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Overview of Climate Change Policies and Development of Emissions Trading in China

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Since the 1978 Economic and Openness reforms, China has made remarkable progress in economic and social development, which has even accelerated in the first decade of the 21st century; however, it has also become the largest annual carbon emitter since 2007 in absolute terms. In a bid to achieve a low carbon economy, China will have to adopt bold policies and measures to decouple its economic growth from carbon emissions. Sole reliance on administrative tools has proven to be insufficient, and alternative policies are needed to control the rapid GHG emissions growth. To this end, China has started implementing pilot emissions trading schemes (ETSs) in some regions to pave the way for a national scheme.

This paper will first present the profile of Chinese GHG emissions and investigate the drivers of the rapid carbon emissions growth. We will then describe China's engagement in international climate negotiations, how it committed to curb CO2 emissions, as well as policies and measures that China put in place to achieve mandatory energy and climate goals domestically. We will finally look more closely into China's move towards carbon trading before examining regional ETSs' developments and pinpointing challenges and ways forward for inter-pilot linkage or scaling up to a national level.

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⇨Addendum

Once our paper was finished, it was announced that the Chongqing ETS could start trading as early as this month. We did not change the main text but updated Table A in Annex 2. It means that the seven pilots could all be in operation before April 2014.

⇨Conversion Table

Below are displayed rough exchange rates between yuans, euros and US dollars. Prices will be given in yuan throughout the paper so the following simple rule of thumb may look useful to keep in mind.

1 US$ = 6 yuan; 1€ = 8 yuan

Note: The views expressed herein are solely those of the authors. Authors alone are responsible for remaining errors.

Introduction

Climate change has emerged as one of the greatest challenges to the sustainable development of human society and now stands at the heart of scientific and public preoccupations. A consensus is gradually building up around the idea that comprehensive action be taken swiftly to both avoid catastrophic consequences caused by rapidly rising temperatures and achieve sustainable development. Most countries have started to engage in the formulation of strategies and implementing measures, tailored to national circumstances, on the path toward a low carbon economy. This global exploration will not reach meaningful results without full participation by China, the world's largest energy consumer and greenhouse gas (GHG) emitter. China has been gradually adopting policies to control its GHG emissions growth. As the country is still at a stage of rapid economic development, industrialization and urbanization, policies addressing climate change ought to be embedded into overall socio-economic development planning. As part of these policies, China recently launched regional emissions trading pilots to test carbon trading before eventually setting up a nationwide emissions trading scheme (ETS).

Although carbon trading versus carbon taxation is a much debated and documented issue, in practice, emissions trading schemes (ETSs) have been widely favored to achieve emissions reductions in a cost effective manner. ETSs are already in operation in several locations around the world, such as the European Union ETS – the oldest and biggest one – the US northwestern partnership (RGGI), or the recently linked system between California and the Canadian province of Québec. In 2013 five out of the seven Chinese pilots started operations. Additional markets are planned to emerge in other regions such as South Korea, Kazakhstan and Vietnam while others are under consideration, as in Rio de Janeiro or Ontario, to name but a few. According to the World Bank (2013) 'implemented and scheduled emissions trading schemes and carbon taxes put a carbon price on at least 3.3 $GtCO_2e$ per year, or 7% of global emissions'.

Policy measures such as the introduction of domestic ETS has been under consideration since 2009 when the NDRC first expressed its desire to test carbon trading through pilot schemes. The Chinese government had previously heavily relied on "command and control" regulations to tackle energy and environmental issues. The recent launch of emissions trading schemes in several parts of China has drawn attention from the international community, which is keen to follow the developments of a cap-and-trade system in a country with a rather immature market economy, not bound by any absolute reduction commitments, and to see what role it will play in China's transition to a low-carbon economy. Although such developments have been inspired by emissions trading systems operating in other parts of the world, China's domestic ETS pilots must fit in the country's specific context and their designs are not definitely settled for now. It will be clear from the main text that the establishment and operation of such schemes has been encountering a number of challenges common to any ETS, as well as some unique to the world's largest developing country. Since the biggest and most effective opportunity lay in imposing carbon trading to the national economy as a whole, the last section of the paper particularly focuses on existing and potential further linkage among the pilots as well as practical considerations for a national ETS, hopefully laying ground for further research.

1. China's GHG Emissions Landscape

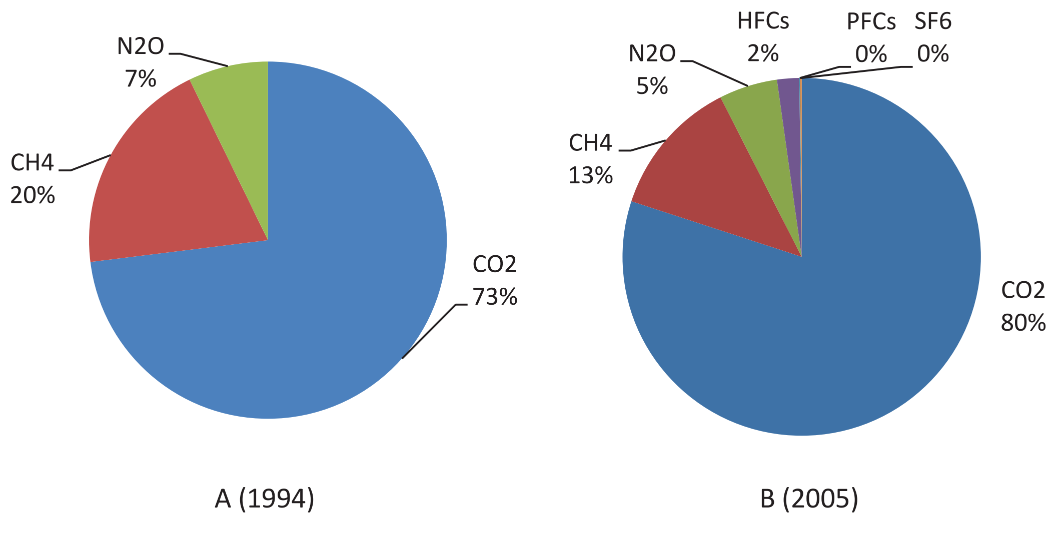
1.1. GHG emissions in China

1.1.1. Total GHG emissions in China

China, as a non-Annex I Party to the United Nations Framework Convention on Climate Change (UNFCCC), is not obligated to report its GHG emissions on an annual basis. As of 2014, the Chinese Government has released two national inventories of GHG emissions - those of 1994 and 2005, incorporated into the Initial and Second National Communications on Climate Change submitted to the UNFCCC in 2004 and 2012 respectively (NCCC, 2004, 2012). In compiling the inventories, China followed the IPCC Guidelines (1996, revised 1996, Good Practice and 2006 versions) for National Greenhouse Gas Inventories and selected emission sources, activity data and emission factors according to China's national circumstances. China chose to estimate only carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) emissions when conducting its first national GHG inventory, but reported on all the six GHGs for the second one. In the meantime, more emission sources under each of the 5 sectors, i.e. energy, industrial processes, agriculture, waste management and land use change and forestry, were accounted in the 2005 inventory.

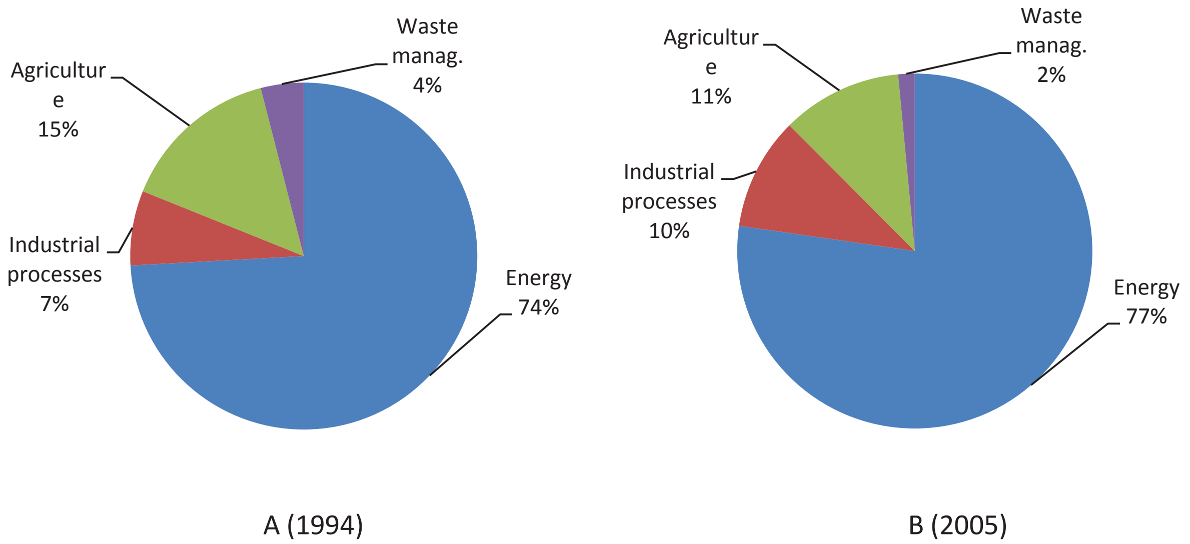
In 2005, China's GHG emissions totaled 7,976 million tons of CO_2 equivalent ($MtCO_2e$) excluding Land Use, Land Use Change and Forestry (LULUCF), more than double the amount in 1994 (3,650 Mt CO_2e). The total net carbon removal through LULUCF was estimated to be about 421 and 407 $MtCO_2e$ in 2005 and 1994, respectively. Carbon emissions from fossil fuel combustion was the largest contributor, accounting for over 70% of global warming potential (GWP) weighted emissions (Figures 1 and 2). Industrial processes were also important sources of CO_2 emissions while agricultural production was the primary source of CH_4 and N_2O emissions. The two sectors together represented about 22% of national inventories. Between 2-4% of national emissions arose from waste management in the form of CH_4.

Figure 1 - Overview of China's GHG emission in 1994 (A) and in 2005 (B)



Source: P.R.C. Initial and Second National Communications on Climate Change

Figure 2 - Composition of China's GHG emission by sectors in 1994 (A) and in 2005 (B)



Source: P.R.C. Initial and Second National Communications on Climate Change

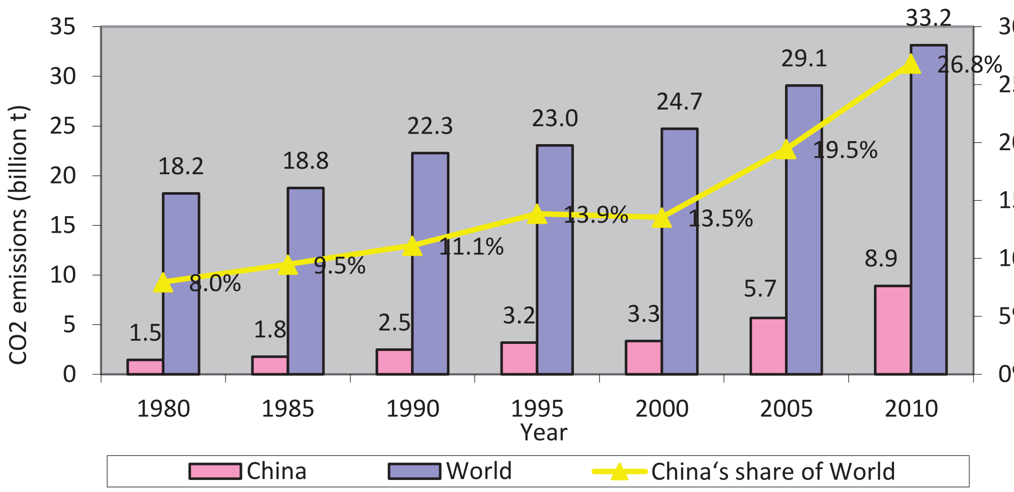
The International Energy Agency (IEA, 2011) and Climate Analysis Indicators Tool (CAIT, 2013) also estimated China's GHG emissions in 2005 before the second national inventory was released. Their results of 7,527 and 7,059 Mt CO_2e are not significantly different from the national statistics. The discrepancies can be partially attributed to inconsistencies between energy consumption data from the national statistical system and that of the IEA (Zhu, 2013). In the future, the Chinese government has committed to start reporting its emissions more frequently, even on a biennial basis as outlined in the Copenhagen Accord with the assistance from developed countries.

1.1.2. CO_2 emission trends in China

Due to a lack of official statistics on GHG emissions updated on a yearly basis, we used estimates of CO_2 emissions in the CAIT developed by the World Resources Institute (WRI) to illustrate carbon emissions trends in China (CAIT, 2013). Figure 3 presents the evolution of national CO_2 emissions and China's share of the world's total from 1980 to 2010. Figure 4 highlights the growth rates of CO_2 emissions and energy use in China from 1990 to 2008 (CAIT, 2013).

China's CO_2 emissions, excluding LULUCF, amounted to 8,896 Mt in 2010 and accounted for about 26.8% of the global total. As Figure 3 illustrates, while the national CO_2 emissions in 2010 were more than twice their 1990 levels, this growth occurred principally between 2002 and 2010 after a slight decrease during 1996-2000. Since 1978, following on China's Economic Reform and Opening-up, annual carbon emissions increased nearly 6-folds. But about 33% of that was produced making goods for export in 2006 compared to only 12% in 1987 (Wang & Watson, 2008). National CO_2 emissions have been evolving at the same pace as total primary energy consumption – the essential driver of CO_2 emissions.

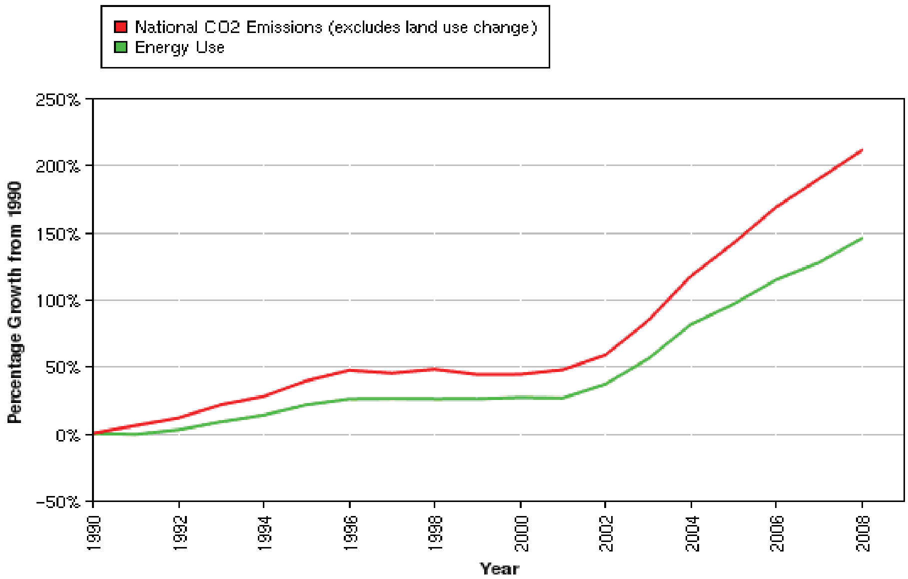
Figure 3 – China's CO_2 emissions evolution and global share from 1980 to 2010



Note: Data in the CAIT include CO_2 emissions from fossil fuel combustion, drawing from estimates by the IEA, and those from cement production, drawing from estimates by the Carbon Dioxide Information and Analysis Center.

Source: CAIT, WRI (2013)

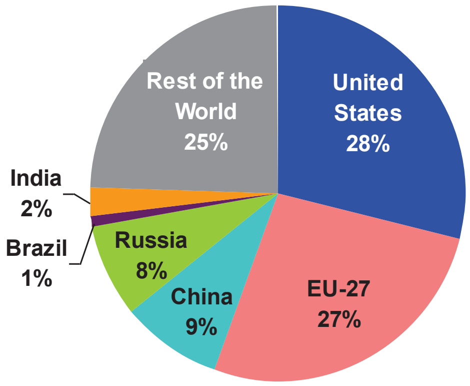
Figure 4 - Growth trends of CO_2 emissions and energy use in China from 1990 to 2008

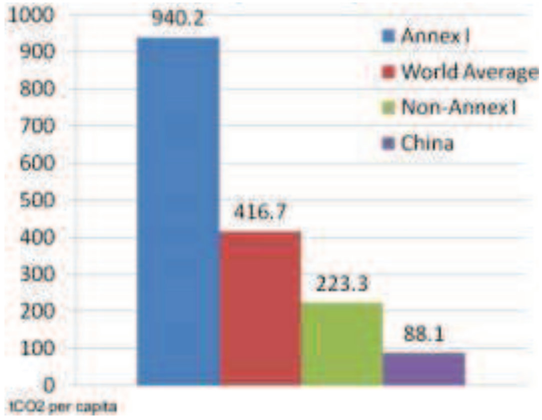


Source: CAIT, WRI (2013)

Although China is now the largest annual emitter of CO2, China is responsible for merely 9% of cumulative CO2 emissions between 1850 and 2006 (Figure 5(A)). In addition, its emissions per capita at 6.65 tons in 2010 were about one-third those of the U.S. (18.33 tons) and approached those of the EU-27 (8.08 tons). In terms of cumulative per capita emission (Figure 5 (B)), it is far less than the levels in developed countries. China therefore advocates taking into account these elements in considering its international mitigation obligations and equity in sharing atmospheric resources. The BP Energy Outlook 2035 (BP, 2014) predicts that per capita carbon emissions in China will surpass the EU in 2017 and the OECD average in 2033, but remain below the US level in 2035.

Figure 5 - World cumulative CO2 emissions 1850 – 2005: total (A) and per capita (B)





(A) (B)

Source: CAIT, WRI & Tsinghua University

1.2. Drivers of carbon emissions growth in China

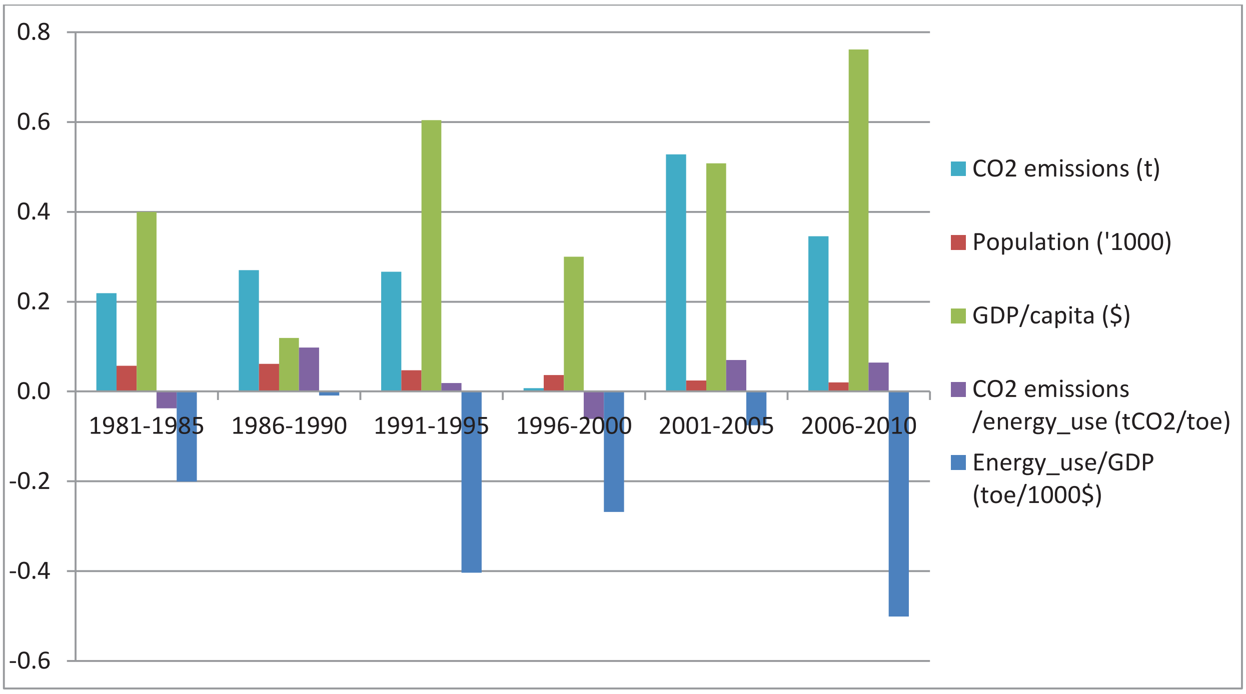
1.2.1. Drivers of CO_2 emission growth in the past

To help explain the causes of CO_2 emissions growth, carbon emissions can be divided into the following four drivers: population, per capita GDP, energy intensity of the economy, and the CO_2 content of the energy use (Kaya, 1990). The relationship can be expressed as:

$$CO_2\ emissions = population \times \frac{GDP}{population} \times \frac{energy\ use}{GDP} \times \frac{CO_2\ emissions}{energy\ use}$$

Among the drivers of China's CO_2 emissions, only the energy intensity of GDP has been in a steady decrease since 1980 (Figure 6) driven by policy interventions and concerted efforts, especially after 2005 (see section 1.3 for more details). Figure 5 also indicates that the growth in total CO_2 emissions in China from 1981 to 2010 was largely triggered by the increase in per capita GDP (responsible for over 70% growth), but was nearly inelastic to population growth. Being one of the fastest growing nations in the world since 1980, China's GDP has increased 30-fold in 30 years. The impact of China's carbon intensity of energy consumption on CO_2 emission was not consistent over time. It declined from 1996 to 2000 as the share of coal in the primary energy consumption declined from 73.5% in 1996 to 68% in 2002 while the share of oil rose from 18.7% to 22.3 % (NBS, 2011). The trend reversed when oil prices started to rise in 2002 and the share of coal reached 70.4% in 2009. Not only was more coal used in this period, but lower-grade coal with higher carbon content was used to meet the unexpected energy demand brought on by rapid economic growth (Levine & Aden, 2008). Carbon intensity of energy use increased by 15% from 2001 to 2010, contributing 8.8% to the increase in CO_2 emissions since 2001.

Figure 6 - Drivers of CO_2 emissions growth in China from 1981 to 2010



Note: For each period, the evolution of CO_2 emissions (expressed as a difference of natural logarithms) is presented by the first bar on the left, which is the net sum of the impact of the evolution of its drivers on the same period shown on the right.

Source: CO_2 emissions are from the CAIT database, GDP and population data from the World Bank database (2013), and the energy use from BP statistical review (2013)

1.2.2. Future trends of GHG emissions in China

It can be predicted that, in the near future, China's emissions will continue to rise rapidly with economic growth and social development. The key determinants that affect the trajectory of future emissions in China shall be the economic growth rate and the level of national efforts in lowering its energy intensity (Figure 6). Starting from a very low point of economic development, in 2010 China's per capita GDP was still less than half of the world average and far more behind the levels of the United States and the EU 27 (Table 1). The nation's development is also characterized by low energy efficiency or elevated energy intensity – 3 times higher than developed countries. In addition, due to a high reliance on coal, energy use in China's carbon intensity is higher than the US and the EU since the combustion of coal emits almost 30% more CO_2 than oil and over 50% than natural gas (BP, 2013).

In the future, if we assume that China reaches the EU living standard, holding levels of energy intensity and carbon intensity of energy use fixed at 2010 levels, its CO_2 emissions would amount to 60,145 Mt, about 8 times the current emissions. However, if China manages to achieve the same level of energy efficiency and technological improvements as experienced in the EU, China's CO_2 emissions would be 9,567 Mt, assuming a stable population and social development comparable to the EU. Even in this case, the emissions would be 35% higher than the current level. As coal is historically predominant in the energy supply in China, reducing the energy intensity will require substantial technological improvements and financial investments to develop clean coal and non-fossil fuels (in particular renewable energies).

