mechanism for GHG emission reduction
Brazil	Reducing 37% by 2025 in comparison with 2005	Adopting the National Climate Change Act, Natural Forestry Protection Law, and National Land Use Act, which serve as the basis for carbon emission reduction. Implementing “National Adaptation Plan (NAP)” to cope with the potential negative impact of climate change. Working on the market mechanism for GHG emission reduction
South Africa	GHG emission will reach the peak during 2020–2025, and begin to drop after a decade, namely in 2035. GHG emission in 2020 will be down by 34% compared to BAU, and down by 42% by 2025	Discussing to introduce carbon tax scheme to set emission criteria for key companies, so that those beyond the standard will be levied with tax. Companies are allowed to purchase the quantity of carbon emission reduction from the global carbon market to offset their tax. A series of policies supporting green industries and renewable energy development have been released, including “protective price for renewable energy”, “government subsidy plan for renewable energy”, “market conversion project for renewable energy”, “certificate trade of renewable energy”, and “wind power project of South Africa”
Republic of Korea	In 2030, the emission is down by 37% compared to BAU	Establishing Ministry of Environment (MOE), and Ministry of Trade, Industry and Energy (MOTIE) as the authorities of emission reduction. Releasing “GHG emission reduction roadmap” in 2014, laying down emission reduction plan and implementation approach for all sectors, and making further reform and adjustment to the operating scheme of carbon trading market

(continued)

**Table 4** (continued)

Countries	Emission reduction targets	Measures
Mexico	In 2030, the emission is down by 25% compared to BAU	Releasing the Climate Change Act in 2012, and National Strategy in Combating Climate Change in 2014, making plans for the coming 10, 20 and 40 years in climate strategy. The carbon tax will be levied on a pilot basis from 2013

### (I) Low-carbon policies in the EU and UK

1. **The EU.** EU is the r and is leading low-carbon policy. As a key participant of global carbon market, the EU drafted adequate legislations to promote low carbon development at an earlier date.

The EU adopted a package plan for energy and climate in 2010. It sets up a series of action targets for combating climate change by means of legislation, including reducing GHG emission by 20% by 2020 on the basis of 1990, improving energy efficiency by 20% by 2020, and improving the use of renewable energy by 20% in total energy consumption.

Based on the above targets, the European Commission released the 2030 Framework for Climate and Energy Policy (hereinafter as “the Framework”) on January 22, 2014, putting forward EU’s target for interim GHG emission and percentage of renewable energy by 2030. The contents of the Framework cover the following:

- (1) Before 2030, reduce EU’s GHG emission by 40% as compared to 1990. If this is achieved, the emission of sectors involved in EU’s emission trade system will have to reduce by 43% as compared to 2005, while those not involved will have to reduce by 30% as compared to 2005. This target will be broke down to be undertaken by member countries.
- (2) Before 2030, the percentage of renewable energy will be 27% of total energy consumption. The EU will not adopt legislation to set obligatory regulations on its member countries. They can make flexible adjustment according to the situation and conditions of their own energy systems.
- (3) Reform EU’s emission trading system. The European Union Emission Trading Scheme (EU ETS) started operation on January 1, 2005. It is the most important policy tools for EU to achieve emission reduction target, and it is also the largest emission trading system in the world. In order to make it more effective in attracting low-carbon industrial investment, the European Commission suggests reforming the market stable reserve mechanism to deal with the surplus in the European Union Allowances (EUAs), so as to improve system flexibility and respond to supply regulation with respect to allowance accounting.

2. **UK.** UK is an active promoter and forerunner in the global low carbon economy. It not only creates business and job opportunities by means of developing, applying, and exporting low-carbon technology, but also plays a leading role for Europe and the world at large in terms of low-carbon economic transformation.

In 2008, UK government formulated Climate Change Act (CCA), which committed UK to reducing GHG by 80% by 2050 as compared with 1990, and identifies “carbon budget” for the coming 5 years. This is the very first act with identified GHG emission reduction target. It also makes UK the first country in the world to embrace a legally binding and long-term structure with respect to GHG emission reduction and climate change adaptation.

