Stakeholder Views on Interactions between Low-carbon Policies and Carbon Markets in China: Lessons from the Guangdong ETS

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Keywords Emissions trading, China, Carbon pricing; Guangdong ETS pilot; Stakeholder survey; Climate change policy; Low-carbon policy interactions

JEL Classification H23, Q58, N45, Q48, Q54

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EPRG WORKING PAPER

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1. Introduction

China's economy has been growing at a sustained average annual rate of over 9% for three decades and energy use has therefore increased five times since 1980 (to nearly 3 billion tons of oil equivalent in 2011) (IEA, 2016). In 2010, China's energy consumption exceeded the United States (Lee and Zhang, 2012). As coal continues to dominate the primary energy structure and occupy a majority of incremental electricity demand in China, energy consumption growth driven by rapid economic China to become the world's leading emitter of greenhouse gas emissions (GHGs) (Guan et al., 2008). The Paris Accord agreed in December 2015 sets out a global action plan to put the world on track to avoid dangerous climate change, by limiting global warming to well below 2°C above pre-industrial levels in the long-term, and to pursue best efforts to limit increased warming to 1.5°C (UNFCCC, 2015). China also formally submitted its intended nationally determined contribution (INDC) to the new global climate agreement as lowering carbon dioxide intensity by 60-65% from 2005 levels and peaking its greenhouse gas emission by around 2030 (NDRC, 2015).

Since the emergence of the EU emissions trading scheme (ETS), which has been the main means for Europe to drive emission reductions cost-effectively using market forces, the world has witnessed a rapid growth in national and sub-national emission trading schemes (World Bank, 2014). The New Zealand Emissions Trading Scheme (NZ ETS) started in 2008 and is the first ETS covering the forestry and waste sectors. The Swiss ETS was also introduced in 2008 and now covers 55 companies from 25 categories of activities, and in 2017 agreed to link to the EU ETS. In the U.S., the Regional Greenhouse Gas Initiative (RGGI) began operation in 2009 and covers carbon dioxide emissions from power plants in nine Northeast and Mid-Atlantic states. In Canada, in 2007, the province of Alberta set up a GHGs reduction program under its Specified Gas Emitters Regulation (SGER). The largest cap-and-trade system outside of Europe is that of California, which in 2014 linked up to the smaller cap-and-trade system in the province of Quebec and in 2018 expanded to the province of Ontario. In addition, Japan has established various sub-national systems since 2010 including ETSs in Tokyo, Kyoto and Saitama.

Although China has not adopted mandatory national emission abatement targets, initial steps towards a national carbon market have been taken through piloting regional carbon emission trading systems, with an eye to establishing a carbon pricing system in the country. In March 2011, China officially included pilot ETSs into the Twelfth Five-Year Plan with a view to helping meet its 2020 carbon intensity target (Cui et al., 2014). In October 2011, seven pilot cities and provinces (Figure 1) were authorized to proceed by the central policy-making body, the National Development Reform Commission (NDRC) (NDRC, 2011). Since the final pilot ETS commenced trading in Chongqing on 19 June 2014, all seven pilots in China have been in operation. Carbon dioxide emissions are being monitored in China's pilot schemes so far (although the Chongqing pilot ETS also covers non-CO_2 GHGs including CH_4 and N_2O), and the trading period of the seven pilot ETS ran from 2013 through 2016, after which a national ETS was launched on 19 December 2017 (NDRC, 2016; NDRC, 2017). Initially, the seven Chinese pilot ETS were scheduled to end after three compliance years and be replaced by the national ETS in 2016. However, as the launch of national ETS was postponed to the end of 2017, the pilots were continue operating until then and probably also beyond. The initial phase of the national ETS will give regulators the opportunity to improve system design as well as allow market participants time to familiarize themselves with the ETS based on experiences in the pilots.