Table 1 - Comparisons of levels of CO_2 emission drivers in China and other countries in 2010

Factors Unit	CO_2 emissions /capita tCO_2	Total CO_2 emissions Mt	Population Million	GDP/capita Current US$	Energy use/GDP toe/$	CO_2 emissions /energy use tCO_2/toe
World average	4.8	32900	6826	9307	231	2.8
U.S.	18.3	5670	309	48358	153	2.5
EU 27	8.1	4057	502	**32074**	121	2.3
China	6.7	8896	1338	4433	394	3.8
China to reach EU27 living standards	48.1	64357	1338	**32074**	394	3.8
China to reach EU 27 levels	9.0	12045	1338	**32074**	**121**	**2.3**

Given these challenges particularly in economic and social development, it may look rather difficult for China to put an absolute cap on its CO_2 emissions in the near or middle term[1]. Nevertheless, addressing the carbon intensity of the economy constitutes key elements of national mitigation strategies since such actions are more relevant to China's current development stage. According to the 'China Energy and CO_2 Emissions Report for 2050' (ERI, 2009), led by the government think-tank Energy Research Institute (ERI) of the National Development and Reform Commission (NDRC), the growth of national GHG emissions will gradually slow down towards 2020 and is likely to peak around 2030 if appropriate policies are put in place. Such actions are needed since China has to cope with a limited resource constraint[2] and its consequent environmental and health issues, now leading to growing public pressure.

[1] In May 2013 it was however reported that China could enforce an absolute cap on its carbon emissions as soon as 2016 as part of its 13th FYP but no official announcements have been made so far. This could, inter alia, unlock international climate change talks. See for example http://www.ft.com/intl/cms/s/0/61cd4ec6-c6b1-11e2-a861-00144feab7de.html#axzz2vC1K3g9k

[2] Of course this refers to the atmosphere's limited capacity to absorb GHG emissions. However China faces similar issues regarding water supply, if not worse.

2. China's Climate Policies

2.1. Brief history of China's Climate Policies

2.1.1. Framework of climate policy making in China

In order to better understand China's climate policies and its position in international negotiations, it is useful to have a look at the national context of Chinese climate policy-making. Originally, the Chinese Meteorological Administration (CMA), along with the Chinese Academy of Sciences (CAS) and the Ministry of Foreign Affairs (MFA), directed climate change coordination efforts to reflect China's initial perception of climate change as a scientific and international issue. As climate change evolved from a scientific topic into an issue also involving economic development and political negotiations, the State Planning Commission (SPC) became the hub for climate change policies in China in 1998. The SPC was renamed the National Development and Reform Commission (NDRC) in 2003 and holds the broad administrative and planning control over China's social and economic development.

NDRC's climate responsibilities are entrusted to the Department of Climate Change, including formulating key strategies and policies dealing with climate change, representing China in international climate negotiations, and coordinating the work of conducting national GHG inventories. Other ministries and government agencies participate in climate-related policy-making by providing their corresponding expertise. For example, the Ministry of Environmental Protection (MEP) formulates concrete regulations and standards, the MFA assists the NDRC in international climate negotiations, the Ministry of Science and Technology (MOST) provides technical advice, and the CMA participates in the work of IPCC[3].

2.1.2. China's engagement in international climate negotiations

China has been engaged in international climate change discussions since the early 1990s. It formally ratified the UNFCCC in 1992 as a non-Annex I country and the Kyoto Protocol on August 30, 2002, as a non-Annex B country. In the following years, although global warming gradually received more attention in China as well as internationally, no explicit climate goal was defined nationally. The First National Assessment Report on Climate Change (NARCC) was released in 2006, which assessed the impact of climate change on the full range of economic sectors and put forward both mitigation and adaptation policies and measures. The Second NARCC was published in November 2011.

Since 2007, climate change has quickly become a much-talked-about topic in both political and scientific spheres, and has rapidly emerged as one of the priorities on the Chinese government's agenda. The cornerstones of climate-related policies in China were the National Climate Change Program (NCCP), released in June 2007, and the China's Policies and Actions for Addressing Climate Change (CPAACC) in October 2008. The latter was updated by the NDRC on an annual basis. In addition, the National Climate Change Adaptation Plan was published in November 2013. These national communications outlined China's efforts both to mitigate and adapt to the impact of climate change,

[3] Should also be included the work of advisory think tanks such as Tsinghua University, National Climate Change Strategy Center, State Information Center, Energy Research Institute (ERI).

its long-standing positions in climate negotiations, and its consideration of integrating climate change into national economic and social development strategies.

Throughout various climate talks and negotiations, China has reiterated the principle of 'Common but Differentiated Responsibilities' that urges developed countries to bear primary responsibility for the historical concentration of GHGs in the atmosphere and thus to take the lead in combating climate change(Figure 5). China also states that developed countries should provide financial resources and technical assistance for developing countries to adopt appropriate measures to mitigate and adapt to climate change. As a non-Annex B country, China was not bound by any emission reduction obligations under the Kyoto Protocol, nor was it willing to take commitments that might constrain its economic growth.

With the issue of climate change continuing to heat up on the international agenda and as the top annual CO_2 emitter, China has been under increasing pressure from industrialized countries to take on more mitigation responsibilities. More importantly, the adverse impact on living conditions, agriculture production and health caused by rapid growth in carbon emissions at the national scale triggered wider discussion on the need for China to switch to a more environment-friendly development pattern. It seems that the climate change stake in China results more from national tensions than international pressure[4]. In this context, the Chinese government has begun to consider the possibility of making firm commitments on climate change. A notable milestone is China's climate mitigation actions submitted under the Copenhagen Accord, the core elements of which were the voluntary pledges to reduce its CO_2 emissions by 40-45% per unit of GDP[5] by 2020 compared to 2005 levels, and increase the share of non-fossil fuels in primary energy consumption to around 15%, forest coverage by 40 million hectares, and forest stock volume by 1.3 billion cubic meters by 2020 from 2005 levels. These engagements reflect both China's long-held position to conserve its development rights by putting an intensity constraint on carbon emissions, and its interest in making greater strides to reduce its carbon footprint.

China stepped up its efforts at the COP 17 in Durban, voicing its intention to be engaged in a post-2020 legally binding framework for emission reduction under certain conditions. This was the first time that China mentioned a timeline for taking on future legally binding obligations to control its emissions growth, although contingent upon progress of international climate talks and China's domestic development by 2020. Such proposals may be presented at the end of 2014 or early 2015.

2.2. From international commitments to national climate targets

2.2.1. The 12th Five Year Plan unveiled to make climate target domestically compulsory

[4] Local pollution has become a vital issue for local population. Particular matter indexes (PM 10, PM 2.5 etc.) are now the main topics of everyday life conversations. In particular the public tensions regarding air quality have escalated, notably since the unprecedented air pollution experienced by many regions of China in early 2013. The government reacted to this pressure by proposing plans to scale down air pollution, such as the "Air Pollution Prevention and Control Action Plan" released in September 2013.

[5] i.e. carbon intensity. The actual emission reduction target is output-dependent, meaning that the absolute emissions will still increase if the carbon efficiency is sufficiently improved, whereas other countries generally take on pledges to constrain emissions in absolute terms.

Early 2011 witnessed the translation of these voluntary international commitments into domestic policies as they were integrated into the national economic and social development plan, i.e., the 12th Five Year Plan (FYP). The Outline of the 12th FYP, released in 2011 to cover the period of 2011-2015, established the policy orientation of promoting green and low-carbon development. For the first time it dedicates a distinct chapter to climate change, thereby incorporating it as a major strategy into its schedule for economic and social development. It explicitly set out targets on both energy intensity and carbon intensity among a range of sustainable development goals. In the meantime, compulsory goals were set for the share of non-fossil fuel in China's energy mix, forest coverage and forest stock volume. While objectives for carbon intensity and forest stock volume were the first-ever to be introduced in a FYP, the other goals followed up on and expanded the ambitions of the 11th FYP (2006-2010). Table 2 illustrates the progression of energy and climate related targets in the 11th FYP, the 12th FYP and those for 2020.

Table 2 - Key energy and climate indicators in China's Five-Year Plans

Indicators	11th FYP (2006-2010) Target	11th FYP (2006-2010) Result	12th FYP (2011-2015) Target	13th FYP (2016-2020) Anticipated target	Nature of target
Energy Intensity (% reduction over 5 years)	20%	19.1%	16%	Not yet available	mandatory
Carbon Intensity (% reduction over 5 years)	NA	20.5% (ERI research)	17%	40-45% vs 2005	mandatory
Non-fossil fuels in primary energy consumption	9%[2]	9.6%[2]	11.4%	15%	mandatory
Forest coverage	Up to 20% from 18.2%	20.4%	21.7%	23%	mandatory
Forest stock volume	NA	13.7 from 12.5 Gm^3	14.3 Gm^3	15 Gm^3	mandatory
Annual GDP growth rate	7.5%	11.2%	7%	Not yet available	expected
National energy consumption[3]	NA	3.25 from 2.36 Gtce[1] (+6.6% annually)	4.0 Gtce (+4.2% annually)	Not yet available	expected
National electricity consumption[3]	NA	4192 from 2494 billion kWh (+10.9% annually)	6150 billion kWh (+8.0% annually)	Not yet available	expected

Note: 1. *tce* stands for metric tons of coal equivalent, unit used by China for energy statistics. 1 tce equals 29.31 GJ or 7 million kcal at low heat value.

2. The target was set for renewable energy instead of non-fossil fuel and was outlined in the 11th FYP for Energy Development -released in 2007.

3. Cap on total energy consumption and electricity consumption were identified in the 12th FYP for Energy Development, released in January 2014.

Source: Data compiled from FYPs and government reports

While the two compulsory targets of 17% cut in carbon intensity and 16% cut in energy intensity are both intensity-based, the "12th FYP for Energy Development" puts caps on total energy and electricity consumption to accelerate the country's switch from energy-intensive growth patterns and to limit exposure to energy dependence risks. The government intends to restrict the national 2015 energy consumption to below 4 billion tce and total electricity use to 6,150 billion Kwh. The suggested target of 4 billion tce implies that China will have to rein in growth of energy use at 23%, or 4.2% annually during 2010-2015: this corresponds to a massive effort considering domestic energy consumption increased by 37.7% over 2005-2010, or 6.6% annually. In 2013, energy consumption in China reached 3.76 billion tce or a 3.9% increase from 2012. In 2014, controlling excessive growth of total energy consumption topped the list of priority tasks put forward by the National Energy Administration (NEA), indicating China's urgent challenges in meeting its energy need. The energy consumption cap for 2014 is reported to be set at 3.89 billion tce.

The "12th FYP for Energy Development" also required the proportion of natural gas in primary energy consumption be increased to 7.5% and the share of coal be reduced down to 65%. In addition, the nation voiced its intention to launch a pilot program to cap the total coal consumption in Beijing-Tianjin-Hebei, the Yangtze River Delta, the Pearl River Delta and Shandong cities in 2014, prompted by the long-term wide-range fog and haze that shrouded many regions of the country.

2.2.2. Decentralization of carbon intensity and energy intensity targets

The Outline of 12thFYP lays out only national goals and the overall framework. It is up to individual ministries or the State Council to draft and implement concrete policies and measures to achieve these goals. The State Council published the "Comprehensive Working Plan for Energy Conservation and Emission Reduction for the 12th FYP Period" (hereafter the Energy Conservation Plan) in September 2011, and then endorsed the "Working Plan for GHG Emission Control" (hereafter the GHG Control Plan) on January 14, 2012. The GHG Control Plan was the first national policy document specifically dedicated to GHG emissions mitigation in China. It outlines both overall requirements and specific policy measures to be implemented and allocates emission intensity target to each province, autonomous region, or municipality (Table 3). China's 31 provinces were divided into 5 groups based on carbon intensity cut targets, taking into account the economic development level of each region.

Table 3 - Carbon and energy intensity targets at provincial level for 2015/2010

Provinces/ municipalities	Carbon intensity reduction target 2015/2010(%)	Energy intensity reduction target 2015/2010(%)	Provinces/ municipalities	Carbon intensity reduction target 2015/2010(%)	Energy intensity reduction target 2015/2010(%)
Guangdong	19.5	18	Hubei	17	16
Tianjin	19	18	Hunan	17	16
Shanghai	19	18	Chongqing	17	16
Jiangsu	19	18	Shaanxi	17	16
Zhejiang	19	18	Yunnan	17	15
Beijing	18	17	InnerMongolia	16	15
Hebei	18	17	Heilongjia	16	16
Liaoning	18	17	Guangxi	16	15
Shandong	18	17	Guizhou	16	15
Fujian	17.5	16	Gansu	16	15
Sichuan	17.5	16	Ningxia	16	15
Shanxi	17	16	Hainan	11	10
Jilin	17	16	Xinjiang	11	10
Anhui	17	16	Tibet	10	10
Jiangxi	17	16	Qinghai	10	10
Henan	17	16	**National Avg.**	**17**	**16**

Source: Energy Conservation Plan and the GHG Control Plan

Almost all provinces receiving higher targets than the national average had a GDP per capita greater than 30,000 RMB (2009), and provinces with targets less than 11% had GDP/capita less than 20,000 RMB (Guérin et al., 2012). Governments at the provincial level then allocated provincial targets to cities, counties and townships located within their administrative borders.

The same distribution work has been carried out for other mandatory targets, such as forest coverage and sink increases, and the renewable energy share in the national energy mix. The performance-based appraisal mechanism sets the fulfillment of these targets as one of the evaluation criteria for local governors, which will consequently affect their political career and promotion opportunities. This system of accountability will help to enforce the implementation of energy-saving and emission reduction policies. Such target allocation system will also be applied to the energy and electricity consumption caps; however, it may receive more resistance from local governments. Still, limiting energy use is seen by many experts as a first step towards the implementation of a nationwide ETS in China.

2.3. Climate policies and actions to meet mitigation targets

2.3.1. Climate and energy related policies throughout 2011-2015

To address both the economic development and climate change challenges, climate policies in China shall accommodate the GDP growth priority but reorient it to be less carbon intensive. In line with this core principle, policies in four fields were prioritized to control emissions: accelerate the adjustment of the industrial structure, promote energy conservation, develop low-carbon energy sources, and increase forest carbon sinks (Table 4). Most of the policies and measures for 2011-2015 under these four pillars showed a continuation and expansion of those defined for the 11th FYP period. They send a clear signal on the need to the transition to a low carbon economy.

In terms of adjusting the sectorial structure, a more ambitious goal was set for the growth of the service industry: 4% growth in GDP share from 2011 to 2015 (while only 2.8% increase was reached during 2005-2010), and the number of sectors forced to eliminate backward production technology and facilities increased from 12 to 19. With regards to energy savings, the number of firms brought under a national absolute energy-saving program was increased tenfold to hold more enterprises accountable for energy efficiency and conservation targets.

Renewable energy development is a key element of energy policies in China. The "12th FYP for Renewable Energy Development" (NEA, 2012) calls for a total of 4,780 million tce capacity from renewable energy to be built by 2015, accounting for at least 9.5% in the energy mix. One hundred and sixty million kilowatts (or GW) of new installed power generation capacity from renewable energy, including 61 GW hydropower, 70 GW wind power, 20 GW solar power and 7.5 GW biomass, are planned to make renewable energy provide over 20% of electricity generation in 2015. Efforts should be strengthened to integrate wind energy into the electricity grid, raise requirements for wind energy technology and quality, improve the subsidy system for solar energy, promote the application of distributed solar electricity generation, and reinforce renewable energy use in rural areas.

It should be noted that policies and programs listed in Table 4 are not exhaustive as some of the national programs were replicated at the provincial level and provinces also have the option to initiate innovative programs specific to the region. In addition, programs aimed at improving industrial structure, enhancing energy efficiency or promoting renewable energy may overlap to some extent, making it complex to evaluate the effects of individual programs. For example, the closure of a small state-owned power plant may be counted in the energy efficiency performance of the owner (under the 1,000 Energy-Consuming Enterprises Program), but also be counted as a sectorial adjustment accomplishment. Nevertheless, this overlap will not lead to double-counting of the national target achievement, which is evaluated by top-down national statistics rather than the sum of achievements by each program.

Table 4 - Major climate and energy related policies throughout 2005-2015 in China

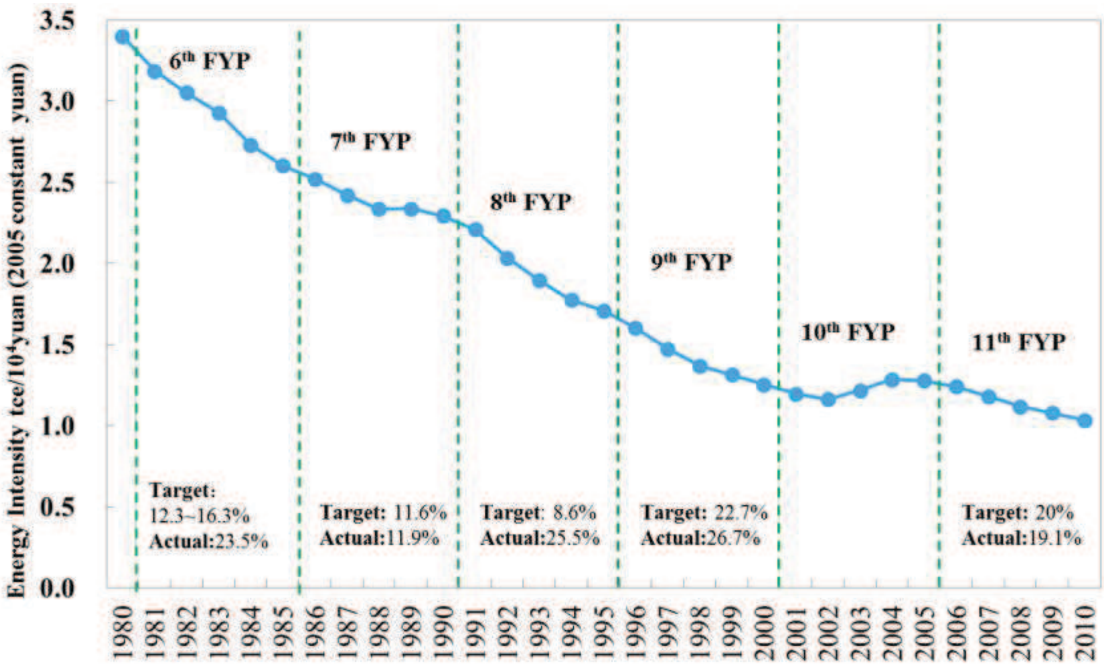
Policy pillars	Goals	Policies and programs
Sectorial structure adjustment	Raise the GDP contribution of the service industry and new strategic industries	- GDP contribution of the service industry rises to about 47% in 2015 up from 43% in 2010. - 7 new strategic industries specified in the 12th FYP: advanced materials, information technology, innovative equipment manufacturing, biotechnology, etc.
	Inhibit excessive growth of energy-intensive and emission-intensive industries	- Reinforce the entrance standards for energy-intensive industries by imposing taxes and raising safety, energy and environmental standards - Restrict the export of energy-intensive products - Prevent shift of polluting and backward production facility to central and west China - Introduce punitive electricity tariffs for energy-intensive industries
	Phase-out obsolete production facilities	The Ministry of Industry and Information Technology (MIIT) allocated concrete tasks of eliminating outdated and polluting capacities to provinces and individual enterprises and released the list of enterprises subject to public supervision in 19 sectors.
Energy conservation and energy efficiency improvement	Save the equivalent of some 300 million tce during 2011-2015 (Ten Key Energy Conservation Programs)	The billion dollar effort to provide financial incentives to promote a wide range of energy saving projects (coal industrial boilers or kilns, waste heat recovery/waste power recovery, petrochemical conservation or substitution, electrical machinery energy saving system and energy system optimization).
	Top-1000 Energy Consuming Enterprises Program in 11th FYP, extended to 10,000 Enterprises Program in the 12th FYP	This program involved initially the top 998 most energy-intensive enterprises in 9 industrial sectors, which accounted for 43% of the nation's total CO_2 emissions in 2006. The extended 10,000 enterprises program in fact covers more than 17,000 top emitters representing 2/3 of China's total energy consumption. They are required to achieve an absolute energy-saving target of 250 Mtce by 2015.
	Promote energy efficiency improvements in other sectors	Standards and detailed actions will be set for the building, transportation and rural energy use sectors.
	Foster market-based mechanisms	Promote energy service companies (ESCOs), energy cap and trade, trading of energy conservation certificates.
Energy mix	- Develop hydropower taking into account environmental protection - Develop safe nuclear power. - Promote wind, solar, biomass and geothermal energy adapted to local conditions. - Increase share of natural gas and clean coal.	The "renewable energy law", enacted in 2006 and amended in 2009, introduced a series of incentives: a provision for renewable portfolio standards (also called 'mandated market share'), feed-in tariffs for biomass, 'government-guided' prices for wind power, an obligation for utilities to purchase all renewable power generated, new financing mechanisms and guarantees (e.g., exempts renewable energy projects from local income taxation), and other market-enhancing provisions.
Forest coverage and sequestration	Afforestation programs, forestry conservation programs and restoration of desertification land	A range of indicators were set for 2015 in terms of land acreage dedicated to forestry and increase of restored desertification, wetland, and natural forestry conservation area.

Source: compiled by the authors from government laws, guidelines and plans

2.3.2. Energy intensity evolution in China

Since energy intensity and carbon intensity of the economy are internally correlated, the achievements of carbon intensity goal shall be to a large extent determined by the evolution of energy intensity. Figure 7 illustrates China's continuous decline in energy intensity despite an important increase in energy demand (Figure 4) from the onset of the economic reform in 1978 up to 2000. As a result, in 2000 the energy use per GDP was nearly two-thirds lower than it was in 1980. Ma et al. (2008) conducted a study to examine the drivers of this decline and concluded that technological change was the dominant factor in bringing down energy intensity while structural change at the industry and sector (sub-industry) level actually increased energy intensity over the 1980–2000 period. Seeing the actual overachievements of energy intensity targets subscribed to previous FYPs, the government removed the energy intensity target from the 10th FYP.

Figure 7 - Energy Intensity evolution during the FYP periods from 1980 to 2010



Note: Data were collected from FYPs; energy intensity (tce/10,000RMB) was calculated based on 2005 constant prices. The target is a reduction target.

Source: Climate Policy Initiative, Tsinghua University (2011)

As the Chinese economy moved into a phase of intensified industrialization and urbanization from 2001 onwards, energy intensity began to rise in 2002 and increased by 1.8% during 2001-2005. In response, the government re-incorporated an energy efficiency target into the 11th FYP and plotted out a diverse range of policies to promote energy conservation, energy efficiency improvement and renewable energy during 2006-2010. These actions reversed the upward trend in energy intensity that had been experienced in the 5 years prior to 2006. At the end of 2010, China achieved a 19.1% reduction in energy intensity against the 2005 level, barely missing the 20% target defined in its 11th FYP. According to the NDRC, this energy intensity improvement represents energy savings of 630 Mtce against the baseline, and a CO_2 emissions reduction of 1460 Mt during 2006-2010. Climate Policy Initiative, Tsinghua University (2011) concluded that energy efficiency improvement was the main driver of CO_2 emissions abatement (about 87% contribution) while a cleaner energy mix was a less significant contributor.

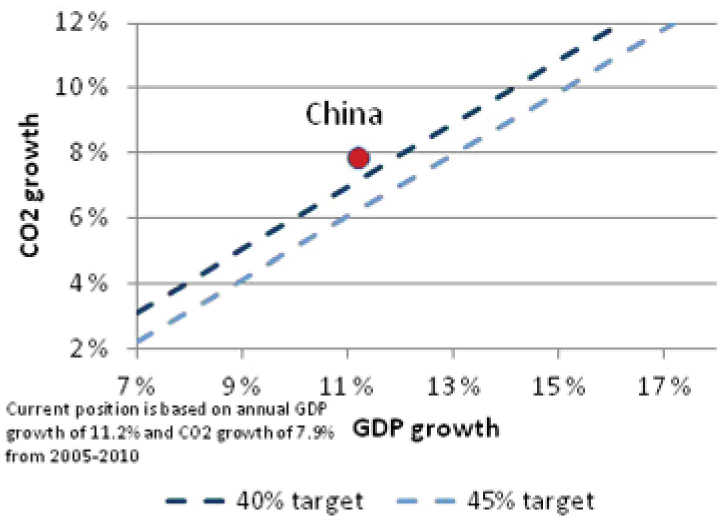
Although China almost achieved its energy intensity target under the 11th FYP, it did not come without difficulty, especially in 2010 when several provinces were still far short of their goals. Missing the assigned targets would negatively affect local officials' job evaluation and career promotion opportunities under the target accountability system. Under this pressure, some local governments adopted political intervention measures such as rationing power to industries, residential buildings, public lighting, and even hospitals in some cases. Such irrational blackouts and enforced power cuts disrupted industry production and people's lives and was quickly halted by the Central Government. This experience suggests that traditional administrative measures have been used to the full. To go further, stronger commitments on emissions and energy consumption shall require longer-term and sustainable mechanisms and additional policy measures, such as emission trading schemes that will be elaborated in Section 3.