Shortly after the “Brexit vote”, the UK government declared new CO<sub>2</sub> emission reduction target, which plans to reduce carbon emission by 57% by 2032 as compared to 1990 and submits the fifth “carbon budget” to the parliament. Those who are concerned that “Brexit” may affect the UK’s climate change policy can now be relaxed, but the new emission reduction target implies that the government will work up to draft a new energy strategy that is consistent with cost–benefit, reducing the reliance on imported natural gas and greatly cuts energy demand of UK families.

## (II) **Low-carbon policies for Umbrella Group countries**

US, Japan, Australia, and some developed countries form up the “Umbrella Group” in the climate change negotiation. Though not as active as the EU on climate change policy, they also take actions domestically against climate change.

1. **US.** US is swinging from side to side with regard to climate change, due to party politics. In 2015, the Obama government, in its submission to the UN, noted that its Intended Nationally Determined Contribution (INDC) in 2025 will be 26–28% less compared to 2005, and ratified the Paris Agreement in 2016. Since Trump took office in 2017, the US began to adopt a negative policy on climate change and provided to the UN an intention letter of withdrawing from the Paris Agreement.

In spite of that, some US states have been very active in climate change. In response to Trump’s withdrawal from the Paris Agreement, California, New York and Washington joined together as the climate alliance, stating that they will continue to fulfill US’s commitment of the year, that is, to cut the GHG emission of 2025 by 26–28% on the basis of 2005, thus reaching or surpassing federal standard for clean energy plan. In addition, mayors from 61 US cities made joint declarations on June 1, 2017 to maintain and enforce the Paris Agreement.

California has been taking the lead in combating climate change. As early as 2006, California passed the Global Warming Solutions Act (AB32) to counter global warming, and identified the reduction target of cutting GHG emission to the level of 1990 by 2020. To achieve this target, AB32 authorize California Air Resources Board (CARB) to draft emission reduction measures including market mechanism. Currently, California has passed local laws introducing GHG quantity control and emission trade scheme. Its carbon trading mechanism was officially initiated in 2013.

2. **Japan.** Japan made the commitment to cut GHG emission in 2020 by 25% on the basis of 1990 during the COP15 in 2009, and it put forward a long-term target that GHG emission by 2050 will be down by 60–80% on the current basis. However, following the Fukushima accident in March 2011, nuclear power policy was affected. The Japanese government was forced to readjust emission target, and withdraw from the second commitment period from the Kyoto Protocol during the COP18 in Doha in 2012. In its INDC submitted to the UN in 2015, Japan noted a new target that emission will be cut by 26% in 2030 compared to 2013 (cut by 25.4% compared with 2005). The year 2013 was selected as the base year, because the earthquake caused nuclear power plants to stop operation, thus GHG emission of that year reached a historical high.

In addition, there are three aspects of climate change policies and actions that worth mentioning:

First, Japan promulgated the Act on Promoting of Global Warming Countermeasures in 1998, which lays down the plan of emission reduction for all sectors under the Kyoto Protocol. Although Japan withdraws from the second commitment period of the Kyoto Protocol, it continues to amend the Act in 2013. The action plan under the Kyoto Protocol is revised as a plan to avert global warming and is still effective.

Second, due to domestic pressure from various interests groups, Japan indefinitely postponed the plan to set up a national carbon trading mechanism, but Tokyo and Saitama Prefecture started a regional carbon market in 2010 and 2011, respectively. The market in Saitama was connected immediately with that of Tokyo at the onset, allowing the flow of approved carbon credit. By September 2016, emission reduction credit totaling 5,600 tons of CO<sub>2</sub> equivalent flows from Saitama to Tokyo carbon market.