China's energy intensity fell by 2% in 2011, 3.5% in 2012 and 3.7% in 2013 compared to the previous year. Such results imply that the energy intensity need to be brought down by 3.9% each year in 2014 and 2015 to achieve the 16% reduction target for 2011-2015.

2.3.3. Is China on track to meet its 2015 and 2020 climate targets?

Carbon intensity reductions are expected to bend China's emission curve in the next decade, although the rate at which total carbon emissions will continue to rise is largely dependent on the rate of GDP growth. Chai et al. (2011) plot China's emissions trajectory (Figure 8), which indicates that, if China strictly follows the expected 7% annual GDP growth rate defined in the 12th FYP, CO_2 emissions growth should be limited to 3.1% on a yearly basis and as low as 2.3% respectively for the 40% and 45% reduction scenario. The red point in Figure 5 indicates that the current development path, with GDP growth at 11.2% and CO_2 emissions at 7.9% during 11th FYP will not allow China to meet the upper range of its climate ambitions.

Figure 8 - China's position towards target reaching (2011-2020)



Source: Chai et al. , Point Carbon Analysis (2011)

Chai et al. (2011) also examine the possibility of China reaching the target relying solely on cleaner energy sources, concluding that a 15% share of non-fossil fuels in the overall energy mix in 2020, combined with average GDP growth rate achieved in the 11th FYP period, will make the 40% target achievable, while meeting the 45% target will require substantial additional efforts.

Reports from the Climate Policy Initiative (2011) point out that it will be challenging for China to meet its climate and energy related targets. The 4 trillion RMB economic stimulus package that the government initiated in 2008 in response to the global financial crisis maintained high economic growth rates and provided strong support to energy intensive industries. At the same time, many of the "low-hanging fruits" in energy efficiency savings have already been picked. For example, the replacement of small plants has nearly reached saturation and will offer very limited room for improvement in the next 10 years. The marginal costs of energy conservation and emission reductions will continue to rise, making the targets under the 12th FYP more difficult to achieve.

3. Carbon Market Development and Insight in China

Until mid-2013, China was familiar with carbon trading only insofar as it had participated as a major supplier of international carbon offsets but no domestic carbon pricing mechanism had ever been in place[6], with the exception of voluntary initiatives (see 3.1.3). In the past five years, China has been gradually considering and even implementing policies in order to rein in its emissions growth and secure a low-carbon path to modernize its economy. The launch of carbon market pilots is a considerable milestone and breathes life into a four-year-old intention that dates back to when the NDRC first expressed its desire to test carbon emissions trading in specific regions or sectors in 2009. A historical perspective of the implementation of the pilots is therefore laid out in Section 3.1, following from which, Section 3.2 outlines pilot markets' development and further design options in light of international lessons and best practices. In a fast-growing economy with a heavily regulated energy sector where climate policy had hitherto mainly consisted of command-and-control approaches such a shift towards carbon pricing mechanisms is bold and thus poses challenges and hurdles to overcome, which will also be presented. Since pilots are meant to generate valuable experiences and feedbacks on various design plans for carbon trading, Section 3.3 focuses on common Chinese ETSs' characteristics and the main different features across pilots.

3.1. From intention to determination: China's move towards carbon trading

3.1.1. Timeline of ETS pilot implementation

At the early stage, the idea of establishing emissions trading scheme in China was recommended by some experts since, as the major source of carbon offsets, China was handing its low-cost abatement opportunities to western countries and could be better off keeping them for itself in order to save room to maneuver in a world where carbon markets were then foreseen to expand quickly. This consideration, however, is not the main reason why Chinese policy makers started contemplating including carbon emissions trading in their climate change policy toolbox. Indeed it may rather be attributed to the fact that the potential of command-and-control regulatory approaches, which were until then extensively employed to deal with energy efficiency and conservation issues, had shown their limits. Therefore, reaching for stronger and sounder commitments on emissions and energy consumption required additional policy measures, such as a domestic ETS which had been eyed since 2009 when the NDRC first expressed its desire to test carbon trading through pilot schemes.

Since then, China's past and new leadership has reiterated its intention to rein in its carbon emissions and growth in energy consumption along with its interest in putting a price on carbon emissions through market-based instruments to tackle these issues together and expand the scope of its climate policy. It could help reduce emissions intensity and in turn, once a peak is reached, diminish emissions. A central question is then to agree on which policy instrument – or combination thereof – to apply and how to devise them to accommodate local specificities. Carbon trading was appealing to the Chinese

[6] However China already has more than 20 local trading platforms where firms can buy permits for pollutants like SO_2 and NO_X (acid rain program) as well as water and energy use. However the SO_2 markets are more state-led pseudo-markets than fully autonomous markets. It is worth noting that China introduced a RPS policy (Renewable Portfolio Standard) in 2007. These green electricity (non hydro) certificates are not tradable for now. One way to improve the system would be to render them tradable and possibly link them with carbon allowances. For more information on renewables support policy in China, see (Bonnet, 2014).

authorities in that it offered flexible options for companies in their compliance strategies while preserving some control for the authority, notably in incentivizing firms towards low carbon investments over the long term. This choice also relates to the necessity to alleviate the heavy dependence on traditional administrative policies to create a comprehensive and more effective policy system to address climate change.

China's commitments under the Copenhagen Accord were translated into national carbon intensity targets in the 12th FYP. It is the first official document that explicitly pinpoints carbon trading as a central policy measure in economic restructuring and shift of growth pattern. During the early debates regarding the ETS there were disagreements as to whether direct pilots on a sectorial or regional basis[7] but in October 2011, opting for a regional approach, the NDRC picked up five cities (Beijing, Chongqing, Shanghai, Shenzhen and Tianjin) and two provinces (Guangdong and Hubei) to be the so called seven pilots to test carbon emissions trading[8]. The national government entrusted the local authorities with the responsibility to design their own ETS based on soft national guidelines so that the various ETS plans could roughly converge on many design elements but there would be some leeway left for specific details to accommodate regional circumstances (see Section 3.2 for details). This diversity in features also allows for the pilots to provide feedback on different design elements and methods and on how carbon pricing affects regional economies. Drawing on these local experiences, the national government should be better prepared to design the features a potential national plan ought to contain, should such a roll-out come to life.

Despite this discretionary power, local DRCs had to submit their implementation plans to the NDRC for approval. These plans set the overall framework for market implementation, such as emission caps which need to be absolute, allocation rules, registry and oversight systems, and so on. Due to be launched over the course of 2013, only five out of seven pilots have started operation as of today while Hubei should kick off in the first quarter of 2014 and there is still no precise launch date for Chongqing. Generally speaking stock-taking, i.e. the process of verifying historical emissions in order to then determine the amount of permits to be allocated on a grandfathering approach, took more time than initially expected. Shenzhen ETS was the first to become operational in mid-2013 while Tianjin or Guangdong rushed to launch their ETSs according to schedule. As a consequence, official market regulations have not been fully released for all operational markets, and when so, they carefully elude important details[9]. A clear example of the great haste ETSs were launched in lay in that recent schemes still have non-fully operational registries, as in Tianjin where, albeit open for trading, the registry does not yet contain accounts for each participant.

In parallel to this bottom-up approach another stream of exploration of domestic carbon markets was carried out via voluntary offsets. Using a top-down approach this time, the central government

[7] Following on from its successful experience with Special Economic Zones (SEZs) the NDRC was certainly more inclined to first confine the experiment to some regions before expanding to the national level.

[8] In the very early stages, though, there only were 6 pilots. The city of Shenzhen then also directly applied to the NDRC to become an ETS pilot and NDRC granted Shenzhen its ability to carry out an ETS in November, 2012. More recently other regions or municipalities have expressed their desires to implement their own ETSs. For the time being however, the central government prioritizes the launch of the seven pilots before officially considering the question of additional regional markets. The Qingdao ETS, in the province of Shandong, could be the first of these additional ETSs to come to life, not until 2015 though.

[9] This opacity should be seen in a context where ambitious timetables were given to local DRCs for preparation. Details will be improved gradually over time.

provides local authorities with MRV protocols and procedures that need to be unified at a national level. In June 2012 the government officially released the interim VER Rules laying ground for a Chinese project-based offset market. Credits respecting these rules are labelled CCERs, standing for China Certified Emission Reductions. The entire approval process closely resembles that of the U.N. CDM mechanism with the NDRC being the counterpart of the CDM Executive Board in that it oversees methodologies, projects registrations and hosts the related national registry. CER producers located in China are also offered a possibility to convert their U.N. approved credits into CCERs via a recent re-registration process (more will be discussed in section 3.1.3).

The developments of carbon trading in China are intriguing to follow and comprehend for at least three reasons. The first is the unparalleled speed and scale at which China's economy is moving toward carbon pricing while keeping on growing. Assessing the implementation of carbon trading through such large scale experiments is indeed a bold move. The other two are that China is the first single-governing party to gradually implement a nation-wide ETS and that it builds its carbon market by degrees from the bottom-up, through regional markets. The bottom-up approach might set an example for timely issues of linking up carbon markets (Section 3.3) as well as provide lessons to the US/Canada, Brazil and Russia and other major economies contemplating implementing regional ETSs. Carbon trading implementation in China is also enthralling in that it faces some major challenges that are peculiar to its situation, some of which will be discussed below. However a thorough summary can be found in the first version of this paper (Wang, 2012, Section 3.4.).

3.1.2. Carbon tax versus ETS: which is possible in China?

Implementing a carbon tax was obviously another option that was assessed at the early stage of the debate in China. Although economic theory provides criteria to pick up the most suitable instrument to tackle climate change[10] it turns out not to be so relevant in practice since governments' concerns are not the same as economists'. Because an additional tax generally encounters public opposition, because firms are often adamant that they would be better off if they can manage their own liabilities in markets and because using a quantity control ensure a certain environmental target is reached, in practice, ETS are generally preferred to taxes[11]. Yet despite this choice authorities wish to control prices, at least to a certain extent, so price management mechanisms are often used (see Section 3.2.5.). As a result, ETSs have often more to do with hybrid schemes than purely quantity-based ones.

A traditional argument in favor of levying a carbon tax was that China did not have the market fundamentals to build a carbon market. Therefore, whereas an effective ETS was quite a challenge to implement, putting a carbon levy on emissions presented itself as a rather straightforward fallback option for it is a policy relatively easy to handle which the government was already familiar with. That is why in parallel to the inception of the ETS, the government continues to give some thoughts as to whether to introduce a carbon tax in China. The MOF, MEP and NDRC initiated relevant research studies as early as 2009 and released reports that gave different suggestions in terms of tax rate, introduction period, taxpayers, use of tax revenues and other aspects (see Annex 1), but agreed on the limited impacts that a carbon tax would generate on GDP and positive incentives signaled to emission reduction. In May 2013, the carbon tax was listed as one of the environmental taxes proposed in the

[10] In the case of shallow marginal benefits under uncertainty (Weitzman, 1974) would recommend to use price control (tax) over quantity control (ETS).
[11] Of course this debate has not yet been settled.

"PRC Environmental Protection Law (draft version)" submitted by the MEP. In short there are still strong different positions on this issue in China with NDRC backing ETS while the MOF and the MEP supporting tax.

As common in countries where ETS and carbon tax co-exist, it may indeed not be desirable to include small emissions sources in the ETS for it would raise transaction costs, in particular when the level of reliability of MRV cannot meet ETS standards. Carbon equivalent taxes can instead be used for that purpose. Furthermore, a carbon tax can be very appealing when there are other tax schemes already in place that can be used to channel the new levy. Although imposing a carbon tax reduces the market depth for other market participants and brings about undesirable effects should tax adjustments/exemptions be made, higher prices and therefore better incentives can be reached with a tax[12]. Another option, especially relevant in the case of transport, is upstream liability on fossil fuel distributors. At the international level, there is a consensus building up around the idea of joint and complementary use of carbon trading and tax (hybrid policy scenario). While the market would deal with big emissions sources above a certain threshold, the levy would cover small and harder-to-reach emitters, such as buildings, SMEs, etc.

3.1.3. Voluntary market: how could it be useful to market development in China?

Poor capacity and infrastructure present major hurdles in the early development of emission trading schemes. The voluntary market could help to some extent to alleviate this albeit its small size compared to a regulated market (Guigon, 2010). Indeed, in order to bring transparency and credibility to nascent domestic voluntary carbon trading, which emerged in early 2009 (see Box 1), and more importantly to consolidate the ground for a Chinese project-based offset market, the national government released the VER Measures (Measures for management of Voluntary Emission Reductions Transactions in China) in June 2012. In doing so, the NDRC intends to centralize the management of offset credits eligible for compliance use in the 7 ETS pilots through the generation of CCERs so that it might ease and boost ETS development.

- ***Eligible methodologies***

The VER Measures require all projects aiming to obtain CCERs to use methodologies approved by the NDRC. As of February 2014, there are 177 such approved methodologies, 173 of which stem directly from existing CDM methodologies, including the notoriously controversial HFC-23 and N_2O adipic acid destruction methodologies that are now banned from use in the EU ETS, with modifications according to China's circumstances. The four new non-CDM methodologies target emissions reductions from forestry and land use[13]. When submitting a new methodology for approval, similar to the CDM process, a relevant project design document must be attached. After receipt of the submitted documents, the NDRC will commission experts to conduct a technical assessment, which should be completed within 60 working days. Following on from the experts' review, the NDRC shall deliver a notification within 30

[12] For example see (Pezzey & Jotzo, 2013). They advocate that tax-based mechanism could work better if they include assistance to industry in the form of tax-free thresholds. Higher cuts in emissions could be reached with the same amount of money being paid by compliant entities.

[13] The four methodologies are "Carbon sequestration forestation methodology", "Bamboo forestation methodology" and "Improved forestry management methodology" and the "Sustainable grassland management methodology"

working days, so that such project holders must wait up to 90 working days to see their methodologies approved.

Box 1: Early Voluntary Emission Reduction Initiatives in China

Several VER initiatives were launched starting from 2009 to test the ground for fostering mitigation activities in the agriculture and forestry sectors.

- The Panda Standard (PS), China's first third-party standard for domestic offset projects, was undertaken by the China Beijing Environment Exchange (CBEEX) and Blue Next in late 2009 and aims to establish itself as a broadly accepted initiative and official tool to serve China's climate mitigation efforts, should a carbon scheme emerge in the future. As the first transaction in March 2011, 16,800 PS credits, to be issued from the Bamboo Forestation Project in Yunnan province, were acquired by state-owned Franshion Property Company at 60 yuan (about 7.1 €)/t CO_2e.
- The China Green Carbon Foundation operates under the administration of the State Forestry Administration and mobilizes enterprises, organizations and individuals to take part in voluntary tree planting and forest protection activities by donating to the Foundation. It claims[14] to have completed several forest planting projects to offset emissions from several conferences.
- Several other voluntary projects have also been initiated in China, including those coordinated by the U.S. Environment Defense Fund on household biodigesters and soil fertilization in rural areas. In these cases, the credits buyers are large American corporations, rather than domestic entities (Lin et al, 2011).

- ***Project eligibility***

Four kinds of projects are eligible to request for registration with NDRC: (*i*) new projects using methodologies registered with the NDRC; (*ii*) CDM projects already approved by the NDRC (acting as the designated national authority (DNA) in the CDM process) but not yet registered with the CDM EB; (*iii*) CDM projects which had previously generated emission reductions prior to registration with the EB, e.g., pre-CDM credits (should be without CER issuance); (*iv*) registered CDM projects yet not issued CERs.

The project starting time should not be prior to February 16th, 2005. To be granted CCER credits, the interim VER Measures recognize GHG reductions from the 6 approved GHGs under the UNFCCC or removal enhancements achieved by an offset project. Type (*iii*) credits are a subject it is noteworthy to dwell on for a moment. Registered CDM projects that have already been issued CERs can request CCER issuance for pre-CDM registration emission reductions only, all the while being allowed to remain in the CDM registry for further CER issuance. Again, registered CDM projects that have not yet being issued CERs can apply for CCERs for pre-registration emission reductions but are allowed to choose whether to remain under the CDM to receive CERs for planned reductions or to switch to the Chinese pipeline and request CCER issuance for these planned reductions, like type (*iv*) credits.

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[14] For example, the total emissions of the UNFCCC Tianjin Conference were offset by the CGCF forestation project in Shanxi, and the carbon footprint of the 2012 China Green Annual Conference was compensated by CGCF forestation project in Inner Mongolia (http://nmsgjhc.com/Article/ShowArticle.asp?ArticleID=536).

However there is still much uncertainty left for the time being. First, it is unclear whether projects no longer eligible under the EU ETS (e.g. projects destroying HFC-23 and N_2O), albeit theoretically eligible for credits, and those previously receiving NDRC approval but rejected by the EB, would actually generate CCERs for the domestic market. The latter projects will certainly have to reapply with modified documents to the NDRC. No such projects have sought approval so far. It is also still questionable as to whether NDRC will in turn approve pre-registration credits from CER-issued CDM projects to enter its offset market.

- ***Project registration***

While foreign as well as national entities and individuals are allowed to buy CCERs, only business entities registered in the P.R.C are authorized to apply for project registration. Central-level, large state-owned enterprises (SOEs) [15] supervised by the State-owned Assets Supervision and Administration Commission of the State Council (SASAC)[16] are allowed to request project registration directly with the NDRC; other business entities must first get approval from relevant provincial DRCs – the counterpart of the DNA under the CDM. SOEs are therefore likely to be subject to shorter registration periods.

Similar to the CDM process, project validation by a NDRC-accredited third party is also necessary, prior to request for registration. The CCER Project Validation and Verification Guidelines were published by the NDRC in November 2012, outlining requirements for entities seeking accreditation with the NDRC as well as the principles, procedures and requirements of validation and verification. As of January 2014, China Quality Certification Center, Guangzhou CEPREI Certification Body and China Environmental United Certification Center have been accredited as eligible validators and verifiers for CCER projects. These three accredited CCER auditors are all domestic Designated Operational Entities (DOEs) under the CDM. This list may extend but it seems unlikely foreign DOEs will be able to get accreditation. The guidance on public review, document review, possible site visit and other procedures resemble those in the CDM Validation and Verification Manual. The technical assessment shall be completed within 30 working days, followed by registration decision-making within another 30 working days.

- ***CCER issuance***

To request CCER issuance, the verification report, completed by a qualified verifier, along with the monitoring report, needs to be submitted to the NDRC. Project validation and verification are allowed to be carried out by the same entity, except for projects with annual emission reductions exceeding 60ktCO_2e. Again, 30 workings days are prescribed for both technical assessment and issuance notification.

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[15] This also includes their subordinate and holding companies. The SOEs list eligible to directly request for project registration at the NDRC is attached at the end of the Measures (in total 43 SOEs).

[16] SASAC is a special commission of the PRC directly under State Council. SASAC consolidates the management of 117 (number to date) central-level, large state-owned enterprises (SOEs). It is responsible for supervising and managing the SOEs, guiding the share reform and restructuring of SOEs, appointing top executives of the key enterprises and evaluating their performances and drafting laws related to SOEs regulation.

- ***CCER transactions***

As of February 2014, about 70 projects were open for public comments as part of the project "validation" process on the China Certified Emission Reduction Exchange Info-Platform[17] but no projects have been officially registered yet. It is worth noting that while most of these projects are wind, hydro and solar energy and half have been registered by the CDM EB, of all the 70 projects, there is only one project in Guangdong which intends to request CCERs through carbon-sequestration by afforestation. CCER transactions will be restricted to trading platforms recognized by the NDRC, and their trading systems should be connected to the national VER Registry to track real time transfer of CCERs. In January 2013, China appointed five exchanges (the environmental exchanges in Beijing, Tianjin, Shanghai, Guangzhou – in Guangdong province – and Shenzhen) to host CCER trading. Until January, two transactions have been completed for yet-to-be-issued CCERs, with two branches of China National Petroleum Corporation purchasing 10k CCERs each, from two wind power projects at a price of ¥16 and ¥20 per ton.

3.2. Status of carbon market development in China[18]

This section reviews the design elements of the various pilots. The general rationale behind each feature is exposed first, followed by its applicability to China. The latter comprises the pilots' developments when they are known or, failing this, our suggestions. It will soon be clear in what way the pilots differ on some specific details to accommodate regional specificities but also test various design elements and combinations thereof as a basis for designing the national market eventually. For that purpose and to allow for a quick overview, Table A in Annex 2[19] briefly summarizes these various market design features. Informations presented below may seem fragmented and insufficient. However they are generally not disclosed and kept private. Guangdong ETS is a notable exception, since informations relative to regulation or auctions are rather transparent.

3.2.1. General features and comments

In order to assess the impact that a carbon price would bear on the economy, the seven pilots must reflect the diversity in economic and social development that prevails throughout the country (see Table 5). The seven pilots can be roughly classified into 3 groups depending on their economic and energy features:

- With high GDP per capita and low carbon and energy intensities, Beijing and Shenzhen comprise the first group;
- The second group is composed of Tianjin, Shanghai and Guangdong with similar GDP per capita as the first group but with relatively higher carbon and energy intensities;
- The third group is made up of Hubei and Chongqing with lower GDP per capita and higher carbon and energy intensities.

[17] See more on http://203.207.195.145:92/ccer.aspx

[18] For more details on experiences from international carbon trading, see (Quemin *et al.* 2013) or (WB, 2013). For more detailed information on the Chinese case in light of international best practices, refer to (Jotzo, 2013).

[19] We will henceforth use Table A to implicitly refer to Table A in Annex 2.

Not surprisingly the latter regions are those which could not meet the deadline to launch their ETSs in 2013. Again, it should be noted that a tight, if not unrealistic, schedule was given to pilots to implement their ETSs. With no precise launch date and an unsettled market design, Chongqing is the ETS that struggles most to catch up with its counterparts. When comparing regional figures with national ones it is apparent that pilots have been given more stringent targets than the national average. In Shanghai, Shenzhen and especially Beijing, industry now constitutes a lower share of economic activity while they have large service sectors. They therefore have rather small industrial emissions and could see their emissions reach their peaks in the near future. Meanwhile other pilots still rely more heavily on the secondary sector. Figure 9 shows the proportions of the power, cement and steel sectors that are invariably covered under each ETS. They tend to vary between regional carbon inventories.

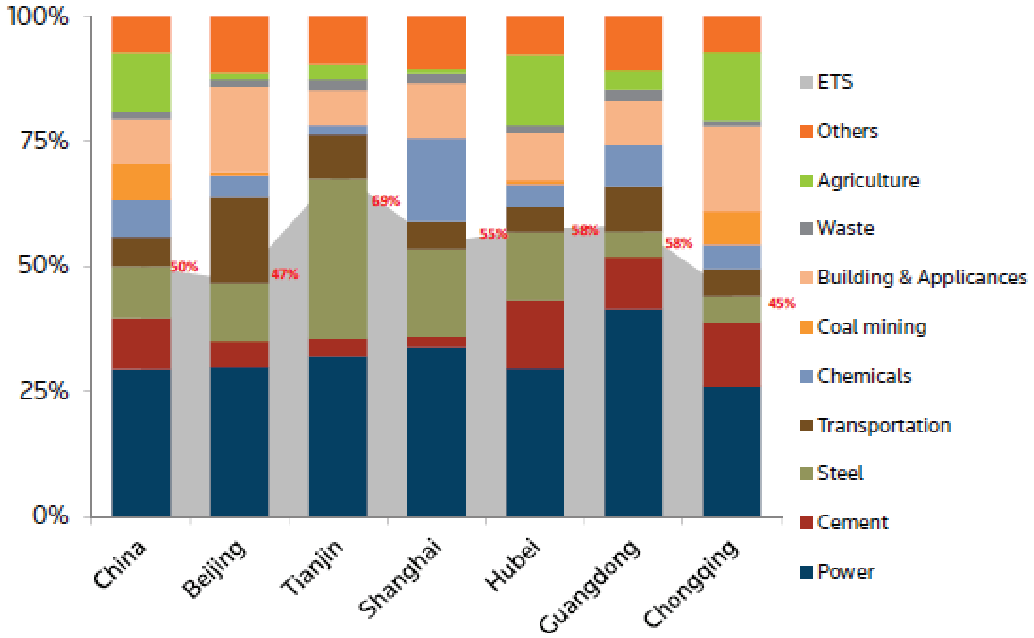
Table 5 – Economic figures in 2010 for the pilots

Group	Regions	Population (million)	GDP (yuan billion)	GDP per capita (yuan 1000)	2ndary sector's share of the economy (%)	CO_2 emissions (million tonnes)	Carbon intensity (tCO_2/10,000yuan)	Energy intensity (tsce/10,0000yuan)	Carbon itensity target (2015/2010) (%)	Energy intensity target (2015/2010) (%)
1	Beijing	19.6	1411.4	75.9	24	110	78	0.493	-18	-17
	Shenzhen SEZ	9	958	106	47.5	83.4	87	0.812	-21	-18
2	Shanghai	23	1716.6	76	42.1	230	134	0.653	-19	-18
	Guangdong	104.4	4601.3	44.7	50	541	118	0.585	-19.5	-18
	Tianjin	13	922.4	73	52.4	155	168	0.740	-19	-18
3	Hubei	57.3	1596.8	27.9	48.7	306	192	0.948	-17	-16
	Chongqing	28.9	792.6	27.6	55	131	165	0.991	-17	-16
	Pilots' subtotal	255.2	11999	47	-	1556	130	0.689	-	-
	Share of PRC %	19	38	-	-	18	-	-	-	-
	PRC	1341	31234	29.9	46.8	8900	206	1.030	-17	-16

Sources: China Statistical Yearbook (2011), Point Carbon Carbon Market Monitor, ICAP Interactive Map. Authors' calculations.

Inclusion in the ETS is mandatory for liable firms, with some pilots indicating that non-liable companies may opt in should they wish to join the ETS. The pilots are meant to operate until 2015 and nothing has been officially scheduled for post 2015. Guangdong stands out as an exception since it has announced a phased system similar to that of the EU. When compliance timeline is known, verified emissions reports are due on April 30 of each year for emissions in the previous calendar year. The deadline to hand over the necessary amount of permits to cover these emissions is June 30 at the latest. Compliance timelines vary across pilots, e.g. with compliance in Tianjin ETS due to take place on 31st May of each year while compliance dates range between mid- to late-June in other ETSs.

Figure 9– Share of CO_2 emissions by sectors in pilot regions.



Notes: Shaded areas represent the common minimum set of sectors covered by each pilot, namely power, cement and steel. Some data are from McKinsey 2009 report.

Source: Point Carbon Carbon Market Monitor.

As shown in Table 6 allowance prices vary from 26 yuan in Tianjin to 80 yuan in Shenzhen at the time of writing. Appended figures and tables (see Annex 3) show allowance prices and traded volumes in the five operating pilots with varying accuracy depending on the pilot. In Shenzhen, prices have greatly fluctuated since its kick off in June last year with inaugural prices at around 30 yuan per ton. They rose to 130 yuan in mid-October[20] and have stabilized at around 75 yuan since late November. As for traded volumes, they have been rather limited with a long period of complete inactivity following the market debut. This significant volatility in prices can be attributed to the market's limited liquidity. By contrast daily prices have been rather steady in Beijing and Tianjin at around 50 yuan and 26 yuan respectively. With an initial range between 25 and 27 yuan, prices in Shanghai have risen to around 40 yuan. It is interesting to note that some 2014 and 2015 vintage SHEAs (Shanghai Emissions Allowances) have already been exchanged on the opening day, at a discount compared to SHEA13[21]. Although volume still remains rather limited it is noteworthy that the Shanghai and Beijing ETSs have recently seen a surge in activity. On the inaugural day (December 19) in the Guangzhou exchange price levels matched expectations, in line with the reserve price (60 yuan) set for the first government auction on December 16. First transfers of GDEAs (Guangdong Emissions Allowances) effectively occurred at 61 yuan (20k GDEAs) and 60 yuan (100k GDEAs) (Point Carbon). Since then, only 100 GDEAs have been transacted.

[20] "Roughly speaking" ETSs are often quite price-sensitive in their early stages as seen in Europe or New Zealand.

[21] It should be noted from the start that it does not mean that spot prices will move that way in the future. In theory it should reflect the current inter-temporal trade-off between agents' bearish/bullish market expectations. However, trying to comment on this would be irrelevant for at least three reasons: (1) the first day transactions are rather symbolic; (2) in Shanghai there has been a one-off free allocation for 2013-2015 so there might not be much difference between SHEA13 SHEA14 and SHEA15; (3) no other SHEAs14-15 have been traded since then so there is only one snapshot (forward curve) available to analyze. In short we believe future years' allowances have been traded once on the debut day mainly for marketing purposes.

In order to boost supply, 5 million GDEAs were on offer at the second government-held auction on January 6, 2014 with a minimum price of 60 yuan. Contrary to the first auction in December, the auction was not fully subscribed with only 3.89 million carbon permits eventually being sold. Bids ranged from 60 to 65 yuan, the market therefore clearing at 60 yuan per permit. This first auction was oversubscribed with some bids exceeding the overall available amount and therefore the 3 million permits available were sold at the minimum price. Highest bidding reached 81 yuan but the sale cleared at the floor price in accordance with the local auction rules[22]. More recently on February 28th, the third auction was held and 1.13 Mt were sold at the minimum price out of the 2 Mt that were on offer. Bids ranged between 60 and 80 yuan[23].

Table 6 – Comparative table of transaction prices and volumes (from debut to February 28, 2014)

Pilot System	Unit	Shenzhen	Shanghai[1]	Beijing	Guangdong[2]	Tianjin
Cumulative volume	kt	210.7	62.9	15.5	120.1	79
Price range	¥/t	28-130	27-46	50-55	60-61	25.5-30.3
Average price[3]	¥/t	70.5	64.3	51.5	60.2	27
Transaction amount	k¥	14,844	2,162	800	8,143	2,130

Notes: Data used for these calculations is laid out in Annex 3. Reminder: 1 US$ = 6 yuan; 1€ = 8 yuan.

1 only accounts for SHEA13 transfers.

2 does not take into account results of government-held auctions (3 Mt + 3.89 Mt + 1.13 Mt until now). Only transfers between participants.

3 volume-weighted average since debut to Feb 28, 2014.

→ In Beijing and Tianjin there have also been 2 and 1.25 million transfers by agreement, not included in the table.

Sources: CEEX in Shenzhen; CBEEX; CTEEX; CNEMISSION; CNEEEX; Shenzhen ETS 2013 annual report, Point Carbon. Authors' calculations.

Although there is a spread between regional carbon prices in China, it does not necessarily reflect differences in the scarcity of permits but rather in how companies feel like they are likely to be short or long. Notwithstanding the relative secrecy about the method employed by local authorities to compute the overall cap[24] – whether it is purposely done so as to have a long or short market – it is the arduous task of transcribing both intensity and national objectives into both absolute and regional ETS targets respectively, that brings about uncertainty. That being said, there are three other sources of uncertainty regarding the allowance price levels resulting from a given cap trajectory. The first is the emissions growth momentum. It is made up of economic growth, how and how fast does the economic structure change, and technological innovations. It determines how much effort is *in effect* induced to keep emissions under the cap[25]. The second relates to the abatement response of the economy, which is troublesome to foresee since China has not had any experience in carbon pricing yet. Depending on

[22] In Guangdong auction rules state that the lowest successful bid determines the clearing price in case of oversubscription. When subscription is less than offered allowance amount, the reserve price shall be the clearing price.
[23] See http://www.pointcarbon.com/news/reutersnews/1.4347833
[24] It is indeed quite difficult to get a precise idea of how much emissions will be covered by the ETSs. Often there are no official figures and estimates may vary by twice as much.
[25] Two cases in point: In Europe, the economic slowdown has had repercussions on energy demand that rendered the cap slacker thereby reducing the EUA price. The development of shale gas in the US is another example.

the shape (steepness mainly) of the marginal abatement curve the emissions cap may appear more or less hard to meet. The third has to do with the uncertainty inherent in China's future climate policy. Price levels generally vary depending on how likely and stringent the future cap trajectory is perceived. A good example is that of the EU ETS where the present low price levels reflect how little confident agents are about the actual stringency of the long term constraint[26].

The relative inactivity of markets is not surprising, in the sense that this little activity is reminiscent of the debut of the EU ETS. Back then the EU had to boost trading by encouraging companies to participate in the market to help build confidence. It is likely that China will do the same as it intends to allow time for both liable entities and exchanges to learn and garner experience in carbon trading as well as demonstrate the capabilities of carbon finance. However traded volume will remain rather limited, in a bid to move progressively towards fully operational markets. As will be explained in greater detail later in the paper[27] there is another reason why we do not foresee that trades of allowances will gain momentum in the coming months. We rather believe that the offset market will see the bulk of trading activity, at least until 2016, i.e., during the pilot phase. The reason behind it is that there is much uncertainty regarding the fate of allowances which are likely to have no value once the pilot phase is over (no carry-over provision). Therefore it is our opinion that allowance trading will be confined to bargaining between liable companies and respective local governments rather than between companies themselves. This, of course, will also depend on the actual stringency of caps. Offsets, on the contrary, may have a higher long-term value since they are likely to be a central part of the future scheme.

In line with confidence-building and market stabilization at the early stage, trading products will be limited to regional allowances and national offsets since no derivatives such as futures will be allowed during the pilot phase. Although this may assuage initial fears of market risks, trading rules will have to be made more flexible in the future so as to guarantee enough liquidity to both integrate various compliance strategies and provide clear price signals. It is also worth noting that in China carbon is treated as a commodity and not as a financial product. There is only one quotation a day and not a continued intra-day quotation. Since only spot transactions are allowed, non-covered individual investors or entities, such as financial institutions, should be excluded from trading.

3.2.2. Coverage

General Rationale

(1) The broader the coverage of emissions sources – both on a regional or sectorial basis – the bigger the overall cost effectiveness and the more flexible the abatement response and consequently, the larger the incentive to curb emissions.

(2) Starting with sectors accounting for a large share of emissions where transaction costs are minimized to ease early functioning, the scope of an ETS can then be extended over time with additional sectors being progressively phased in on a schedule known in advance.

(3) There are thresholds for direct liability under the scheme so as to limit both overall compliance and administrative costs. This however causes distortions via cut-off effects both small

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[26] Albeit falsely so, it is often said that low prices result from the allowance surplus. Low prices rather demonstrate that agents do not see the long term target as credible/stiff enough.

[27] See sections relative to linking and offsets.

emitters are not incentivized to curb their emissions and firms located just above the threshold may find it advantageous to reduce emissions to fall below the limit. Coverage gains and transaction costs are increasing concave and increasing convex functions of the inclusion threshold, respectively.

(4) Since carbon trading inherently brings about transaction costs[28] direct downstream liability can in some cases become economically-inefficient. It might therefore be complemented and replaced by upstream liability, and equivalent taxes or standards in sectors where pricing instruments are unpractical. Provided that distributors can effectively pass on the carbon price to consumers, upstream liability on distributors can potentially and indirectly cover all fossil fuel uses and small emitters, which reduces the number of liable entities, thereby cutting transaction costs.

Applicability to China

In line with *(1)* and as most existing ETSs in the world, the pilots in China cover emissions from fuel use and combustion in the power sector and (heavy) industries (cement, iron, steel, etc.)[29]. Public and commercial buildings are sometimes included as in Beijing, Shenzhen or Tianjin. Transport is generally excluded from the scope for now, with the exception of the Shanghai ETS which includes aviation[30], but may also be included in the future. For example the newly released regulation in Guangdong ETS indicates the inclusion of transport and Shenzhen has already carried out extensive preparatory work in this way (for road transportation in this instance). While some pilots like Tianjin concentrate on a limited number of energy and industry sectors, almost all sectors of the economy are capped in the Shenzhen ETS. The Chongqing ETS may also well target emissions from forestry but this remains hypothetical. To account for their large service economy and so as to increase their emission coverage Beijing, Shenzhen and Shanghai all have obligated major service companies to be liable under their ETSs.

With potential future expansions, the scopes of the schemes are therefore likely to broaden over time *(2)*. For instance, up until the Guangdong DRC published its new regulation on January 15th, 2014[31], it had hinted it would expand the scope of its scheme to further encompass five new sectors including ceramics, textiles, paper and plastic production and non-ferrous metals. The transition to Phase II in 2016 would also have comprised the inclusion of transport and construction/buildings. However, in its new regulation, the government opted for immediate inclusion of transport as well as buildings as of March 2014 and lowered its inclusion threshold so as to broaden its ETS base. Such phased inclusion of additional sectors may give time to gather experience and draw up more detailed guidelines which can then be adjusted to fit better. Setting regional or sectorial coverage aside, which gases are covered is also a relevant point. For the moment being the pilots only take account of CO_2 emissions. Although nothing has been stated, the scope of GHGs covered may widen in the future.

[28] That is costs of market participation as well as costs of MRV since emissions data must meet some standards of accuracy and reliability.

[29] Generally these are large sources of emissions where accurate measurement is already in place (therefore easy and low-cost) with plenty of abatement options available.

[30] The six Shanghai-based airlines are required to surrender permits for their domestic commercial flights. One cannot help but be reminded of the ongoing disagreement between China and Europe over the issue of the incorporation of aviation to the EU ETS. As in the EU ETS, Shanghai's endeavor to include aviation could eventually be scaled up to a multiregional level.

[31] Due to enter into force on March 1st. See: http://www.cnemission.com/article/zcfg/201401/20140100000638.shtml

Roughly speaking the relative sizes of liable companies are somewhat smaller in cities than in provinces, which may explain why inclusion thresholds are generally lower in municipalities than in provinces, where covered sectors are much like those in Europe, namely power and big industries *(3)*. In Tianjin, Chongqing and Shanghai the inclusion threshold is 20 $ktCO_2e$ per year while cut-offs are lower in Beijing, Shenzhen and Guangdong, so that, on the whole, relatively more companies are enrolled in these three pilots when compared to the size of each market. As part of Guangdong's new regulation, the inclusion threshold is to shrink to 10 $ktCO_2e$ for industrial entities and to 5 $ktCO_2e$ for other liable sectors, from 20 $ktCO_2e$ earlier. In Hubei, on the other hand, the threshold is much higher and only a restricted number of big emitters are included. This latter provision, if combined with measures to incentivize small emitters, may be a rather promising feature *(4)*. It may indeed be desirable to implement a "rather high" threshold for direct liability under the ETS and include smaller emitters via, say, upstream coverage of fuel distributors. Upstream liability may become really attractive an option when the vast majority of emissions derives from a plethora of "relatively small" emitters and not from a restricted number of big emitters, as is the case for city-based pilots. Mandatory reporting thresholds are generally (much) lower as in Hubei (60 ktce/year against 8 ktce/year) so as to improve emissions data and better assess both the possibility and gains from lowering the inclusion threshold in the future.

This upstream-downstream balancing challenge is crystallized in the inclusion of the power sector and electricity consumers. Indeed since both electricity prices and power dispatch are regulated, a scheme based only on direct emissions (supply-side) could not induce a carbon cost pass-through to the consumers (demand side), who in turn would not be incentivized. That is why some pilots also intend to put a price on indirect emissions from electricity uses. This point will be further discussed in Section 3.2.7. In line with above comments, this is done in parallel with a possible move towards lower inclusion cut-offs, so as to increase the amount of covered carbon emissions.

3.2.3. Emission Caps

General Rationale

(1) By imposing a cap on firms' emissions the regulator creates the scarcity of permits, thereby putting a price on the right to pollute. Defining both the cap i.e. the overall amount of emissions allowed over a given period of time (generally one year) and the cap trajectory for the following years is therefore a prerequisite to start an ETS.

(2) Since an ETS does not cover every sector of an economy the ETS-specific target may differ from the economy-wide one.

(3) Absolute targets guarantee environmental goals are attained while intensity targets tie environmental outcome to GDP growth. Intensity targets can be translated into absolute caps by assuming a rate of GDP growth. Hinging upon the forecast growth rate, resulting caps may vary, which is therefore a source of uncertainty.

(4) In case of intensity targets, to allow market participants to form sound expectations and build both consistency and confidence despite uncertainty, the cap should be computed on an ex-post basis based on transparent and predetermined rules and proscribe unscheduled ad-hoc modifications.

Applicability to China

Although national and regional objectives are expressed in intensity targets, the NDRC requires pilots to have absolute caps on emissions. However a steadily decreasing cap like in Europe is out of the question in China for it would constrain emissions, leaving no leeway for economic development. Determining an absolute cap from intensity targets is quite a challenge in itself since different projections must be made for each sector *(2)*. This issue is exacerbated in China since it faces significant uncertainties due to its rapid growth – now forecasted to slow down – and its rapid structural and economical change. Local authorities are therefore left with a challenging trade-off between equity and efficiency *(3)*. To deal with efficiency concern, sectorial growth projections need to be reasonable to leave room for the economy to grow. On the other hand, over-allocation will not incentivize emitters towards low-carbon technologies and emission-reduction activities. As a consequence of this uncertainty the resulting carbon prices may be too high or too low and the introduction of supply-side flexibility via price management mechanisms may be considered (Section 3.2.5.).

Beijing and Guangdong are the only two pilots that enforce explicit absolute emission reductions. For instance in Beijing firms in the manufacturing and service sectors will see their allocation shrink each year, from 98% of 2009-12 emissions in 2013 to 94% in 2015. As for power generators, they are not compelled to reduce absolute emissions via carbon trading but are rather required to replace all their coal-fired plants by natural gas ones by 2017. Similarly in Shenzhen annual absolute emissions growth shall be no more than 10% compared to 2013 levels.

As shown in Table A, caps are not always given and when known the figures often lack accuracy and local governments have yet to disclose their calculation methods. All this therefore remains rather obscure, which is contradictory to *(4)*. On top of that caps often seem significant when compared with both local emissions and announced percentages of covered emissions, which may hint at generous and lenient caps and therefore oversupplied markets. The difficulty lies in that economic growth momentum is still significant, especially for less developed like Hubei and Chongqing. Policymakers have therefore set emission targets in line with expected growth rates. What may be advisable would be to correct caps on an annual basis for realized GDP growth using methods known in advance so that absolute caps more intimately reflect the economic reality and better fit with intensity targets. In this regard the Australian five-year rolling cap may be an inspiring example[32].

Regarding the cap, a special feature of Chinese pilots is that the usual rationale that one permit equals one ton of CO_2 does not always apply. Generally speaking there are concerns that electricity-related emissions may be counted twice: first when electricity is produced at the power plant level; second when used by facilities (indirect emissions), so that the amount of emissions actually falling under the scope of the ETS is unclear; that is, the actual figure of covered emissions may be smaller than the cap. The treatment of double-counting issue indeed breaks with accepted norms since in cases where both power supplier and consumer are liable under the scheme, they both are required to hand in permits for a same carbon ton. In order to avoid double-counting, Guangdong DRC is considering modifying its reporting rules so that large electricity users would only be accountable for their self-use emissions.

[32] If the Australian ETS were not likely to be repealed and were still to transition to its flexible-price phase from 2015 on, the government would have set, this year, the first 5 years of caps for the 2015-2016 period onwards, and then extended the cap by one year every year, so that 5 year worth of caps would have been known at any given time. Thus, the cap could be annually adjusted for new market overview and context. Before being proposed and approved by Parliament, the cap was to be assessed by the Minister based on advice given by the independent Climate Change Authority. In case of default, legislation ensured that pollution caps were provided for covered emissions, at least consistent with the minimum 5% reduction target.

3.2.4. Allowance allocation rules & revenue use

General Rationale

(1) Permit allocation is another central pillar when implementing an ETS. Since permits can either be allocated for free or sold, allocation is intimately related to the question of revenue use.

(2) On the one hand this supplementary source of revenue can be used to finance other climate policies; help households affected by related rising costs via lump-sum checks or lowering of other taxes; or simply be directed to general budget as part of the overall fiscal revenue mix. On the other hand, handing out free permits as general assistance to industry has an opportunity cost for the government.

(3) Industry assistance can be seen as necessary for energy-intensive trade-exposed (EITE) industries to the extent that the carbon cost pass-through is limited and they must stay competitive against other firms outside of the scope of the program. Such payments are generally carried out through free permits based on historical emissions (grandfathering).

(4) There is also a significant political dimension in the allocation method, and support to industry, albeit not mandatory for economic efficiency, can help garner support and ease industries into the scheme but is likely to bring about large windfall profits. It may however create distributional issues[33].

(5) The share of auctioned allowances is to increase over time as some transitional free allocation based on a benchmarking approach remains for EITE sectors, to be gradually phased out. Even without considering auctions, the share of free allocation should be set to decrease over time.

(6) Another option for free allocation to specific industries is output-based and generally achieved with the use of benchmarks. Contrary to historically-based allocation which provides full incentive for both reducing emissions intensity and possibly output, a benchmarking approach only incentivizes firms to reduce emissions intensity since benchmarks are indexed on output levels. If benchmarks are high it may therefore act as a perverse subsidy to expand production.

Applicability to China

As shown in Table A, in general pilots have opted for free allocation based on grandfathering for most permits *(3)*. Although historical emission periods used to calculate these allocations differ across pilots, they all only span a few years (2009-12 at most) due to limited available data. When specified, benchmarks are used to treat the case of new entrants. In the Shanghai ETS, the amount of free allocation is to be determined with benchmarks whenever possible *(6)*. Only two schemes include early action rewards with 20% of all freely allocated permits to be distributed based on early actions in Hubei and additional permits being handed out in Shanghai for early actions over the period 2006-2011. Often, a share of the annual cap is set aside to feed a governmental reserve for macro control and adjustment (Section 3.2.5.). The allocation process is entirely different in Shenzhen where firms' own estimates of output and cost mitigation are used to compute the volume of free permits but the precise game-theory mechanism has not been unveiled. While liable companies are generally endowed with permits on an annual basis, there is only one one-off allocation for the whole pilot phase in Shanghai and potentially in Shenzhen.

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[33] As in Europe where it generated within-sectors differences within the scheme as like facilities received varying amounts of free allowances depending on the nations they were located in. Harmonization was achieved by replacing free allocation with auctioning as the basic principle of allocation.

Auctioning is often mentioned as a complementary allocation measure whose share should increase over time *(5)*. For the time being though only Guangdong requires 3% of its annual cap to be auctioned and has initiated auctioning. This share is set to rise to 10% by 2015. More interestingly the government imposes auctioned permits to be sold at a reserve price of 60 yuan. Twenty-nine million more permits labelled for 2013 compliance are to be auctioned by the end of June (compliance date) which might generate at least around $300 million. It is worth noting that liable firms are explicitly forced to take part in the government-held auctions under the threat to be withheld free permits. Participation at auctions is indeed mandatory since firms are required to first buy the 3% of allowances set to be auctioned before being endowed with the remaining 97% of free permits. This strong example of political will may well explain the difference between high participation at auctions and rather scattered spot trading. The government said it intended to bring this revenue for general financial management *(2)*. In Shenzhen less than 3 percent of the annual cap is required to be sold via governmental auctions, but none have taken place yet. There the local authorities said the raised revenue would be used to buy back permits from the market in case of over-allocation. More recently Hubei province stated it would auction up to 2 million permits in March during the week of the launch of the ETS. In total there will be 9 million permits auctioned each year. The government said the auction will comprise a minimum price next month but has not set it yet. Also in Tianjin, possible revenue from auctioning or fixed-price sale would be dedicated to subsidize carbon emissions reductions.