Third, bilateral emission reduction mechanism is confirmed to replace clean development mechanism under the Kyoto Protocol as a new mechanism for promotion. Japan is accelerating the establishment of bilateral emission reduction mechanism with Southeast Asian countries and developing countries, so that Japanese companies may obtain emission reduction credit by investing in clean technologies (such as renewable energy). By October 2017, Japan has signed bilateral agreements with Mongolia, Vietnam, Indonesia, Philippines, and other 13 countries.

3. **Australia.** Australia has adequate implementation framework and management system regarding climate change policy. Climate change issue is managed centrally. The former “Australia GHG Office”, which manages climate change, was upgraded into Climate Change Ministry in 2009 with the responsibility of drafting domestic climate change policy.

On November 8, 2011, Australia Senate adopted a package plan including the Clean Energy Act, and it identified a national emission reduction target of cutting GHG by 5–25% on the basis of 2000 in 2020. In addition, Australia submitted its

INDC in August 2015, putting forward a target of cutting GHG by 26–28% in 2030 as compared to 2005. Besides, in December 2015, Australia adopted the National Energy Efficiency Plan (2015–2030), noting that the energy efficiency in 2030 will be up by 40% compared with 2015.

Furthermore, the Australia Labor Party government once introduced a carbon pricing mechanism and was officially implemented on July 1, 2012, then is abolished by the Conservative Party in 2015. The Australian government set up the Emission Reduction Fund (ERF) in 2016 to purchase emission reduction credit from compliant emission reduction projects. The system also includes a “baseline-offset” mechanism. Facilities emitting over 100,000 tons of CO<sub>2</sub>e are required to control their emission within a threshold, thus any exceeding part needs to be offset by purchasing emission reduction credit.

### (III) Low-carbon policies in main developing countries

1. **India.** India submitted its INDC in 2015, stating the target of reducing per unit GDP emission in 2030 by 33–35% on the basis of 2005. In order to achieve this target, India launched the National Action Plan on Climate Change, which identifies 8 core national plans for implementation, including solar energy plan, energy efficiency plan, sustainable living environment plan, water resource plan, Himalaya eco-conservation plan, green India plan, sustainable agricultural development plan and study plan on climate change strategy. In addition, 32 states (co-dependencies) have joined the State Action Plan on Climate Change, so that climate change initiatives will be promoted at the state level.
2. **Brazil.** In its INDC, Brazil set the target of cutting the emission reduction in 2025 by 37% compared to 2005. The main emission source in Brazil is deforestation, thus the key measures for controlling GHG in the future lies in reducing deforestation. China's National Plan for Combating Climate Change National Plan on Climate Change put forward a series of measures to cope with climate change in 2008, mainly including improving energy utilization efficiency; maintaining a high level of power supply by renewable energy; further utilizing biofuel; continuously reducing deforestation. On the basis of that, the Natural Forestry Protection was adopted in 2012 to further cut down on GHG emission caused by deforestation. In addition, the Brazilian government also began to implement the National Adaptation Plan since 2016 to deal with the negative impact brought on by climate change.
3. **South Africa.** South Africa set down its mid and long-term GHG emission reduction target as follows: cutting emission by 34% in 2020 compared to “baseline emission scenario”, and cutting the emission by 42% in 2025. The emission will reach a peak between 2020 and 2025, and will begin to drop after keeping on that level for a decade.



In order to achieve emission reduction target, South Africa has released a series of policies in support of green industries and renewable energy, including “protective price for renewable energy”, “financial subsidy plan for renewable energy”, “market conversion project for renewable energy”, “certificate trade of renewable energy”, and “wind power project of South Africa”. Meanwhile, South Africa commences to introduce carbon tax. Its taxation and budget report of 2012–2013 provided explanations and interpretations with regard to the carbon tax proposal. This proposal is similar to the fixed carbon tax in Australia, levied as of July 1, 2012. The proposal was postponed several times, and the new plan will be implemented from 2017.

4. **The Republic of Korea.** Considering its long-term economic competitiveness, the Republic of Korea has identified green and low-carbon growth as its development strategy. Korea set the target of cutting emission by 37% in 2030 in comparison with “baseline emission scenario”, and incorporated this target in the INDC.