Almost 100% free allocation for power producers (direct emissions) is understandable given the highly regulated environment they are in – no pass-through is feasible. However this reasoning does not hold for emissions resulting from indirect electricity uses. As for manufacturers, free allocation cannot be as easily justified since they can better reflect the carbon price in the prices charged to consumers, all the more so that the differential in carbon prices between covered and uncovered regions is expected to be transitory, pending a future national roll-out. An example is Beijing where in 2013 coal-fired plants received free permits for 99.9% of their average emissions over the period 2009-2012. This amount is set to slowly drop to 99.5% by 2015. As for manufacturers, they will be handed out free permits for up to 98% of their past emissions in 2013, somewhat declining to 94% by 2015. In Hubei, in a bid to allow to adjust annual caps, i.e., how many permits each company gets, one third of the cap will be held back by the government until firms have submitted their emissions reports.

As already mentioned, stock-tacking is likely to have lasted longer than initially planned. The main challenge of doing so lies in the fact that the stock is an ever-evolving and moving target. Indeed while old and polluting installations must be removed from the stock once closed, new and more efficient ones must be included in it. The prime difficulty here lies in that the former have the incentive to postpone their shutdown so as to receive some more free permits while the latter are setting up in great number in a dynamic economy. This issue is all the more so relevant to the case of China where the momentum of turnover in plants, with less efficient ones shutting down and more efficient ones sprouting up, is significant.

Rules for new entrants and closure must therefore be carefully and innovatively designed to deal with this huge challenge. First of all, a share of the overall cap is set aside in a reserve dedicated to new entrants so that they can be given permits when entering the market. New entrants' reserves amount to about 6% (or 20 Mt) and 2% of the overall cap in Guangdong and Shenzhen, respectively. New entrants will receive permits using a benchmarking approach in Beijing, Shenzhen and Tianjin, as in the

EU ETS. Other pilots have yet to disclose how they intend to allocate permits to new entrants. Second, in case of closure or relocation of activity, compliance activity is due and, when specified, 50% of following year allowances shall be taken back so as to minimize the incentive for old plants to receive allowances and then to shut down to sell permits. In the same vein, quotas shall be reallocated when activity changes – whether reduced or increased – beyond a predefined range.

3.2.5. Price management mechanisms

General Rationale

(1) In regard of the uncertainty-related issues exposed in 3.2.1.[34], price management mechanisms can possibly be implemented to provide supply-side flexibility to supersede the cap.

(2) So as to smooth prices over time (inter-temporal flexibility) banking and borrowing may be seen as desirable.

(3) Besides banking/borrowing there are different options available for price management. They can be purely quantity-based such as variable allowance supply or they can also blend in price-driven instruments like price-triggered reserve, price floors and ceilings, etc. (hybrid systems).

(4) It can be argued that leaving prices to fluctuate in conjunction with other markets and in accordance with long-term expectations is the best solution but some supply-side flexibility offers a buffer against price variability in nascent schemes where marginal abatement curves are not known yet. This should help build up confidence and garner support as well as initiate lower-emissions investments in the first stages of the scheme.

Applicability to China

Generally speaking pilots have chosen to manage price control through a variable permit volume meaning that the authority can intervene in the market by selling more (if prices spikes) or buying back permits (in case of oversupply). It involves the creation of both an allowance reserve by setting aside a share of the cap and a monetary fund dedicated to market intervention. The size of the fund is never given, except in Hubei, nor is its origin, except in Shenzhen where auction proceeds are explicitly dedicated to this purpose. In the same vein, the size of the allowance reserve, or the limit of governmental intervention as a share of the cap, is not always detailed, as in Beijing or Shanghai. In Tianjin, 15% of the annual cap is set aside in the reserve. Similarly in Guangdong, 18 million quotas of the annual cap are moved to the reserve. In Shenzhen, lastly, the reserve is made up of 2% of the annual cap plus leftover from auctions and government-purchased allowances. On top of that the trigger mechanisms, i.e., the condition for such governmental intervention, whether price or quantity driven, have not been disclosed yet. This lack of transparency is understandable given that ETSs are still really young. Again, it should be reminded that such mechanisms may be desirable to cushion the expected bumpy ride of the beginning but it should transition to a fully floating price at some point, in particular if trading with other international markets are envisioned. Different market intervention rules may indeed generate hurdles to linking (see Section 3.3).

Banking allows liable entities to hold unused allowances for future compliance *(2)*. It is an incentive for early action and prevents the price to drop to zero in case of an oversupply as long as the planning

[34] Whether the cap is slack or stiff, i.e. depending on the underlying emissions growth momentum and price of abatements, it may be desirable to tighten up the cap in one case to achieve greater emissions reductions or conversely, to loosen it up to avoid a surge in compliance expenses.

horizon is distant and the long-term constraint is deemed credible and stringent enough. Therefore, banking is always allowed during the pilot phase, except in Hubei. In this province liable companies will not be allowed to bank unused permits over compliance periods. The government argues that cancelling unused surplus permits could help prevent the development of an allowance glut. Symmetrically to banking, borrowing allows liable entities to use allowances from future compliance periods in advance. It has the advantage of being an efficient short-term response, notably in case of price surges. However, it bears the risk of future non-compliance since covered firms are not incentivized to reduce their emissions in the early stages of the scheme. Therefore explicit borrowing is forbidden within pilots[35]. One exception is Shanghai where participants have already been endowed with free permits for the whole pilot phase (one one-off allocation for 2013-2015). As said above, 2014 and 2015 vintage permits have already changed hands. Although it is not borrowing *stricto sensu* it might be associated with a lesser form of traditional borrowing. Another important point is that although the EU transition from Phase I to Phase II has proven the necessity to allow inter-period banking for allowance value not to drop to zero, the odds are that there will be no carry-over provisions for allowances from the pilot phase into a possible future scheme. As in Europe it may underline the will to clearly separate the trial phase from a possible future expanded ETS.

3.2.6 Offsets

General Rationale

Oftentimes referred to as spatial flexibility, linking a cap-and-trade with an offset mechanism allows covered entities to use credits generated by projects reducing or sequestrating emissions outside the scheme's perimeter, for compliance under a cap-and-trade scheme. In principle, offsets allow a transfer of knowledge and technology and unlock investments outside the scheme while the scope of possible mitigation options is expanded, thereby reducing compliance costs within the scheme. As they offer a financially interesting compliance option, qualitative and quantitative limits can be set in order to control the effect on the ETS cap and secure environmental integrity. Qualitative restrictions can be set either on the type of project or its location.

Applicability to China

Table 7 shows estimations of offset demand in the seven pilots according to their respective limits of use. It is worth noting that the VER Rules state that pilot regions may elect both type and volume of CCERs to be allowed under their ETSs. Generally speaking compliant entities are allowed to meet up to between 5% and 10% of the emissions obligations with government-approved offsets. On top of that a certain amount of CCERs must originate from the region ETSs are located in. For the moment, Guangdong, Hubei and Beijing require at least 70%, 100% and 50% of offset compliance to stem from local projects.

[35] In other carbon markets, borrowing is sparsely allowed. When allowed it is constrained by restrictions on volume, as in Australia or South Korea.

Table 7 – Estimations of CCER annual demand in the 7 pilots

Pilot	Annual obligation* (cap in Mt)	% of offsets allowed for compliance	Offsets allowed for compliance (Mt)
Beijing	60	5	3
Chongqing	*100*	8	*8*
Guangdong	350	10	35
Hubei	220	10	22
Shanghai	150	5	7.5
Shenzhen SEZ	33**	10	3.3
Tianjin	80	10	8
Total	993	2013 compliance	56.8
		2014-15 compliance	86.8

Notes: * For each market the actual cap is considered, i.e., without both government reserve and new entrants set aside. It is possible, however, that some caps do include various reserves. Therefore our calculations may be overestimated.

** When unclear, other data from Table A are used to get a proxy for the actual cap. For Shenzhen the overall three-year cap is equally divided by three.

Source: Authors' calculations

At the time of writing, only a few advance purchases of future CCER have occurred[36]. The last trade to date has been settled at around 15-20 yuan per offset[37], which stands below government-issued allowances prices in the five operational pilots, roughly ranging from 26 yuan Tianjin to about 80 yuan in Shenzhen. It is also reported that potential deals are under negotiation for around 10 yuan, with some buyers even seeking offsets for as low as 5 yuan each[38]. This spread in prices between local permits and national offsets therefore offers an attractive opportunity to meet compliance at reduced costs, provided liable entities are short in allowances and these are not handed out for free. Hence if offset supply is sufficient and companies are not given enough freely-allocated permits, this cheap compliance option shall be used up to its cut-off limit. However there are two main challenges when assessing the demand for offsets. The first one lies in that the maximum use of offsets for compliance is expressed as a percentage of the cap. However since not all caps have been precisely set, the demand cannot be accurately known. The second challenge is that demand for credits also depend on the stringency of caps, i.e., on the gap between the cap and the actual emission levels. If caps are rather loose, as is currently expected, then the actual demand will fall below the compliance limit. Indeed if companies under the cap are given enough free allowances to cover their emissions they will not seek compliance with offsets although there is a price spread between allowances and credits. This holds since annual offset limits cannot be banked for future years' compliance if not used to the full. For the 2013 compliance we estimate the maximum CCER demand to be around 55 Mt. For the seven schemes taken together, i.e., for the 2014 and 2015 compliances, the annual allowed amount of usable CCERs would add up to a maximum of 85 million (see Table 7 for calculations).

Given the number of projects that could apply for CCER issuance, future supply is foreseen to be huge in comparison with annual demand. China indeed hosts thousands of CDM-approved carbon-cutting projects accounting for about 60% of CERs issued worldwide. Due to a dearth of demand the U.N. carbon market is estimated to be oversupplied with CERs by 2020, in the order of 2 billion offsets. With

[36] No CCER has been issued yet.

[37] For information: \$1 ≈ 6 yuan; €1 ≈ 8 yuan.

[38] Thomson Reuters Point Carbon, China's state utilities move on preferential rules in carbon offset market.

CER prices lingering at rock-bottom levels (around $0.5 i.e. 3 yuan) offset generators are likely to request CCER issuance instead, if the CCER price could exceed the CER price. It should be more than enough to cover for the pilots' CCERs needs. However some more time is needed for this re-registration process to be fully functional, which accounts for the short-term restrained CCER supply. It is likely that only a few million offsets will be issued before the 2013 compliance deadline on June 30th, 2014[39] despite project developers' rush to receive their CCERs prior to that date. It represents about one percent of total compliance obligation over the five operational pilots (about 750 Mt). However by the time of the 2014 compliance next year the market should be overflowed with low-cost offsets. Given the oversupply the CCER prices are likely to fall down to the issuance cost plus the cost of converting from the CDM pipeline for UN credits.

However, basing our computations only on the CDM database without considering further policy choices by the NDRC yields an unrealistic overestimate of future CCER supply. It is likely that the NDRC will exercise a certain control over the supply of credits by regulating the flow of issued offsets, e.g., by delaying the issuance process of certain credits. In addition, local regulations stating that a certain share of offsets must stem from local projects also brings about another leverage over offset supply control. Listed below are some considerations we can reasonably make concerning NDRC's attitude and unequal treatment towards offsets:

- NDRC is likely to favor small-scale projects over large-scale ones. The large volume of credits that could flow from the latter would flood the market. This would drive prices down to the issuance cost and would annihilate any incentive for other projects to set up;
- The odds are that CCERs will only stem from existing CDM projects. As already mentioned the CDM market is mainly established in China so that it is rational and economically justified for project developers to first seek the switch from the CDM pipeline to the CCER framework before eyeing the development of new projects. Another reason is that it will take time for new projects using new methodologies to come to life so that very few new projects will be issued credits before 2015 compliance. It is particularly true of forestry projects for which credits take time to materialize in the first years. As for the other three land-use methodologies, they are deemed to be potential large source of credits, which refers back to the first bullet point, so that such projects may not receive credits;
- Since China intends to gain leadership in climate change negotiations via its pilots it seems unlikely it will allow internationally controversial projects to receive CCERs. Quite on the contrary, it may even favor projects with perceived higher environmental integrity such as renewable projects.

The case of HFC and N_2O projects is a telling example in that they generate large volume of offsets and that issuing such credits would lead to international criticism. It is therefore unlikely that such projects will be issued CCERS. In short, in a bid to build a solid framework for its national scheme to come, small-scale projects that are perceived with high environmental integrity will be the most likely to receive credits.

[39] It is worth noting that this corresponds to the latest compliance date for all pilots. Indeed compliance dates differ among pilots, with the first compliance deadline due to take place on 31st May 2014 in Tianjin for 2013 compliance. Deadlines in other schemes range from mid- to late-June 2014.

3.2.7. The special case of the power sector

General Rationale

To be fully effective, carbon pricing in the power sector should induce a shift in both investments and electricity dispatch (supply-side, direct emissions) as well as incentivize end-users towards lower energy demand (indirect emissions). This aim is generally achieved when the energy sector is deregulated, i.e., where the carbon price induces a shift in both relative profitability of different technologies (alters the dispatch and investments) and consumption habits (demand). It is generally acknowledged that reductions in demand account for a more significant share of emission reductions than supply-driven reductions in the short term. The latter, however, through shifts in sources of electricity generation, are the main vehicle to curb emissions over the medium to long term.

Applicability to China

In 2011, power generation and heat roughly accounted for half of China's carbon dioxide emissions, 68% of which was used by the manufacturing and construction sectors (IEA, 2013). These two figures highlight that the electricity sector has to be included in the ETS if broad coverage and large span of abatement opportunities are targeted. It also underlines that to be fully effective, carbon pricing should apply to both supply and demand sides. China's electricity production is heavily coal-fired, accounting for 66% of its total installed generation capacity and 77% of its total electricity production in 2011. Despite recent achievements to alter its power structure and a somewhat reduced energy demand increase in 2012, the 12th FYP eyes an installed coal-fired generation capacity of 960 GW in 2015 compared to 660 GW in 2010. An early and efficient inclusion of power in carbon pricing is therefore essential given the lifespan of plants which may bring about a lock-in to higher-emissions options in the long term if carbon costs are not presently factored in the investment calculus. The power sector is a key industry to the Chinese economy in the sense that it takes the responsibility to guarantee stable, reliable and affordable supply of energy. This is achieved through fixed electricity price and regulated power dispatch. Although the optimal scenario would be to completely repeal the current regulation so that decisions could be made as a response to the price signal, this option deviates from the authority's main focus that is price stability and supply security. For instance Zhang *et al.* (2013) shows that the current policy of fixed end-use electricity prices has a negative bearing on national welfare when a national ETS is in place.

However carbon pricing and a comprehensive energy system reform need not be simultaneous. As explained below, there are ways to implement carbon trading with the current regulation in place. Although the potential of carbon trading would not be fully used, it could in turn foster a future energy reform since deregulation could help rake in higher profits, through a better allocation of resources.

Since electricity prices are fixed by the NDRC it is impossible for power plants to pass on the carbon cost to end-users who, in turn, cannot be properly incentivized. Free allocation must therefore be carefully designed to both attend to power plants' claims[40] and avoid introducing distortions (e.g.,

[40] Power plants are likely to try to undermine the scheme if they perceive they will have to pay for the additional cost; they already claim that their revenues are marginal for fuel prices have been widely liberalized, on the contrary to electricity prices. This notably brings up the issue of State Owned Enterprises (SOEs). Today there are about 120 SOEs in China all of which have to do with ETS key sectors (power, heavy industry, etc.). Since they

windfall profits) and becoming perverse incentives for production. There might be a differential treatment of different types of electricity production. As seen in 3.2.4., this may create discrimination across technologies but also between plants. The treatment of new entrants is also very tricky since allowances must be set aside but how much is uncertain. These issues can be remedied by using an alternative: output-based allocation. In this system all electricity producers (even renewables) receive a given number of permits for each unit of electricity they produce (the benchmark). It gives the right supply-side incentives in that a coal-fired plant and a less intensive one with the same output receive the same allocation, but the cleaner plant can then sell its permits to the coal-fired one. Depending on the common benchmark, the risk is that too many permits are handed out to the whole sector, thereby acting as perverse incentive for production. The other obstacle facing the power sector is the regulated dispatch. In China operating hours of all power plants are established in advance on a yearly basis by local authorities. Since lower-emissions plants cannot climb higher up the merit order and more running hours cannot be increased for carbon-leaner facilities, there cannot be an effective response to the price signal. Since dispatch regulation is likely to remain for the time being[41] an interesting option would be to artificially simulate the introduction of a carbon price into the merit order without actually implementing one but doing as if it were so.

In order to target power-related indirect emissions, the best option – both in terms of coverage and effectiveness – would undeniably be to put a permit liability on a restricted number of power distributors. But it would require that power prices be raised in accordance with the carbon price they pay to acquire permits in order to provide incentives for demand-side power management. The only viable option is therefore to place the liability on large power users for their indirect emissions. Since both power plants and large electricity users are required to surrender permits, carbon emissions can be counted twice (double counting). The calibration of the inclusion threshold is of prime importance to control the relative share of emissions covered over transaction costs. Symmetrically imposing a carbon levy on power exchanges could possibly raise funds for the authority but would deprive the market from many participants, thereby working against the aim of having a broad market with certain level of participants.

In particular for the five cities the treatment of electricity imports must be addressed. Pilots are indeed connected to power grids and can draw energy from sources located outside the boundaries of the scheme. On average, the pilots import 15% of their overall energy use, with Beijing being the most

are likely to demonstrate resistance, implementing an ETS will therefore require a political will at the highest political level.

[41] It is however interesting to note that there have been some pilots to test dispatch deregulation (the so called Energy Efficient Dispatch or EED, see (NDRC, 2007)), which have achieved both energy and CO_2 savings. Five pilot provinces were involved in EED in 2007, namely Guangdong, Guizhou, Henan, Jiangsu and Sichuan. (NDRC, 2007) provides a defined order for unit commitment and states that among each of these categories units are to be prioritized in order of increasing heat rates, and when equal, according to emissions rates. Under this program dispatch agencies set day-ahead unit commitment plans and then assign forecasted load across power plants but no standards are specified as to how to distribute load so that it may not minimize cost or average heat rates. (Karhl *et al.*, 2013) argue that savings from EED measures are relatively small compared to those that an incentive-based dispatch reform could achieve. This is because large efficient generators already accounted for the major share of total generation and because EED remains an administrative measure that do not change economic incentives. Again, it would require that wholesale and retail prices be set on a cost-basis, or, at least that power pricing be delegated from the present planning agency (NDRC) toward an independent regulatory agency implementing more transparent ratemaking process.

energy-dependent pilot (about 70% of imports) and Hubei being the only net exporter of electricity (about 40% of its production). The in-principle solution is to apply an equivalent carbon levy for imports that varies depending on the source of power imported so as to shift import patterns towards cleaner technology. It is however impossible to distinguish the origin of electrons once they enter the power grid so that the only feasible option is to apply an average emission factors to all imports, whatsoever the real source. The liability to this potential levy would have to be set on large users located within a given scheme and that draw energy from the grid. This approach would be similar to that developed by the California Air Resource Board (CARB) in the California ETS compliance obligation falls on the first jurisdictional deliverer. Provided that the source can be precisely identified, the importer is allowed to calculate its emission factor, under the final supervision of the CARB. Otherwise imports are assigned a default emission factor initially set at 0.428 Mt/MWh when sources cannot be identified.

In short & pilot developments

Due to existing intricate regulatory structures, encompassing the electricity sector in the ETS may well be the greatest challenge of all but it is also essential in nature and feasible. The optimal solution would be to open up both price and dispatch regulations through a comprehensive reform. However, carbon pricing can be introduced ahead of such a measure and still be effective. As the pilots have opted for, the best option in such a context is the full upstream coverage of all power plants while other sectors may be covered downstream. Except for Shenzhen, every other pilot has gone for allocation roughly based on grandfathering. Shenzhen plans, however, may look more promising with free output-based allocation, i.e., based on the amount of energy produced, with an emission factor in line with the intensity target. On the whole, the downstream approach to cover indirect emissions relies on confining emissions of large energy users under a cap. It certainly lets slide a significant share of overall energy use made up by small energy users but it would be too costly to make them directly liable under the scheme and impossible to reform the energy system now. It should be noted that the details of this mixed upstream/downstream approach (allocation, double counting, etc.) have not been made public yet, if not definitely settled. In short, although regulations indicate to include indirect emissions, they remain rather obscure on how. More importantly present regulations do not deal with the case of electricity imports.

3.2.8. Monitoring, Reporting, Verification Standards (MRV)[42] and Enforcement

General Rationale

Another issue of prime importance in an ETS, and particularly relevant to China since it raises many concerns from international observers, is MRV. Having reliable and robust MRV standards is a precondition to guarantee program integrity. Without complete, transparent and accurate emissions data, it is impossible to ensure accuracy in goal setting and compliance monitoring and therefore secure confidence in an ETS. In the EU ETS the "GHG Emissions Monitoring and Reporting Guidelines" regulate GHG emission monitoring and reporting. Both verification by accredited third parties (DOEs) of emission reports and their public disclosure are mandatory. The verification process is carried out in accordance with the Verification Guideline and ISO standardizations. The responsibility to implement MRV procedures to ensure compliance is met falls on Member States, which, in turn, must notify the EU of the regulations and related amendments as well as reveal fraudulent or non-compliant

[42] For more details on MRV standards and related guidance regulations across pilots, see (Environomist, 2014).

liable entities. Firms under the cap failing to hand back enough allowances are fined €100 per missing permit (will increase at a rate based on the EU Consumption Index) and will have to surrender this lack of allowances in addition to next year's compliance.

Applicability to China

A specific feature of Chinese MRV worth explaining is that the liability falls on the compliance unit and not the installation. It notably differs from the EUETS where liability lies at the installation level. For the time being, local DRCs are entrusted to formulate MRV guidelines for their ETSs which may differ from one another. As time of writing, Shanghai and Shenzhen have released guidelines on emissions quantification and reporting based on ISO 14064-1: 2006 terms, and Shenzhen also published the verification guidelines. In parallel NDRC is currently developing a national electronic reporting and verification system. In a move to strengthen both emissions database and reporting means, in several pilot ETS, non-compliant firms are also required to report their emissions. The inclusion thresholds for mandatory reporting only are lower than those for direct liability under the cap. As for enforcement measures and fines in case of fraud or non-compliance are summarized in Table A and vary across pilots. Roughly speaking non-compliant firms must pay a fine of about three times the average market price for each missing allowance and they will see their following year allocation be reduced by one time the missing amount, or more.

3.3. What are the main features tested in the pilots?

In line with the objective to garner experience from the pilot phase to then scale up carbon trading to the national level, it is appropriate to dwell for a moment on significant differences across pilots. We lay emphasis on features we consider relevant in evaluating different design options. Taken together, these common features make up the basis of ETS characteristics in China. Offsets, price management mechanisms should therefore be excluded from the list below for there is a rather good uniformity of treatment between pilots. There are few slight differences but they do not bring pertinent insight into the debate.

- Common Chinese ETS Characteristics

  Pilots only account for carbon dioxide emissions (potential exception in Chongqing where 6 GHGs could be covered) and cover roughly 35 to 60 percent of each regions' emission totals. Generally speaking there is a constant base for coverage among pilots made up of power, heat and industry, such as steel, iron, cement, glass, paper and (petro)chemicals. Free allocation based on historical emissions is the main form allocation, along with auctions (oftentimes with minimum prices) and fixed-price selling from the government being complementary measures. The share of allowances allocated free of charge is set to decline over time. Allocation for new entrants is generally based on benchmarks. Banking is generally allowed during pilot phase while borrowing is forbidden. Allowance reserves are generally set aside for price stabilization purposes. Compliance periods span over a year. Offsets can be used as compliance instruments for up to 5-10% of obligation, with a given share having to originate from local projects. Given that electricity prices are fixed and no carbon cost pass-through is feasible double counting is likely to occur for electricity-related emissions since both power generator and large electricity consumers are liable.

- Scope

Covered sectors vary greatly between schemes but what is really interesting is the inclusion of buildings or transport in the ETS. How and to which extent it is done will be interesting to follow. The inclusion of aviation in the Shanghai ETS is a case in point. More intriguing is the potential incorporation of forestry into the Chongqing ETS. For the moment, decreasing absolute caps are explicit in Beijing and Guangdong only. As for differences between inclusion thresholds, they reflect various trade-offs between coverage gains and transaction costs and vary depending on the size of the pilot, with smaller pilot having to impose lower thresholds to enroll more firms.