In order to achieve that aim, the Republic of Korea promulgated the Basic Law on Low-carbon and Green Growth in 2010, which is the first of its kind in the world regarding low-carbon green growth. The law lays down a fundamental regime structure for the Republic of Korea to shift toward low-carbon and green growth. On May 2, 2012, National Assembly of the Republic of Korea adopted an act introducing carbon trading mechanism, making itself the first Asian country to embrace carbon trading legislation. The Republic of Korea’s trade mechanism was officially launched in 2015, covering 60% of the Republic of Korea’s total emission. In December 2016, the Republic of Korea government released the Basic National Roadmap for GHG Emission Reduction by 2030, which summarized the key role of the carbon market in achieving the Republic of Korea’s INDC, and broke down national targets into specific sectors.

5. **Mexico.** Mexico parliament adopted the General Law on Climate Change. This law has the main objective of promoting GHG emission reduction and effectively mitigating the negative impact of climate change. It also identified a long-term target that by 2050, Mexico’s GHG emission will be 50% less than in 2000. Following the UK, Mexico is the second to set a legally binding emission target for the long term. In order to accomplish that, Mexico also set a mid-term target of cutting emission by 25% in 2030 compared to “baseline emission scenario”.

In actual practice, Mexico began to try out with the carbon tax policy in 2013. On August 15, 2016, the Ministry of Environment and Natural Resources of Mexico, the Mexican Stock Exchange, and its trading platform of voluntary carbon emission reduction signed a cooperation agreement to jointly pilot on the voluntary carbon emission trading system. A simulation carbon trading operation was officially initiated in November 2016 to familiarize stakeholders with emission trading concept, raise the preparation awareness of companies to this policy tool. The simulation

didn't introduce trade parameters and is expected to finish in December 2017. By then a national registration system for major companies under emission control will be online, which will lay the foundation for Mexico to execute nationwide carbon market in 2018.

## **2 Carbon Market—Booster for Low-Carbon Transition**

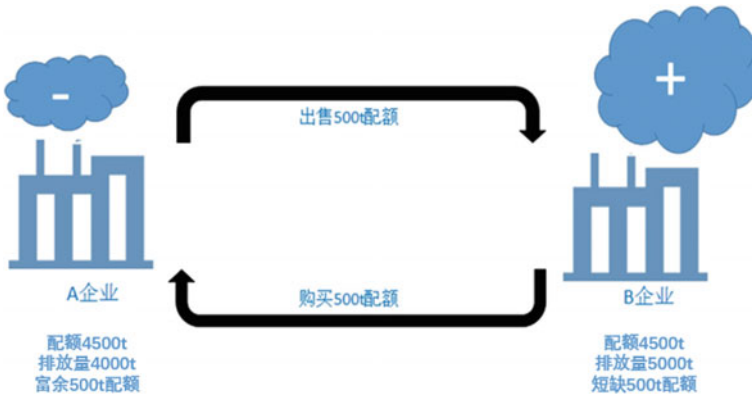
### ***2.1 Fundamentals of Carbon Trading***

The core component of achieving emission target through economic means lies in setting a carbon emission price. If a company undertakes no social or economic responsibility for environmental damage caused by CO<sub>2</sub> emission, it will never consider carbon emission in its decision-making process, nor will it be encouraged to cut carbon emission. This is called Economic Externality. If carbon emission price is set, companies will begin to pay for its CO<sub>2</sub> emission, and they will consider carbon emission cost into overall financial accounting and management decision-making. They will also be stimulated to cut CO<sub>2</sub> emission to reduce operating cost. Meanwhile, with a sound carbon pricing mechanism, companies won't be afraid of cost increase due to technology upgrade or business improvement and potential loss of competitive advantage. This will inspire technology and management innovation.