- Allocation

What really stands out in these developments is the diversity of allocation mechanisms to adjust the cap. There are three such notable mechanisms. First in Hubei, one third of the annual cap is set held back by the government until firms have reported their emissions. If necessary this adjustment reserve is distributed. Second in Shanghai there is only one one-off allocation for the 3-year pilot phase so that liable firms can smooth their use of permits over the whole period. Last but not least in Shenzhen allocation is partly output-based. The amount of allowances to be freely allocated depends on historical emissions, performance and assessed-level of output. Another interesting feature are early reductions rewards: in Shanghai firms can earn extra allowances for early actions while in Hubei 20% of all free permits are granted on an early-reduction basis.

- Banking & Borrowing

There are two extreme cases to evaluate banking and borrowing provisions. The first is that of Shanghai where the one-off allocation comes down to full banking and borrowing provisions over the pilot phase. On the contrary in Hubei both banking and borrowing are explicitly proscribed. Annual surplus of unused permits will indeed be cancelled so as to avoid the formation of an allowance glut.

4. Challenges and ways forward for a national roll-out and potential linkages among pilots

It is clear from (NDRC, 2013)[43] that Chinese authorities intend to "steadily improve the pilot projects", and drawing on the experience gathered by the pilots move on towards "research and establishment of a national emissions trading scheme". Rolling out regional carbon markets to the national level is a lever for both more efficient and cost-effective climate change policy. Under the auspices of the Partnership for Market Readiness (PMR) the NDRC has submitted a Market Readiness Proposal (MRP), i.e., a master plan containing its first thoughts on how to implement a national scheme. This section will therefore focus on the scheduled transition from regional to national carbon trading. There are two possible options[44]:

- Keep the focus on regional ETS pilots, develop and extend this process to other regions/municipalities from 2016 on. As already hinted at, there are other potential regions that mentioned their willingness to implement such pilots. The key idea would be to apply standardized design plans that are drawn from the experiences gathered during the pilot phase. The regional pilots could then be linked together via a national registry. Each local government would be responsible for determining regional caps and liable entities but would eventually be subsumed by the national target and authority. As for now, pilots are already *indirectly* linked through the offset mechanism.

- Establish a national ETS by setting a national cap. It could be done only once a proper national GHG database is constructed. In this case it is more likely that such a mechanism would only cover power and main industrial sectors. This would include setting caps for each sector and then allocate allowances to firms under the cap. It could also draw from lessons gathered during the pilot phase.

Since nothing has been officially inked regarding the implementation of a national ETS yet, we reckon that envisioning a national scheme via linkages among pilots as a first step is the best perspective to tackle the problem in the short run. We therefore lay greater emphasis on this option. The first section provides the basic economic rationale about linkage. The second section elaborates on the existing indirect linking between pilots via the offset mechanism. The third part examines the issue of direct linkage between pilots. The final part compares the two options and concludes.

4.1. ETS linkage: some theoretical background[45]

Traditionally, linking corresponds to a formal relationship between different ETSs allowing for compatibility between foreign compliance instruments and therefore official exchanges of domestic

[43] See section "ID.8.5. We will effectively respond to climate change."
[44] Of course a third option would consist of doing nothing and keeping pilots as they are now.
[45] There are plenty of papers dealing with linking issues. For a more comprehensive introduction to linkage, the reader can refer to (Zetterberg, 2012); (Jaffe et al., 2009); (Metcalf & Weisbach, 2012); (Stavins & Jaffe, 2007);

allowances or offsets. Depending on the degree of fungibility (or recognition) of permits among schemes, not all linkages are equal in nature. As shown in Figure 9 and in accordance with the bottom-up approach it is possible to distinguish a three-staged path toward full linkage with relative integration increasing by degrees. The first stage is that of fragmented markets where there are no interactions whatsoever between schemes. Then follows the indirect linking framework where independent markets can be linked through direct links to a common system – generally a crediting system. Finally, the final stage is that of full linkage where the eligibility of allowances for compliance is reciprocal. It highlights that a full two-way linkage is the overarching goal while one-way linkage via offsets, albeit strategic, is transitional[46].

Figure 9 - The various types of linkages

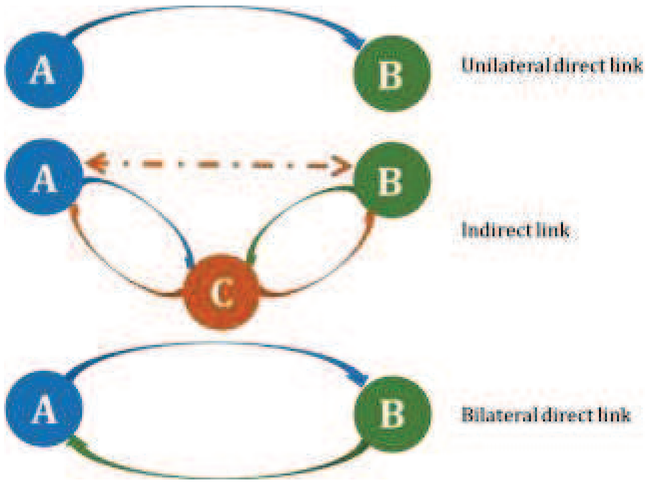
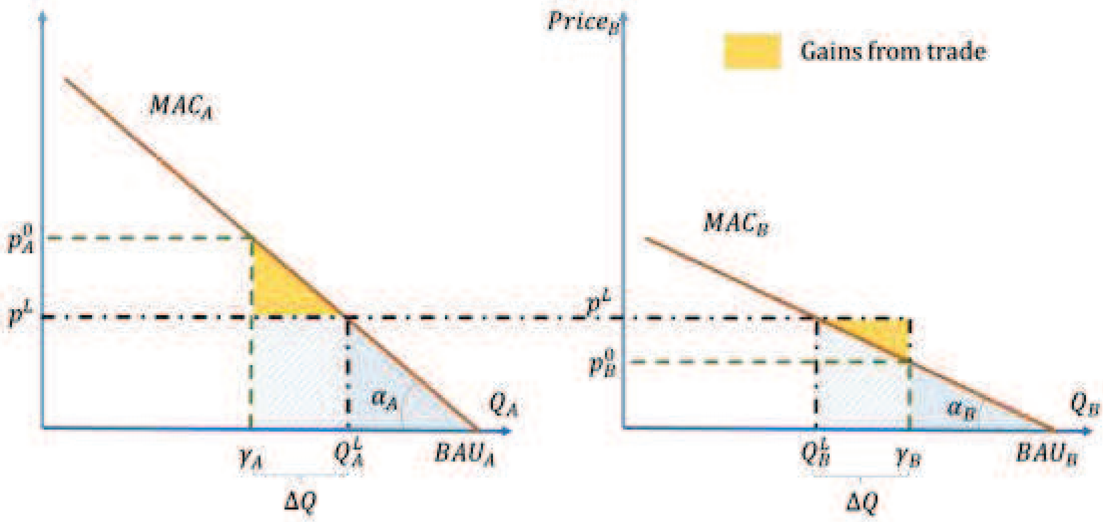


Figure 10 - Two linked markets with a common allowance price



Legend: p_i^0: pre-link price; p^L: post-link price; γ_i: individual cap, levels of emissions prior to linking; Q_i^L: post-linking levels of emissions; MAC_i: Marginal Abatement Curve for I; α_i: slope of the MAC. The steeper the MAC the more expensive abatement options are. For A, striped areas represent the amount A has to pay to buy ΔQ permits from B. For B it represents the cost of additional emissions.

(Mehling and Haites, 2009) or (Olmstead & Stavins, 2012). For a literature review and a more theoretic approach see (Quemin, 2014).

[46] Project-based crediting mechanisms are strategic in the sense that they help build up market institutions and readiness but can't be forever and must elevate/upgrade at some point.

The basic rationale for direct linking is that it can reduce efficiency losses, i.e., make up for differences in marginal abatement costs across regions and achieve the same reduction effort at the least cost. This is virtually shown in Figure 10 where yellow-colored areas represent gains from trade for the two linking partners. Economic theory has it that permits are transferred from the low-cost system (B) to the high-cost system (A) while funds flow the other way round until marginal abatement costs are eventually equalized between both schemes. It means that B reduces emissions beyond its imposed cap to sell these additional allowances to A which in turn emits more than its cap would allow. Provided there are no restrictions on trade, this goes on as long as emission reductions are cheaper in B than in A i.e. until carbon prices converge. It can easily be shown that the ratio of surpluses is equal to the ratio of MAC slopes. Therefore the greater the difference in abatement responses, the bigger the gains from trade. Roughly speaking it can be argued that international negotiations have stalled in search of a compromise to share the surplus and because of the explicitness of money transfers between regions.

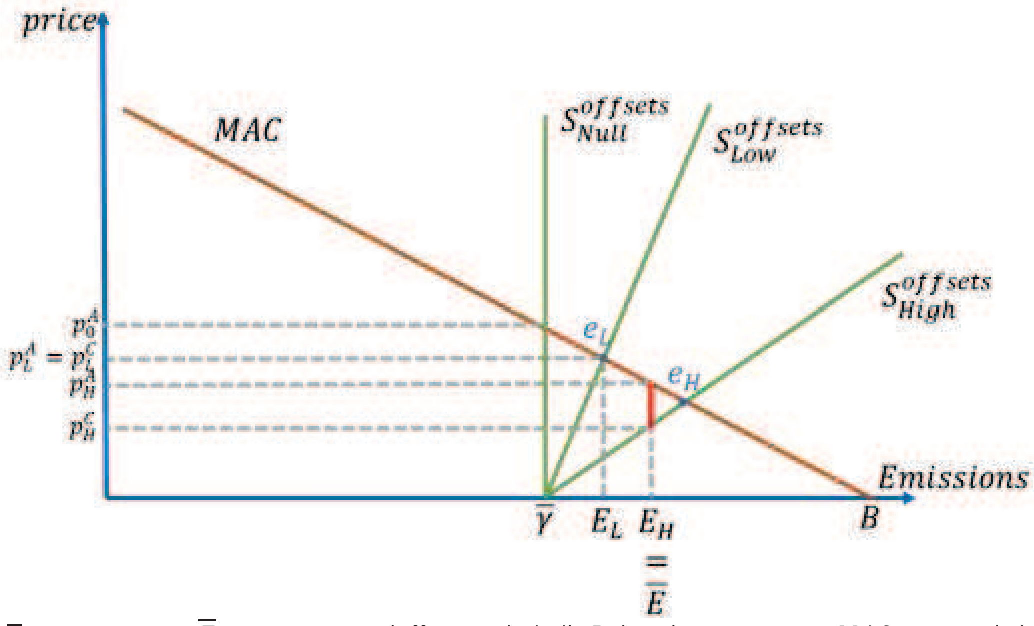
There are other advantages and disadvantages to linking. For instance linkage could lessen other inefficiencies. By broadening the market for allowances price discovery is enhanced and transaction costs may decline. Due to more liquidity in the market linking assuages concerns about market power. Linking may also alleviate concerns about carbon leakage and competitiveness issues to the extent that the differential of carbon prices between regional schemes shrinks to zero. As for price volatility some think that additional volatility could be imported from partners if a certain shock were to occur there while others argue that an economic shock could be better buffered in a coalition thereby reducing volatility. Should co-benefits related to domestic emission reductions be accounted for, the linking partner that buys permits and emits more than its cap may consequently suffer from lower levels of air quality, green R&D, carbon-lean investments etc. On top of that, this reasoning holds only insofar as schemes are taken as a whole. When taking it down to the level of market participants distributional effects are likely to arise. Although a region is better-off from linking when taken as a block, there may indeed be agents that were net sellers of permits before linkage and that have become net buyers afterwards. Finally the above considerations are confined to a static and partial equilibrium framework; one would gain much from a dynamic and strategic as well as general approach. Therefore the potential benefits resulting from linkage may be thought of in light of these comments. Moreover when linkage is considered, questions about market compatibility are likely to arise. It will be discussed in Section 4.3.2.

4.2. The existing indirect linkage between pilots

The case of offsets has already been widely discussed above. We are now focusing on the CCER-induced indirect linking between pilots. As compliance instruments, CCERs are meant to be perfect substitutes for local allowances in every pilot. This would imply that CCERs sell at prices close to that of local allowances. However there are both quantitative and qualitative restrictions that limit the aggregate offset use. As illustrated by Figure 11 and discussed below, offsets would necessarily sell at a discount rate should this constraint be binding. The correspondence $(\overline{\gamma};p_0^A)$ represents the case where abatement is purely restricted to the system itself. However when offsets are allowed into the scheme, emissions may exceed the cap by the amount of credits surrendered for compliance. The offset supply curve must therefore originate at the cap level. The case where no offsets are allowed correspond to a vertical supply curve. Then, depending on the abundance of offsets, the supply curve varies in steepness. Considering that an aggregate cap is imposed on emissions, that is that offset use for compliance is limited in volume to $\overline{E} - \overline{\gamma}$, two possibilities arise depending on the offset supply profile:

① When the supply of cheaper offsets is low enough for the aggregate offset constraint to be slack (i.e., non-binding), emissions would amount to somewhat less than $\overline{E}$ and the offset price would be pegged to the allowance price, so that both would be in principle equal ($p_L^A = p_L^C$)[47];

Figure 11 – Theoretical relationship between local allowances and offsets prices



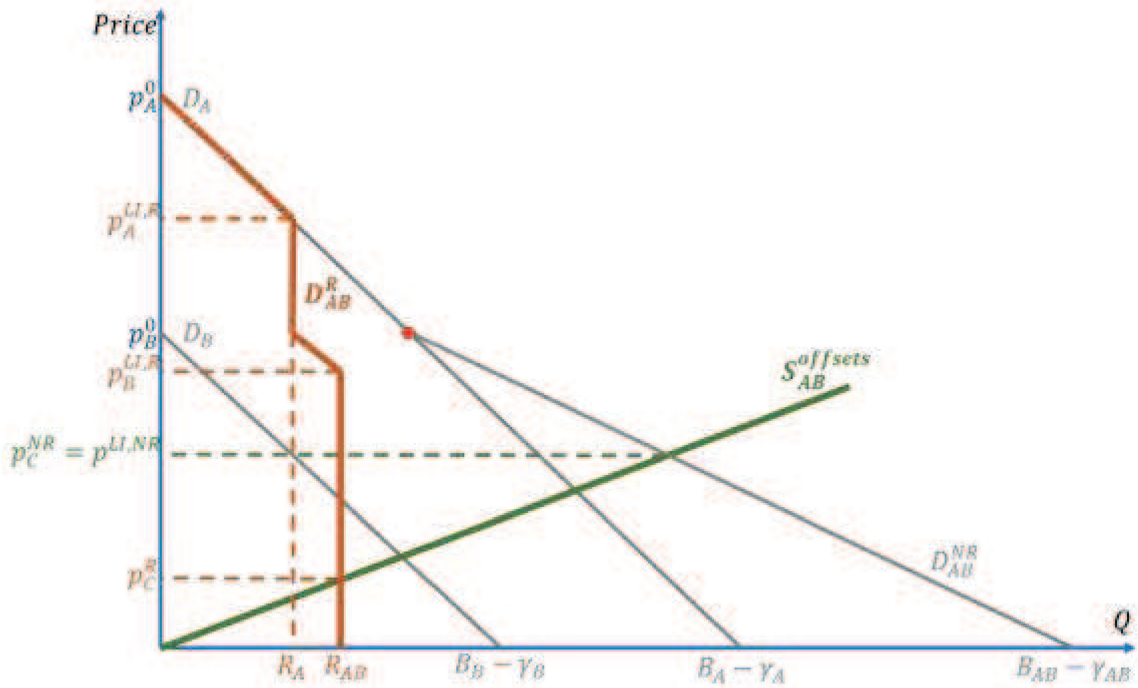
Legend: $\overline{\gamma}$: emissions cap; $\overline{E}$: aggregate cap (offsets included); B: baseline emissions; MAC: marginal abatement cost curve; E_x: emissions when offset supply is high (x=H) or low (x=L); p_x^y: price of allowances (y=A) or offsets (y=C) when offset supply is high (x=H) or low (x=L) or null (x=0); the red stick represents the spread between allowance and credit prices when the offset limit is binding.

② Conversely when cheaper offsets are abundant enough so that the limit on offset use is binding, offsets will be priced at a discount compared to allowances. Since total emissions cannot exceed $\overline{E}$, this implies an allowance price of p_H^A. Notwithstanding offset suppliers' willingness to sell more credits – at least until the theoretical equilibrium point e_H – they cannot do so and are forced to compete to be able to sell the credits they have generated. This competition drives the offset price down to $p_H^C < p_H^A$. This spread highlights the shadow price of the emissions constraint on offset use. This means that possibly $(\overline{E} - \overline{\gamma})$ times the discount can be spared which should lead to the offset limit being used to the full. This framework, albeit stylized in nature, can lay ground for analyzing offset use among pilots[48].

[47] With offsets selling at prices somewhat lower than the allowance price to account for the risk inherent to crediting projects.

[48] Such a project would also require detailed offset regulation, information on offset availability (see Section 3.2.6.) as well as an accurate database for offset trades.

Figure 12 – Indirect linkage: restrictions (R) vs. no restrictions (NR)



Legend: D_x^y: demand curve for offsets, i.e. MAC curve with y=R, NR whether there are restrictions or not and x referring to the market considered. p_x^y: price of permits (x=A or B) or credits (x=C) before linking (y=0) or after (y=LI). The red point is a threshold point: if the offset supply curve is underneath it then both A and B buy permits otherwise only A is willing to buy some.

Note: Compared with the previous figure the origin-point now corresponds with so that the reduction effort $B_x - \gamma_x$ to rein in one's emissions under the cap is plotted.

All pilots have a unilateral link to a common pool of offsets. However there are both quantitative (volume) and qualitative (type, location) restrictions on offset use in the pilots. The effect of such restrictions are illustrated in Figure 12 and discussed below. If there were no limitations on the use of offsets, one could expect regional prices to be equalized and converge down to p_C^{NR}, provided there are enough credits at a price standing below all pre-link allowances prices. However if the offset supply curve is steep enough to pass above the red point then price convergence is incomplete. Indeed A's liable entities buy credits at a price that exceeds B's willingness to pay for credits (p_B^0). B's allowance price is unchanged since it only relies on domestic abatement while A's allowances and offsets trade at the same price, somewhat below p_A^0. If these conditions are not met, that is with a flat supply curve and restrictions in place as in China, then the difference in regional prices would only be narrowed up to the extent that schemes are allowed to buy cheaper compliance instruments and credits would be expected to flow first to schemes whose pre-link allowances prices are higher. Since A's firms have a bigger willingness to pay for credits than B's, A would first exhaust its offset quota to the full at a price of $p_B^{LI,R}$ while A's domestic allowances price settles at a higher price $p_A^{LI,R}$. Then B buys offset as long it is allowed to do so for at a price of p_C^R and its domestic allowance price settles down at $p_B^{LI,R}$. This reasoning however holds if and only if liable entities have no knowledge about the future amount of offsets available and they have no means to communicate. Yet in China offset supply is known to become abundant in a year's time and therefore offset suppliers will again be forced to compete and sell at the lowest possible margin (or even at a loss) if they wish to clear their existing offset lots. In this case credits should in theory be sold at p_C^R in both A and B simultaneously, that is the issuance cost.

Currently, offset trade at around 20 yuan and contracts settling at about 10 yuan (and possibly as low as 5 yuan) support this thesis, with firms seeking to rake in as much of the spread as possible by taking advantage of the offset oversupply to come. It should be noted that the effects on both prices and cost efficiency due to restrictions on offsets can be more complicated to analyze since some pilots require that a certain amount of offset stem from local projects.

Offset developments in China are also reminiscent of international examples. Generally speaking domestic offsets have come into vogue in recent schemes whereas domestic offsets were only introduced in RGGI a few years ago with complicated rules[49] ; consequently, offsets have never been used as compliance instruments in RGGI due to low allowance prices. As part of the brand new linkage between California and Québec, liable firms can only use specific offsets issued from projects located in either of the two regions for up to 8% of compliance obligation[50]. One can possibly explain this preference for domestic offsets since they ensure domestic green investments and emission reductions but also help reach sectors otherwise hard to be included in ETS even if, on the downside, local projects are often more costly and may be small in number. Another reason for opting for domestic offsets may draw from the European and New-Zealander difficult experiences with international offsets. Back then it was indeed foreseen that there would be a high demand for U.N. credits at the global scale and carbon prices were anticipated at higher levels than in the recent years. In practice, Europe ended up being the major and almost sole source of offset demand, and consequently faced a huge supply of international offsets (Trotignon, 2012). In a similar vein, New Zealand designed its ETS to be open given its limited domestic market size and allowed up to 100% of compliance to be met with offsets. New Zealand has therefore been subject to international carbon price fluctuations: via the CDM, the NZ ETS was indirectly linked to the EU ETS and given their relative market sizes, the drop in EUA prices heavily impacted the NZU prices, driving them to very low levels.

Nevertheless, even if international offsets are banned at the outset, this restriction may be removed in the course of ETS operation. This goes for the now late Australian scheme in which only CFI-issued offsets were meant to be used for up to 5% of compliance obligation during the fixed price period[51]. As of 2015 though, eligible international units (CERs, ERUs and EUAs as part of the one-way link with Europe) would have been allowed within a limit of 50% of obligation in total and of 12.5% for Kyoto-based credits. Another example is that of South Korea where only CERs stemming from CDM projects

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[49] The Regional Greenhouse Gas Initiative is a US cap-and-trade program made up of 9 northwestern states that started in 2009. Offsets rules: 3.3% of an entity's obligation may be met with offsets that generate emissions reductions within the state. The threshold can go up to 5% (+ access to offsets from another participating region granted) in case the allowance price exceeds $7 or up to 10% (+possible use of international offsets) in case it goes beyond $10. RGGI members recently repealed this two stage trigger events for lack of transparency and predictability in terms of price control and to be consistent with the simultaneous decision to add a CCR mechanism. (RGGI 2013).

[50] See California Code of Regulations, Subchapter 10 Climate Change, Article 5, Sections 95854 and 95942(c). More precisely Québec-based liable firms are currently allowed to use offset stemming from projects located in Québec or Canada. In California offsets originating from North America and Mexico are, at least theoretically, accepted as compliance instruments.

[51] The Carbon Farming Initiative is a program dedicated to deal with land-based emissions under which farmers and land managers can earn and then sell credits for storing carbon or reducing GHG emissions in the land sector.

located on its soil will be allowed for up to 10% of obligation between 2015 and 2020. International offsets cannot be included before 2020 and would be limited to the same use limit.

It should however be noted that this indirect linking is effective if and only if local CCER exchanges are linked, which is not the case at the time of writing. Consequently one cannot yet transfer a CCER from Shanghai to Guangdong for example. Nevertheless it has no immediate impact since no CCERs have been issued yet. Finally and in coherence with the following section the registry system for Chinese credits should serve as the basic frame and pave the way for a national scheme. Furthermore linkage is often deemed easier to achieve when prices are similar in the first place. This underlines how offsets may have a strategic purpose towards full two-way linkage since indirect linking first narrows the gaps between regional prices.

4.3. Toward a future direct linkage?

4.3.1. Current developments in China

Given that the details of how and when a national market will be implemented remain rather obscure, it therefore makes sense that regional markets are considering options as to how best to expand their size and scope, in a bid to tackle risks of illiquidity and inefficiency. The first way to look at is inner expansion. As exposed in previous sections this can be done by lowering the inclusion threshold or via sectorial enlargement. Once regional potential has been exhausted another solution would be to look for additional alternatives outside of the scheme. Given that both lower thresholds and inclusion of harder-to-reach sectors mean higher transaction costs while the number of cheap abatements is rather restrained and inherently upper bounded, the second option is likely to be the most cost-effective and attractive one.

The most telling example certainly is that of Hubei pilot which has recently welcomed five of its neighboring provinces[52] to consider entering its soon-to-be ETS. Obviously Hubei is not the sole region to envision its scheme growing through regional extensions. As early as 2011 Guangdong and Hubei announced they were examining a potential linkage between schemes. However no official announcement has been made on this matter since then, so that such an undertaking may be deemed unlikely as of today. More recently Shanghai expressed both its consent and interest towards linkage. Two other trading regions (Beijing and Tianjin) also encourage linking as they initiated a study with the provinces of Hebei, Inner Mongolia, Shandong and Shanxi on how to tie disjoint provincial carbon markets[53]. Of course it is clear that what these various linking provisions can achieve is limited in the absence of a nationwide binding framework. Schemes would be better off if the central government could set up a legal framework and provide guidelines, if only for agents to have the ability to discern fair transactions and prevent hampered cross-provincial trading. Absent any national binding framework and to circumvent national legislative difficulties, one way to move towards linking, although in a diminished form, would be to push for neighboring big emitters to opt in on a voluntary basis, notably on the grounds that they will be better prepared when the national scheme shall enter

[52] Namely Anhui, Henan, Hunan, Jiangxi and Shanxi.
[53] Point Carbon News, http://www.pointcarbon.com/news/reutersnews/1.3819201

into force. Legally speaking, provisions for voluntary participation might provide more flexibility in this rather uncertain environment.

Although the central government is for now inclined to let regional markets evolve on their own accord, a nationwide carbon market is likely to be imposed top-down, certainly relying on existing market infrastructures, notably those developed for offset trading. In this regard, there is therefore an incentive to take the political lead in distinguishing oneself from other trading places. For instance, besides aiming at increasing market liquidity and leveling the carbon playing field, the underlying goal for Hubei is to take a strong position in a bid to establish itself as the country's central carbon trading hub. Finally it is worth noting that linkage with markets outside Chinese borders may also be eyed at some point in the future. Although it is far too early to seriously consider the question, Guangdong already stated it was open to potential linkages with California and Europe. Local authorities also declared that the current auction price floor was drawn up to drive prices in line with international ones, especially to allow for future international linkage, although such comments need be taken with a grain of salt.

4.3.2. Considerations for a national scheme through linkage

Linking when design features differ

It may now be useful to put a particular emphasis on the regulatory implications and challenges that naturally occur when linking up regional markets in a move towards a national scheme. Ways China intends to explore in order to shape a national carbon market have been exposed in (PMR, 2013). However, account needs also to be taken of the extent to which future national rules differ from regional ones in the sense that potential hurdles may arise. Indeed some unpleasant surprises may emerge when schemes with different designs merge. Generally speaking potential barriers to linkage can be classified into two groups depending on the levels of hindrance to linkage they might cause, as illustrated in Table 8.

Table 8 – Design elements according to their linking-induced hindrances (in general)

Design elements unlikely to hamper linkage	Design elements likely to hamper linkage
Registry	MRV Rules
Rules for new entrants and closure	Borrowing
Forms of allocation	Relative stringency of targets
Compliance periods	Offset provisions
Coverage	Cost-containment measures
Banking	Enforcement & penalties

To begin with, different allocation methods that vary over time i.e. whether allowances are purchased at auctions or freely allocated, have no bearing whatsoever on the market price or allowances' cost of opportunity. Although different compliance periods are unlikely in China, it would not pose a problem for linking, quite on the contrary. Arguably, a linkage involving linking partners with partially overlapping compliance periods would even improve market liquidity. The treatment of new entrants and closures is tricky since distortions are likely to appear when these treatments differ across regions[54]. However this problem is not inherently related to linking as it also exists when schemes work independently of each other. Furthermore, the EU internal process has shown that linking could still take place when such treatments are not harmonized across Member States (Ellerman et al., 2010).

Moreover, when linking occurs between regions, the regional regulation that provides most leeway (i.e. the supplest provision) will automatically be spread to the whole linked system. This holds for measures such as banking/borrowing, offsets and cost-containment provisions. Indeed, assume that banking is allowed in scheme A while forbidden in B. Then firms from A and B could seal a contract allowing firms from B desiring to bank any given amount of permits to temporally sell it to firms from A and to purchase them back when needed in the future. Consequently, banking *de facto* extends to the whole scheme based on the most flexible provision. However this consideration should not be a major problem for Chinese pilots since designs are rather harmonized across regions. Indeed, provisions for banking, borrowing and offset use are nearly identical between schemes. The same goes for price control mechanisms since the general consensus is slanted towards permits reserve and possible intervention in the market (buying back permits or selling additional permits at fixed price). Triggers for such mechanisms should nonetheless be aligned for the purpose of linking.

The need for integrity

Varying stringencies of targets is not a strong political precondition to linking since both a national scheme and local targets are imposed by the central government[55]. For no other reason than different political and technical circumstances of each market inception, coverage will differ among schemes. Since allowances will trade in a common pool their regional and sectorial origins will be indiscernible. Therefore, behind the issue of the sources of emissions reductions lies that of integrity, which is key to linking. As summarized in (Ellerman, 2012a) the only requirement for linking is that 'a ton be a ton'. Consequently it is interesting to better focus on the following two points that develop from the need for integrity when considering direct regional linking:

- MRV standards:

For a linking among pilots to potentially take place, ideally, compliance entities as well as third party auditors in the linked locations should follow comparable MRV rules and procedures. For the time being, however, local DRCs are entrusted to formulate MRV guidelines for their ETSs which may differ from one another. A welcomed action is that in October 2013, the NDRC issued GHG emissions accounting methods and reporting guidelines for companies in the ten sectors of steel, chemical, aluminum, power generation, power grids, magnesium, flat glass, cement, ceramics and civil aviation. Guidelines for ten other industries are currently in development. Indeed, such national documents shall form key reference for local authorities in their MRV preparation and therefore alleviate potential MRV inconsistencies for future ETS linking as well as pave the ground for a national ETS. In the same line, NDRC is exploring how it could roll out a national registry for GHG emissions from major enterprises as early as this year. On February 24th, 2014 NDRC released a notice requiring key enterprises to report their emissions (inclusion thresholds: 13 ktCO_2e in 2010 or 5 ktce of energy

[54] Firms may have the incentive to relocate their activity in regions where allowances are handed out free of charge.
[55] In general partners must acknowledge their respective efforts as mutually acceptable. This issue also refers to the current intricate U.N. debates on how to measure relative stringencies in a world of heterogeneous costs and various coverages.

consumption in 2010). It is estimated that over 20,000 enterprises are subject to this mandatory reporting. The logical next step would be implement a national registry. Finally to ensure system integrity, penalties for non-compliance and surrender procedures need also be consistent across regions.

Again, it may prove fruitful to draw from international lessons. The Kyoto Protocol was underpinned by solid MRV standards that have served as a reference worldwide. The European scheme notably borrowed from them and, roughly speaking, there seems to be a convergence towards these standards at the international scale. China could therefore base its MRV standards on international ones. In fact, the MRV procedures for CCERs in China echo those relative to the CDM. Moreover, collecting reliable information can prove to be an arduous undertaking, a case in point being the EU ETS where, although the European data collection system is one of the more advanced in the world, only four Member States succeeded in meeting the deadline for notifying the National Allocation Plans (NAPs) to the Commission before the kick-off of Phase I in 2005 (Ellerman *et al.*, 2010). Therefore delays should be expected for a fully operational MRV system to be in place at a national scale and reliability of data will be a major issue in China. Even if no reason were explicitly given to account for the postponing of pilots over the course of 2013, it may in part be explained by difficulties in collecting enough emissions data for the ETS to kick off. Historical emissions are indeed needed when free allocations are based on grandfathering. However since China requires both its Top 1000 enterprises to carry out energy efficiency audits and all its state-owned-enterprises to report emissions, it must have improved its knowledge of its emissions pattern, thereby possibly upgrading its MRV framework.

- Registry:

Since registries record allowance issuance, transfer and surrender, they are an essential part of an ETS. Given the immateriality and electronic nature of carbon permits in registry accounts, the security of registry is of prime importance. In China, the Energy Research Institute has been entrusted with the responsibility to formulate proposals for the establishment of a national registry regarding CCER trading. Eventually in January 2013 five exchanges were appointed to host CCER trading (see 3.1.3.). This may serve as the basic frame for a future national registry for allowance trading. However local allowance trading platforms have been designed based on local authorities' plans and although various registries may be made compatible with technical means this might come at a significant cost. Another puzzle that needs to be clarified is that of the various legal basis for carbon trading across pilots. The lack of a nationwide bill hampers the construction of a uniform legal framework. NDRC is endeavoring to finalize the development of Climate Change Law to make up for this deficiency and provide the legal level of accreditation needed.

It is unclear how national offset and regional allowance registries will be tied in the future. In this regard it may look promising for China to draw lessons from the EU ETS for registry building as well as for security enforcement. In the EU and for Phases I and II each member state established an individual National Registry complying with the guidelines in the EU ETS Directive. All National Registries were connected to the Community Independent Transaction Log (CITL), which automatically checked, recorded and authorized all transactions of EU ETS-compliant instruments[56] that took place between accounts of the EU ETS participants. From mid-June 2012 onwards, all of the EU ETS participants' accounts were transferred from National Registries to a single Union Registry (UR) to be

[56] These instruments include EUA (European Union Allowances), CER from CDM projects and ERU (Emission Reduction Units) from Joint Implementation (JI) projects.

consistent with changes for Phase III, in particular with regards to auctioning and centralized governance at EU level. In addition, the UR reinforced measures for market integrity in the wake of allowances theft from national registry accounts and VAT frauds in early 2011.

The central issue of cap-setting

Like the saying goes, we saved the *best* for last: cap-setting and allowance distribution. Determining the cap and its apportionment certainly is the toughest challenge in enforcing an ETS in a decentralized, multiregional setting. Again the EU ETS provides a model for what the first steps towards a national scheme in China might look like if starting from the bottom-up approach. In the EU ETS during PI (2005-07) and PII (2008-12) respectively it was up to member states to determine National Allocation Plans (NAPs) which specified both the national cap each member state would issue and its apportionment among liable entities within their borders. The EU-wide cap was the sum of national totals. According to (Ellerman, 2012b) two elements were essential to the EU ETS success in both deciding the cap and how it was apportioned. The first was the unusual delegated power to the European Commission to review and, if necessary, to reject NAPs. In bypassing the usual process, this special authority allowed the Commissions to have the final say on cap levels. In particular, it prevented national caps to be purposefully inflated. The second was the pre-existing reference point in the presence of the objectives of the Kyoto Protocol and the European Burden Sharing Agreement (BSA). It provided a solid basis to determine the cap level and its distribution among EU members since the EU ETS was EU's main instrument to meet its binding obligations under the Kyoto Protocol. Although this decentralized cap-setting structure was cumbersome and subject to critics[57] it nevertheless has worked and got the scheme started. Then this structure has gradually evolved away from decentralization to centralization. During PII the structure was the same but very little leeway was left for member states to bargain with the Commission. This notable change of tone has to do with the fact that PII corresponds with the Kyoto compliance period and contrasts with the "trial" period (PI). From 2013 on, the cap-setting process has evolved into a fully centralized one, with both the overall cap and its distribution among member states[58] unilaterally settled by the Commission.

This example indicates that if a decentralized process is required in the first stage, as seems likely for a national scheme in China, it could, in turn, evolve into a more centralized one. More importantly it also stresses out the necessity of having an overarching entity able to perform the role of the European Commission. Of course the obvious candidate for this in China is the NDRC and there is no doubt on whether it could exercise the same essential functions, such as reviewing and possibly rejecting what we could call Regional Allocation Plans (RAPs). A fundamental element similar to the BSA in Europe is the transposition of national targets into regional ones in China to help local DRCs set their cap. Therefore, as far as cap-setting is concerned, experience tells us that all ingredients are there for regional ETSs to be linked, should this path be taken by central authorities. First mimicking the European evolution, the allocation process could then be gradually centralized.

[57] It notably unveiled the problem of harmonization in a decentralized approach to allocation.

[58] Here the distribution of the EU-wide cap among member states takes the form of rights to sell a specified amount of allowances at auctions instead of free allocation – with some remaining but transitional free allocation for specific sectors and countries – but the apportionment is clear.

The need for harmonization

As mentioned above, harmonization in the allocation process is an issue that will inevitably occur in a multiregional setting. Much of the lack of harmonization originates in the main criterion for cap-setting; that is, the differentiation of targets across regions. In a multiregional setting with different emission targets it is indeed hard to imagine how differentiation would not imply discrepancies in the amounts of allowances handed out free of charge to like facilities in distinct regions. In Europe it proved to be an issue even if there was a high degree of uniformity across member states. Therefore, even if regional ETSs are expanded on the basis of a standardized plan under the supervision of NDRC, the latter will have to deal with this issue. A decentralized free allocation process is therefore likely to create within-sector differences within the multiregional setting in which like facilities receive different amounts of free allowances depending on the regions they are located in.

In the EU ETS the apparent irreconcilability between harmonization and differentiation was however dealt with by replacing free allocation by auctioning as the main allocation method. The share of auctioned allowances is set to increase over time as some transitional free allocation based on an EU-wide and centralized benchmarking approach[59] is still allowed for some sectors, to be gradually phased out by 2020 for power plants in Eastern Europe and by 2027 for industrial facilities, with an exception for Emissions-Intensive Trade-Exposed (EITE) sectors. Auctions also generate revenues for the auctioning authority, which is likely to be decentralized to the local governments in a multinational setting. Apportioning varying amounts of *rights* to auction allowances from country to country allows to satisfy differentiation at the national level while like facilities in different countries are treated alike (via benchmarks). Therefore differentiation by country moves toward differentiation by sector. Again the European experience shows that in a multiregional setting like in China auctioning needs not be enforced right at the outset of a national scheme as the basic principle of allocation, if free allocation is initially required to get the scheme started. However free allocation could then be replaced by an allocation method similar to that of Europe. Other ETSs in the world have also opted for this approach, namely dominant auctions complemented by decreasing transitional free allocation.

4.4. Which is the more likely option?

At some point in time, NDRC will have to elaborate and enact a roadmap for its future climate policy. It should comprise the path toward a national scheme, i.e., how to scale up pilots into a national ETS. At the beginning of this section we identified two different paths to do so: keep on developing regional pilots based on a standardized approach and link them via a national registry (bottom-up); or drop the current regional approach to impose a national cap and allocate allowances emissions instead, i.e., start from scratch to build a uniform national ETS, based on lessons learned from the pilots (top-down).

It appears that there is no definite answer to the question asked in the title of this section[60]. According to a study commissioned by NDRC and reported in (IETA, 2013) it merely hinges upon the timeframe we consider: the bottom-up path is the easier option to implement and manage in the short-run while the top-down approach would be favorable in the long-run, although not practical for the time being.

[59] Based on the emission rate of the 10 percent most efficient facilities in each sector or product, times baseline output.

[60] Moreover, beyond technical issues, government willingness is the main challenge for linking and a national roll-out.

The latter would indeed require that a national GHG database be precisely constructed. However a more centralized approach and a single cap would make it more cost-effective for liable firms since markets would not be as segmented as with pilots in which rules and standards differ. Coverage would be enlarged and the least-cost abatement more easily ferreted out. For instance (Zhang *et al.*, 2013) find that a national target with trading of allowances across regions results in about 20% lower welfare loss relative to the regional targets approach. However these concerns could be assuaged in a multiregional setting if design plans are standardized by national guidance, drawing from experiences generated during the pilot phase. Similarly, in a multiregional setting, allocation (for both individual cap and distribution) would be determined at the regional level before being aggregated nationally. It might lead to more generous allocation than when centrally operated so that the environmental objective may be somewhat lesser when establishing a national ETS via the bottom-up, except if the central authority has the power to reject inflated regional allocation plans. The decentralized process for cap-setting and allocation may be cumbersome and open to criticism but it reflects what is possible in the underlying political context. After all, time was also needed in Europe before it could move on to a centralized scheme, so the same should be expected in the case of China.

Although pilots' characteristics do have some similarities with one another, they differ on many design features. As mentioned in Section 4.3, the slightly different approaches implemented among pilots could pose practical obstacles for linking up regional ETSs. However, if standardized design plans are applied to existing and new pilots from 2016 on, then these barriers would vanish. Section 4.3 rather highlighted the need for a standardized process so as to ease the linkage of pilots through a national registry. Should such a standardizations end up being unfeasible given the diversity of approaches and local circumstances, a second-best option for a national ETS might be to provide some common ground on elements such as MRV while allowing local governments some leeway on designing the other ETS features. If differences across pilots are significant enough, this might also be a reason for NDRC to favor the top-down option; that is, design and implement a uniform national ETS.

Given that many new regions or municipalities have expressed their desires to implement their own ETSs, this is another argument in favor of the bottom-up option. A first example is that of the city of Jining (Zhejiang province) which approved a plan putting forward an ETS in August 2013[61]. Other ETSs are said to be under consideration by local authorities in three cities part of the Jiangsu province. In the same vein, the city of Shenyang (Liaoning province) launched a voluntary market for carbon allowances a few months after the city of Hangzhou (Zhejiang province) initiated trading energy consumption units in July 2013. Even more explicitly, DRCs from Beijing, Tianjin and the provinces of Inner Mongolia, Hebei, Shanxi and Shandong recently agreed to join hands on evaluation of a potential inter-regional emission trading.

Despite this enthusiasm the national government had until recently refused to consider the question officially, stating that to get the seven pilots started was its top priority. Now that the seven pilots will soon all be operational, the central authority can ponder the question as to whether to add new regional markets. Research projects commissioned by the national government to explore ways to develop a national scheme have been launched. In a statement on its website, the Minister of Environmental Protection said China was now working on new regulations for pollution permits and

[61] The following informations are from http://www.pointcarbon.com/news/reutersnews/1.4172949

would soon publish new pilot projects proposals. Northeastern Shandong's city of Qingdao has recently become "eighth pilot", i.e., the latest city to have announced it would implement an ETS. Capping emissions from up to its 300 biggest firms, the ETS could possibly start next year. Of course this would help local governments speed up economic restructuring towards less-intensive industries with higher added value but, more importantly, it would implicitly pave the way for a future direct linkage between regional ETSs via a national registry. This goes in pair with the fact that setting up a national cap remains a political challenge. There is no doubt that the central government would initially have started this way, had it been able to gather support from large energy lobbies.

Conclusion

The inclusion of carbon intensity targets into the Chinese 12th Five-Year Plan for national social and economic development (2011-2015) is a strong signal of China's intention to transition to a less carbon intensive economy. To promote further energy conservation and emission reduction activities, the scope of the policy measures implemented under the 11th FYP period were expanded. Although traditional command-and-control regulatory approaches will remain the fundamental environmental and energy policy measures in the years to come, their negative impacts – such as the extreme measures adopted in some regions to fulfill the year-end energy intensity target – have demonstrated their limits. In addition this will likely lead to policy interaction and overlap.

In this context, policy makers have considered the use of other kinds of policy measures, among which emissions trading has been explicitly defined in official documents. Five out of the seven pilots have started operations in 2013 while the other two are to be launched over the course of March 2014. Implementation of carbon trading pilots comes at a time when both climate change and environmental issues increasingly become governmental priorities. In parallel the "Air Pollution Prevention and Control Action Plan" released in September last year sets forth the objective of capping coal to 65 percent of energy consumption and aims at banning new coal-fired plants in the vicinity of major cities such as Beijing, Guangzhou and Shanghai. China is also heavily investing to clean up air pollution in the short-run. This shows that carbon trading is just one piece of the package China is endeavoring to develop to tackle the twin challenge of climate change and air pollution.

Taken together the seven pilots' caps should amount to about 1 $GtCO_2e$; that is around one ninth of China's total carbon dioxide emissions and more than half the amount of covered emissions in the EU ETS. First trading prices range from about 27 yuan (€3) in Tianjin to 80 yuan (€10) in Shenzhen, which compares with European Allowance prices fluctuating around €6. However exchanges remain rather limited in volume (see Annex 3 for details).

Despite some similarities, pilots' design plans also diverge in many ways to accommodate for local circumstances and varying economic contexts. Experience garnered from regional carbon trading should help craft a national emissions trading scheme. The possible roll-out to the national scale was initially scheduled for 2016 but has then be delayed to 2020. Now the Chinese government is even careful not to give an explicit start date but experts expect it to begin in 2019 or 2020. As part of the survey carried out by (Jotzo *et al.*, 2013) 80% of the observers say they believe a national ETS will exist by 2020. Expanding ETSs to new regions based on a standardization process to then link them all up is the easier option to manage in the short-run while moving away from the regional approach to set a uniform national ETS would be more beneficial in the long-run, although not feasible in the current state of things.

A national scheme, whatever the form it takes, should provide more cost-effective opportunities than regional ETSs without cross-region trading. However the details of how and when a national market could be implemented have not been officially inked yet. In this context it makes sense for pilots to encourage regional linking, in a bid to seek for more liquidity and cost-efficiency. In this respect, it is noteworthy that pilots are already indirectly linked through the Chinese offset system. The offset registry system could serve as the basic frame and pave the ground for a national one, and indirect linking in itself could ease direct linkage between regions by first narrowing the gaps between regional prices. It should be noted that uncertainty remains regarding the basis of the future national law on climate change, namely energy or carbon. Instead of an ETS for carbon, a cap on coal could also be implemented since both options have been set forth.

Notwithstanding significant progress, various obstacles remain and do not facilitate the launch of functioning regional ETSs as well as a national ETS. Indeed the implementation of a market-based policy is a bold move in a fast-growing economy with poor market fundamentals and a heavily-regulated energy pricing system, which hitherto had predominantly relied on command-and-control policies to tackle energy-related issues. China needs to invest massively in programs to build the infrastructure needed for a nation-wide ETS over the coming years. It means building a national registry and developing GHG accounting methodologies to underpin a solid and reliable national MRV framework. The World Bank (notably through the Partnership for Market Readiness), the European Commission and other international cooperation programs will back and assist this intricate process. Another example is the Californian cooperation with Guangdong and Shenzhen on emissions trading.

It is too early to tell whether the ETS experiment is successful although pilots seem to be functioning as designed so far. One can expect that the offset market will see most of the activity during the pilot phase compared with the allowance markets. Moreover allowance trading is likely to be limited to bargaining between governments and companies rather than between companies themselves. The reason behind is that allowances shall lose their value once the pilot phase is over while offsets are likely to be a key element of a future national scheme. By mid-year, pilots will have completed their first compliance period so it will be possible to evaluate the entire cycle of typical ETS activities for the first time. With first lessons drawn from the pilots, this year could also provide some indications of how and when China intends to go beyond pilots.

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Annex 1 Discussions on levying carbon tax in China

As early as September 2009, research institutes attached to the MOF, MEP and NDRC have initiated relevant research studies on carbon tax in China. Released reports gave different suggestions in terms of tax rate, introduction period, taxpayers, use of tax revenues and other aspects. The NDRC wants to separate the carbon tax as an individual tax, attributable to the regulation of the National Energy Bureau while the MEP favors it included in the list of environmental tax. It is reported that carbon tax program was being discussed in the NPC. The report released by the MOF suggested levying a carbon tax in China following the reform of resource tax while the NDRC and the State Administration of Taxation do not regard such a reform as a premise to imposing carbon tax. Regarding tax rate, the MOF report suggested a lower initial tax rate to only 10 yuan/t starting between 2013 and 2015 and gradually increasing to attain 40 yuan/t in 2020 while that of MEP recommended 20 yuan/t as the starting point to reach 50 yuan/t in 2020. In terms of taxpayers, the NDRC think energy producers should be liable to a carbon tax, at least in the initial stage, to avoid the challenge of emission accounting and minimize management cost, while the MOF and MEP believe imposing energy consuming companies to be more reasonable. NDRC favors tax revenue to be recycled to subsidize emission reduction actions while the MOF believes it should be directly included in public finance budget. However, carbon tax has not been put on the agenda, indicating no consensus being reached among decision-makers and more research and debate are expected on this topic before any decisions can be made.