As shown in Figs. 1 and 2, carbon trading mechanism is a policy tool created on the basis of carbon pricing theory. Government introduces the Cap and Trade system to set a limit for carbon emission. If a company's emission in a given period exceeds that set by the government, it needs to purchase the corresponding allowance through carbon trading in the market to achieve the set target, otherwise, it will be faced with a high penalty fee. A company may also choose to cut carbon emission by low-carbon technology upgrade or business improvement, or sell its allowance surplus to acquire economic benefit through carbon trading. Each company will choose a carbon emission standard favorable to itself according to its own condition and based on cost-benefit accounting, either by self-emission or by purchasing emission allowance through carbon market. Compared with a rigorous and inflexible administrative approach, this marketized measure provides companies with flexible and low-cost means, which also reduces the overall social cost for GHG quantity control.

### ***2.2 History of International Carbon Market***

Initiated by the US, the Kyoto Protocol was adopted during the 3rd Conference of Parties to the Convention held in Kyoto, Japan in December 1997. The Kyoto Protocol introduced three flexible mechanisms that are intended to help developed countries accomplish their emission reduction targets. This opens up a new channel



A 企业	Company A
配额 4500t	Allowance 4500t
排放量 4000t	Emission 4000t
富余 500t 配额	500t surplus
出售 500t 配额	Sell 500t allowance
购买 500t 配额	Purchase 500t allowance
B 企业	Company B
配额 4500t	Allowance 4500t
排放量 5000t	Emission 5000t
短缺 500t 配额	500t allowance deficit

**Fig. 1** Functional diagram of carbon market

for global carbon emission trading and serves as the base for global carbon trading market.

The Kyoto Protocol sets down GHG emission reduction targets for the first commitment period of 2008–2012 for the developed countries with emission reduction obligations. According to the Kyoto Protocol, by 2012, all developed countries have to cut the mission of 6 kinds of GHG.<sup>2</sup> (including CO<sub>2</sub>) by 5.2% compared to 1990, while developing countries shoulder no emission reduction obligations. Emission reduction targets for developed countries are shown in Table 5.

By means of emission reduction targets, each developed country is given an assigned amount of units (AAUs), which is comparable to an assigned emission allowance by the UN. Developed countries with emission obligations can directly buy and sell or transfer their AAUs, which is the emission trading (ET) stipulated by

<sup>2</sup>CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFCS, PFCS, and SF<sub>6</sub>.

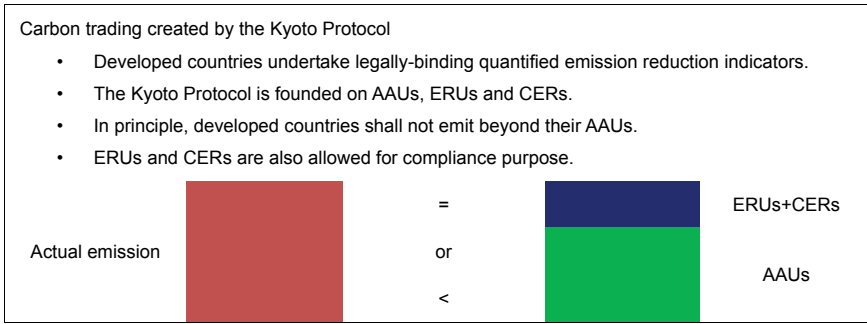


政府	Government
核证减排量 ( CCER )	China Certified emission reduction (CCER)
减排项目	Emission reduction projects
金钱	Money
交易所	Exchange
配额/金钱	Allowance/Money
金钱/配额	Money/Allowance
控排企业	Emission control company
与排放量相等的配额	Allowance equivalent to emission
配额	Allowance
排放数据	Emission data
第三方核查	Third party verification
投资机构/个人投资者	Investment institution/ individual investor
碳金融	Carbon finance
质押融资	Pledge financing
碳债券	Carbon bond
配额托管	Allowance Allowancetrusteeship

Fig. 2 Operating mode of carbon market

Table 5 Emission reduction targets of developing countries under the Kyoto Protocol