Annex 2 Comparative table of market design among pilots

	Pilot System →	Beijing	Chongqing	Guangdong	Hubei	Shanghai	Shenzhen	Tianjin
ETS Structure	Start Date	November 28, 2013	March 2014?	December 19, 2013	March 2014	November 26, 2013	June 18, 2013	December 26, 2013
	Total GHG Emissions	103 $MtCO_2e$ (2010)	125 $MtCO_2e$ (2010)	510 $MtCO_2e$ (2010)	320 $MtCO_2e$ (2010)	211/240 $MtCO_2e$ (2010)	83.4 $MtCO_2e$ (2010)	134 $MtCO_2e$ (2010)
	Issued cap	60 Mt each year	About 100 Mt, subject to annual reduction	388 $MtCO_2$ (350 allowances+38 reserve)	220 $MtCO_2$ each year	About 150 $MtCO_2$ for 2013. May be ex-post adjusted	About 100 $MtCO_2$ in total for 2013-2015	80 $MtCO_2$ each year
	Trading center	CBEEX	CCEEX	CEEX in Guangzhou	HCEEX	SEEEX	CEEX in Shenzhen	CTEEX
	Allowance name	BEA	x	GDEA	HBA	SHEA	SZA	TJEA
	Guidance regulation	Decision on carrying out pilot ETS under the strict control of carbon emissions in Beijing	Interim Measures completed and waiting for government approval	Interim Measures for the Administration of Carbon Emissions of Guangdong	Interim Measures of Hubei carbon emissions trading	Interim Measures for the Administration of Carbon Emissions of Shanghai	Provision of Carbon Emissions Management of Shenzhen (public review)	Interim Measures for the Administration of Carbon Emissions of Tianjin
Coverage	GHG covered	CO_2 (direct and indirect)	6 GHGs (direct and indirect)	CO_2 (direct and indirect)	CO_2 (direct and indirect)	CO_2 (direct and indirect)	CO_2 (direct and indirect)	CO_2 (direct and indirect)
	GHG emissions cov.	49%	39.5%	40%	35%	57%	54%	60%
	Sectors	Electricity providers, heating sector, manufacturers (automobile, cement, petrochemicals) and major public buildings (health, education, banking, …)	Production of electrolytic aluminum, ferroalloys, calcium carbide, cement, caustic soda, iron and steel. Could target emissions from forests. Not officially confirmed though.	Power, cement, steel, iron, petrochemicals) Textile, non-ferrous metals, plastic, paper may be included later. Transports and buildings (public, commercial) construction are part of the newly released regulation (from March 1st).	13 sectors: power plants and industrial companies (iron and steel, cement, chemicals, automobile, manufacturing, nonferrous metals, glass and paper)	16 sectors: industrial sectors (electricity, iron & steel, petrochemical, non-ferrous metal, chemical, building materials, textile, pulp & paper, rubber, chemical fiber), other sectors (aviation, ports, railway, commercial, hotel and financial sector buildings).	Almost all sectors. 26 sectors for now. Including industrial companies, building sector and electricity generators. Transport inclusion under consideration.	Iron and steel producers, chemical facilities, power and heat generators, oil and gas exploitation, civil buildings.
	Liable entities & Mandatory reporting	About 490 entities Threshold: 10ktCO_2/yr (average of 09-11) Mandatory reporting and voluntary participation. Threshold: 2k ttce/yr energy consumption.	About 240 Threshold: 20,000 tCO_2/yr(any year of 2008-2010), and new installation after 2010: 20,000 tCO_2/yr	Now: 242 liable entities with > 20 $ktCO_2$/yr (any year of 2011-2014) New regulation: Industry > 10 $ktCO_2$/yr, mandatory reporting when > 5 $ktCO_2$/yr, Non industrial sectors: with > 5 $ktCO_2$/yr. Transport: threshold TBD	Province's 138 biggest emitters Threshold: 120,000 tCO_2e/yr (any year of 2010-2011). Mandatory reporting Threshold: 8ktce of energy consumed/yr.	191 companies Threshold: 20 $ktCO_2$/yr (any year of 2010 or 2011) for industrial companies; 10 $ktCO_2e$/yr for other sectors. Mandatory emissions reporting for about 600 firms. Threshold: 10 $ktCO_2$/yr.	635 city's biggest companies. Threshold: 5 $ktCO_2e$/yr. 197 large buildings. Threshold: 20,000m^2 for public buildings and 10,000m^2 for state office buildings. Mandatory reporting. Threshold: emissions between 3-5 $ktCO_2e$/yr. + other specific firms and buildings.	114 entities Threshold: 20 $ktCO_2$/yr (any year since 2009) Mandatory reporting for carbon intensive industries and civil buildings with > 10 $ktCO_2e$/yr (steel, iron, power, heating, (petro)chemicals).
	New entrants and activity change	Entities with emission change of > 5 $ktCO_2$/yr or >20% are liable to request allowance change.	x	New entrants reserve (20Mt). New project (including capacity extension or reconstruction) with > 10 $ktCO_2$/yr should purchase all quotas prior to operation. Quota reallocation for activity change, reduction and closure.	x	In case of closure or displacement of activity, compliance obligation is due and 50% of following-year allowances after obligation shall be taken back.	Reserve (2% of total cap). New fixed-asset projects with over ¥ 200 million investment should submit emission evaluation report. In case of closure or displacement of activity, compliance is due and 50% of following-year allowances shall be taken back.	Compliance obligation in case of closure.

	Compliance Period	One year	x	One year	One year	One year	One year	One year
Allocation	Trading Period (Pilot Phase)	2013-2015	2013-2015 or 2014-2015	Phase I: 2013-2015 Pilot Phase II: 2016-2020 Improvement Phase III: post 2020 Maturation & Operation	2014-2015	2013-2015	2013-2015	2013-2015
	Form of allocation	Free allocation: 99.9% in 2013 to 99.5% in 2015 for coal-fired plants, 98% to 94% for manufacturers. Absolute reductions for manufacturing and service. Small amount reserves may be auctioned.	Free allocation based on historical emissions.	Free allocation of 97% in 2013-2014 to 90% in 2015. Auctioning is used as a complementary method. Auctions revenue is for general financial management.	21.43% of the cap is set aside for new entrants and 8% as the reserve for government adjustments. The rest is allocated free of charge.9 Mt auctioned each year.	Free allocation only. Auctioning under consideration. Early action over 06-11 rewarded with additional permits.	At least 90% of cap is freely allocated. Auctioning, fixed-price sell will be complementary methods. Auctioned quota should be <3% cap. Absolute emissions growth limited to 10% by 2015 compared to 2013 levels.	Free allocation. Auctioning or fixed-price sell may be used only in case of large market price fluctuation, and generated revenue shall subsidize emission reduction activities.
	Allocation mechanism for free allowances	Free allocation based on 09-12 emissions (industry) or carbon intensity (power), corrected by a sector-specific factor, declining with time. New entrants' allocation based on benchmarks.	Free allocation based on 2008-2010 emissions	For P1: mainly grandfathering based on 2010-12 emissions, considering sectors' characteristics.	80% of free allocation is based on 2010-11 historical emissions and 20% for early action reward. One third is held back until firms report emissions to adjust cap each year.	One-off free allocation for 2013-2015 based on 2009-2012 emissions, growth considered. Whenever possible (electricity and aviation), benchmarks will be used.	Free allocation based on firms' 2009-11 historical emissions, performance and future activity level. New entrants' allocation based on benchmarks.	Free allocation based on 2010-11historical emissions (existing entities) and benchmarks (new entrants).
Flexibility	Banking & Borrowing	Banking allowed within pilot phase. Borrowing forbidden. Only spot trading allowed.	x	Banking allowed within pilot phase (P1). Borrowing forbidden. Only spot trading allowed.	No banking allowed. Annual surplus permits will be cancelled.	Banking allowed within pilot phase. Borrowing forbidden.	x	Banking allowed within pilot phase.
	Offsets & Credits	Up to 5% of CCERs are allowed for compliance obligation. At least half of used CCERs must originate from local projects (except certain types of projects owned by liable entities).	Only CCERs from local projects allowed for up to 8% of compliance obligation. Forestry credits likely to be eligible.	CCERs allowed for up to 10% of compliance obligation, 70% of which must stem from local projects.	Only CCERs from projects located in Hubei (Forestry projects incl.) Up to 10% of compliance obligation.	Up to 5% of annual compliance obligation.	Up to 10 % of CCERs are allowed for compliance obligation.	Up to 10 % of CCERs are allowed for compliance obligation.
	Price management & Cost Containment	Auction or government buying back permits from the market.	x	Market price adjustment quota reserve (18 Mt). Minimum price for auctions at 60 yuan.	Holding reserve for macro control. A 100 million yuan reserve is planned for the government to intervene in the market. Price floor at auctions (not set yet).	Holding reserve under consideration for market control, including government buy/sell in the market.	Allowance reserve (2% of total allowances + rest allowance of auction+ government's purchase) to control price.	Government buy/sell in the market.
Compliance	MRV	Yearly emissions reports submitted by April 15. Verification by accredited 3rd party required and report submission before April 30. Allowance allocation by June 30 and compliance by June 15. Compliance information dissemination before end July.	x	Allocation on July 1 each year. Compliance before June 20. Verification by a third party is required.	Yearly emissions reports submitted by February 28, and verification report submitted by a third party before April 30. Yearly allowance allocation before June 30. Compliance before end May.	Following-year monitoring report submitted by December 31. Yearly emissions report by March 31 and verification report by a 3rd party submitted by April 30. Annual compliance between June 1 and June 30.	Yearly emissions report submitted by March 3, and verification report submitted by a third party before April 30. Yearly allowance allocation before May 31. Compliance by June 30. Not allowed to use the same verification agency for 3 consecutive years. Compliance information dissemination before end July.	Following-year monitoring report submitted by November 30. Yearly emissions report and verification report by a 3rd party submitted by April 30. Compliance by May 31. Not allowed to use the same verification agency for 3 consecutive years.

	Enforcement/Penalty (including administrative penalty)	Failed to submit emission report in due time: rectification and then ¥50,000/firm. For non-compliance:3-5 times market carbon price for every missing allowance.	For non-compliance penalty: 3 times highest market price	Fraud in emission report: rectification and then ¥10k - 30k penalty/firm. Impediment of verification work: rectification and then ¥10k -30k up to 50k penalty/firm. For non-compliance penalty: deduct 2 times the missed quota from next year's allowances and 3 times average market price. Also penalties for fraud of trading exchange and verification entities.	Fraud in emission report: rectification and halve next year's allowances. Fraud in trading and other activities: rectification and <150k penalty. For non-compliance penalty: deduct 2 times the missed quota from next year's allowances and 2 times market carbon price for every missing ton. Also penalties for fraud of trading exchange and verification entities.	Failed to submit emission report in due time: or fraud in emission report rectification and then ¥10-30k/firm. Impediment of verification work: rectification and then ¥30k -50k /firm. Non-compliance penalties range from 5,000-100,000 RMB/firm. Also penalties for fraud of trading exchange and verification entities.	Failed to submit emission verification report in due time or fraud: rectification and then ¥10-100k/firm. For non-compliance: reduction from following year's allowances and 3 times the market price for every missing allowance. Also penalties for fraud of trading exchange and verification entities.	Levels and details of penalties not specified.
	Reporting date	April, 15th	x	x	Last working day in Feb.	April, 15th	March, 31st	April, 30th
	Surrender date	June, 15th	x	x	Last working day in May.	June, 1st to June, 30th	June, 30th	May, 31st
Other	Linkage	Encourage regional linking.	x	Potential linking with Hubei announced in 2011. Open to potential linkage with EU or California. Encourage regional linking.	Potential linking with Guangdong announced in 2011. No information since then. Deemed unlikely. Encourage regional linking.	Encourage linking with other ETS.	x	Encourage regional linking.
	Allowed participants	Compliance entities. Investment institutions, individuals are not allowed?	x	Compliance entities. individuals and investment institutions?	All except DOEs and banks?	Compliance entities. individuals and investment institutions?	Compliance entities. individuals and investment institutions?	Compliance entities. individuals and investment institutions?
	Transaction modes	Spot, agreement transfer.	x	Listed bidding, check bidding, agreement transfer.	Fixed-price transfer & negotiation bargaining	Listed trade, agreement transfer.	Spot, electronic bidding, block transaction.	Web Spot, agreement transfer, auction.
	Remarks	Floor and ceiling prices were put forward but negotiations have stalled due to lobbying over fears of higher costs.	Was the least developed of the 7, notably due to technical issues (e.g. on building the registry) and city-level politics scandal.	Biggest provincial economy, it will be the biggest market of the 7. Only scheme to auction some allowances for now. Two auctions have been carried out till January 20 2014.	Private investors and foreign trading houses (belonging to other pilots) may be allowed to trade Hubei carbon permits (?).	Only pilot of the 7 to cover aviation. Trades are de facto not restricted to spot exchanges since vintage 14-15 permits are already owned and have already changed hands.	First to kick off, it is also the smallest of the 7. Will share market design strategies and experiences with California. Double-counting of emissions from scope 2 sectors and electricity generators.	Peculiar treatment of double-counting issues: if both supplier and consumer are regulated they both need to hand over a permit for the same ton of CO_2.

Sources: Thomson Reuters Point Carbon, ICAP Interactive Map, local regulations when available (CEEX, CBEEX, CTEEX, CNEMISSION). Sometimes information come from personal communications. Information presented herein must therefore not be taken for granted, all the more so that regulations are evolving.

Notes: TCE stands for Metric Tons of Coal Equivalent. 1 TCE is equivalent to about 2 tCO_2 emissions.

Annex 3 Carbon transaction price and volume fluctuations

Figure A – Shenzhen ETS

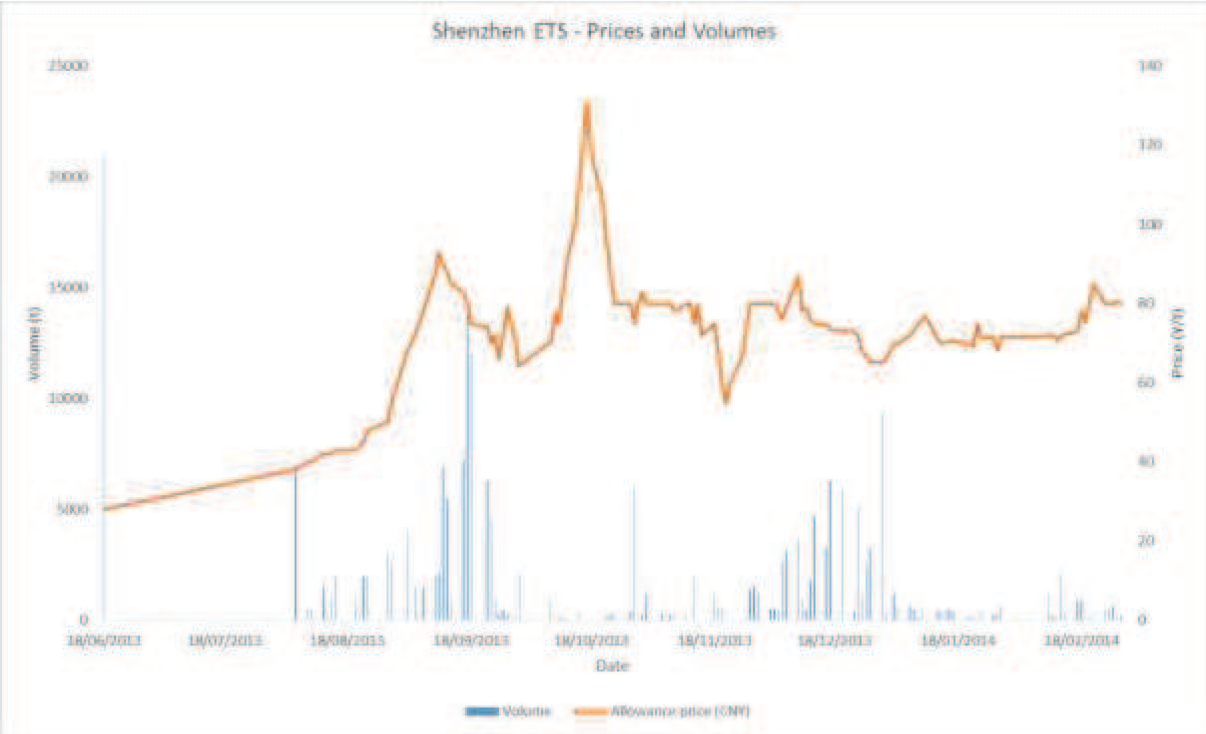

Figure B – Beijing ETS

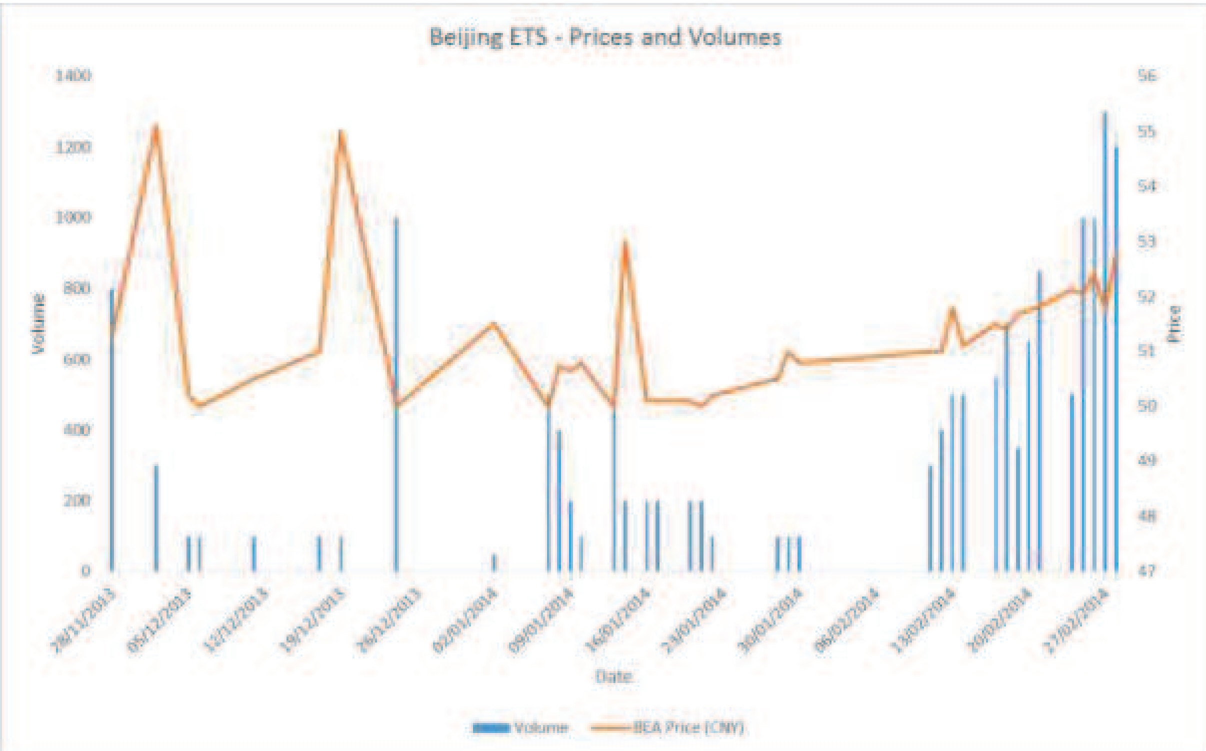

Figure C – Tianjin ETS

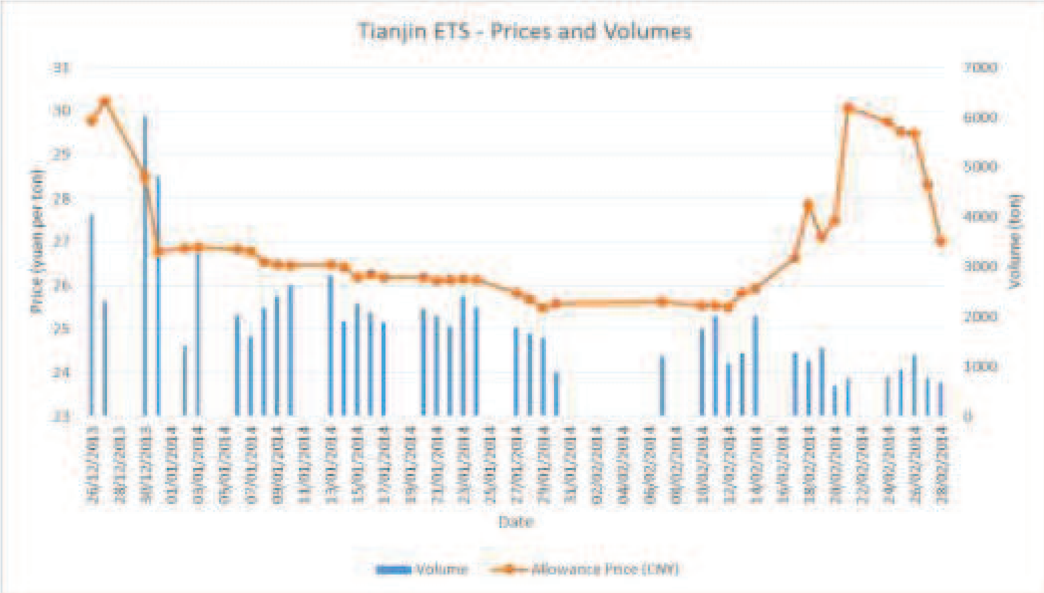

Figure D – Shanghai ETS

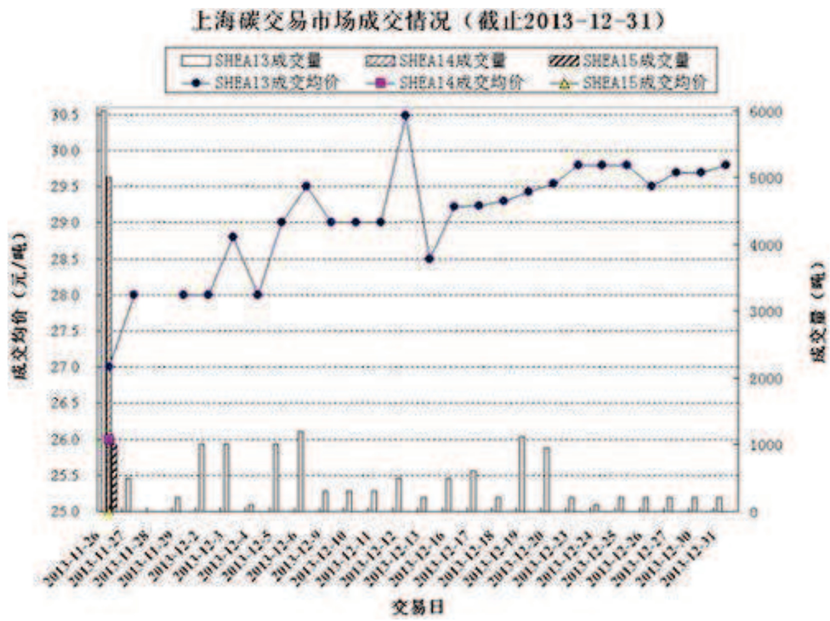

Figure E – Price fluctuations in the five pilots

Table F – Shanghai ETS

	SHEA13 in 2013	SHEA14 in 2013	SHEA15 in 2013	SHEA13 in Dec. 2013	SHEA13 In Jan. 2014	SHEA13 2014.02.17–2014.02.21
Price (¥/t)	28.4 (27–31.8)	26	25	29.2	31.4 (29.5–33)	40.5 (35.7–46)
Volume (t)	17270	5000	1000	10570	6650	28492

Table G – Guangdong ETS

GDEA Trades	Transactions		Gouvernment-held auctions	
	2013.12.19	2013.12.20	2013.12.16	2014.01.06
Price (¥/t)	61 - 60	60	60	60
Volume	20 + 100 kt	100 t	3 Mt	3.89 Mt
Cumulative number of transactions		8,143,447 t		

Notes: For Tianjin prices are not available from the kick off date on CTEEX website.

For Fig.D, left axis = price per ton; right axis = ton; Time axis between lauch date and end 2013.

For Fig.E, blue = Shenzhen; red = Shanghai; green = Beijing; violet = Guangdong; turquoise = Tianjin. Time axis spans from 18 June 2013 to 27 December 2013.

Sources: CEEX in Shenzhen (A); CBEEX (B); CTEEX (C); CNEEEX (D,F); CNEMISSION (G); and Shenzhen ETS 2013 annual report (E).

Allowances issued from the five carbon trading pilots were estimated to amount to approximately 730 million tons in 2013 and up to 800 million tons considering reserve quota. As of December 31 2013, 445,500 tons of allowances have been transacted on the secondary market of the five pilots, resulting in a total turnover of ¥24.91 million.

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