Countries or regions	Emission reduction targets
EU	8%
US	7%
Japan	6%
Canada	6%
East European countries	5–8%
New Zealand, Russia, and Ukraine	Stabilize on the level of 1990
Ireland, Australia, and Norway	Increase respectively by 10%, 8%, and 1%



**Fig. 3** Fundamentals of compliance with the Kyoto Protocol

the Kyoto Protocol. Meanwhile, the Kyoto Protocol also provides developed countries with CDM and JI as two offset mechanisms. The main difference between these two is that, CDM uses certified emission reduction (CER) as the emission reduction credit, and it comes from emission reduction projects of developing countries with no emission reduction obligations; JI use emission reductions units (ERU) as the emission reduction credit, and it comes from emission reduction projects of developed countries with emission reduction obligations.

According to the implementation of the Kyoto Protocol, developed countries with emission reduction obligations have to calculate their GHG emission quantity based on UN's accounting rules for the first commitment period, which shall not exceed their AAUs, ERUs, and CERs combined, otherwise they will be subject to penalties (Fig. 3).

In addition, EUETS also connect with the three flexible mechanisms under the Kyoto Protocol by "linking directive". Since 2005, companies under EUETS may partially use CERs and ERUs generated respectively from CDM and JI projects to offset their emission. On one hand, this expands the depth and width of the global carbon market established by the Kyoto Protocol, on the other, it also provides greater flexibility for EU ETS.

### 2.3 The Classification of Carbon Market

There exist several types of carbon market globally, with diversified levels and multiple categories in their structures and contents. Based on whether a carbon market is founded on legal basis and motive of trade, there are mainly two types of market, namely, mandatory carbon market and voluntary emission reduction market. Another

way of categorization is based on the types of trading products, which covers the allowance market and offset market.

### **(I) Mandatory carbon market and voluntary emission reduction market**

#### **• Mandatory carbon market**

Mandatory market is based on laws and regulations. Those participating in the market must comply with the Convention, while market demand comes from legal enforcement. The mandatory market in its early form is exhibited as CDM, JI, and ET founded by the Kyoto Protocol. Serving as a bond, the Kyoto Protocol connects main countries to create a global carbon market, which is normally known as the “Kyoto” carbon market.

Another type of mandatory market is founded on domestic legislation, including country-level carbon markets in EU, New Zealand, Republic of Korea, and local carbon markets like California, Quebec, and such provinces in China as Guangdong, Hubei, Beijing, Shanghai, Tianjin, Chongqing, and Shenzhen.

By means of legislation, EU single-handedly connects the EU carbon market with the “Kyoto” carbon market. Since 2008, companies under the EU carbon market may use CERs and ERUs to offset their mission for compliance assessment. This means that EU individually confirms CDM and JI as a legitimate offset mechanism, which further expands the demand for CERs and ERUs under the Kyoto carbon market. It is with CDM that China participated in the global carbon trading market. The quantity of emission reduction from domestic emission reduction projects is developed into CERs that are sold to companies under EU carbon market for Convention implementation, or sold to the governments of EU member states, Japan, Canada, New Zealand and other developed countries, in order for them to fulfill the first commitment period of emission reduction under the Kyoto Protocol.

#### **• Voluntary emission reduction market**

Following the principle of self-discipline, some Non-Governmental Organizations created offset mechanisms that provide CERs and certification service. These CERs usually comes from corporate social responsibilities (CSR) rather than legal enforcement. This type of carbon market is known as the voluntary emission reduction market, with its widely accepted forms of verified carbon standard (VCS) and gold standard (GS). Since the demand is not created by legal enforcement, the scale of voluntary emission reduction market is way less than mandatory markets. But voluntary markets are also less affected by policies, thus they are more stable than mandatory markets.

Voluntary emission reduction markets started earlier than mandatory markets. The earliest trade in voluntary emission reduction happened in the 1990s. The society, individual and non-profit entities, in order to voluntarily offset their GHG emission, purchased emission reduction credits generated from GHG offset projects. Around 2002, more and more companies and individuals paid attention to global