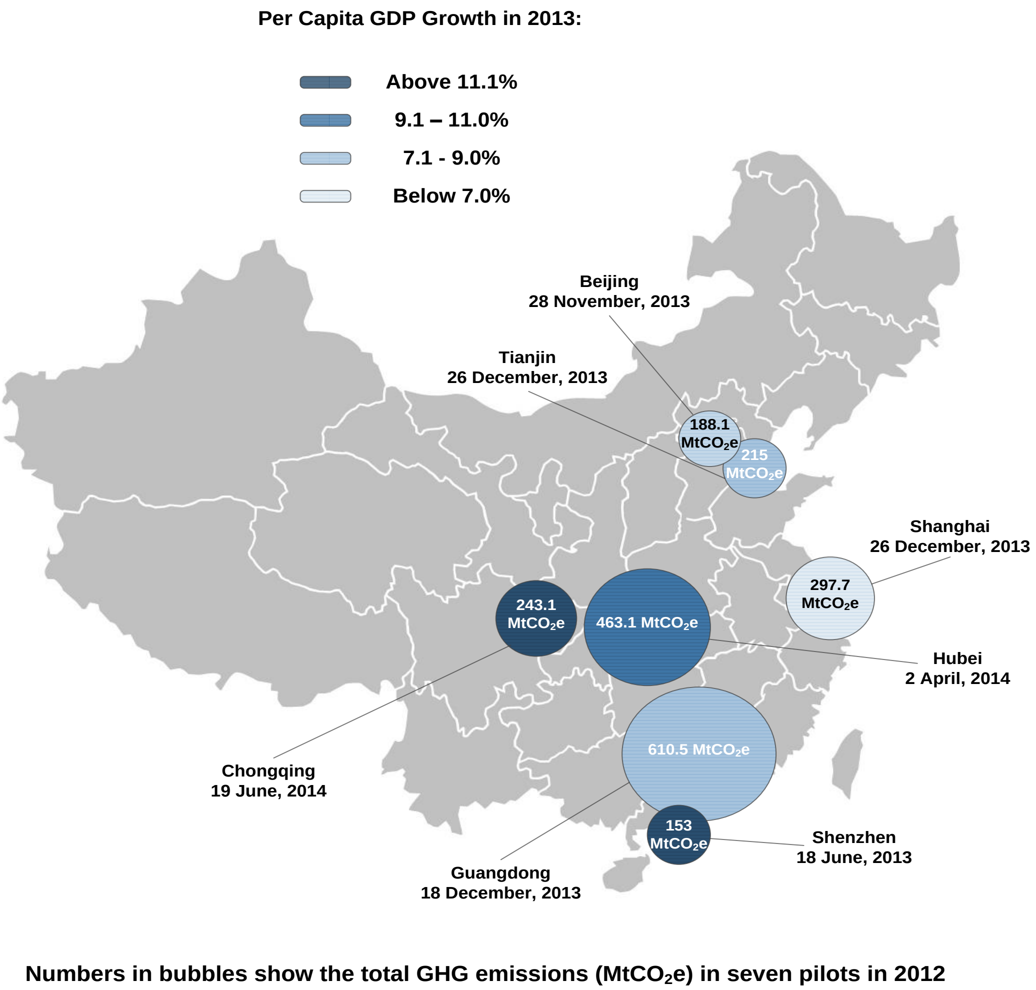

Figure 1 Map of seven pilot ETSs in China (Ernst & Young, 2014)

Each province or city participating in a pilot ETS has a different economic growth outlook and GHG emissions profile, which implies each pilot ETS will have different effective reduction targets and design characteristics in order to achieve its target. For instance, Beijing, Tianjin, Shanghai, Shenzhen are commercial centres along the coast, with relatively higher GDP per capita, and larger commercial and residential buildings are covered in these ETS (Table 1). Conversely, Hubei and Chongqing are located in central China with a lower GDP per capita but higher GDP growth rates and are less commercialised. Accordingly, these pilot ETS cover heavy industrial sectors only, and emissions offset credits must originate from within their own provinces, because the abatement cost is expected to be cheaper within these provinces (Ernst & Young, 2014). The diversity of the emissions trading market design roughly corresponds to the regional income level, thus regional emission reduction targets can be achieved without adversely affecting economic growth projections.

Guangdong Province, often referred to as the Pearl River Delta Economic Zone, has some characteristics of an advanced industrialized economy. Guangdong Province contributes 11.6% of national GDP in 2013, and the Guangdong ETS pilot is the largest of the seven schemes, with an absolute cap of 408 $MtCO_2$ in 2014, initially covering the power and industry sectors, to be followed by the transportation sector. These sectors account for more than half of the province's emissions (ICAP, 2016). Hence, the experiences of implementing carbon emission trading policies in Guangdong will be important in designing and operating a larger national ETS. To avoid any confusion with the other six pilot systems, survey respondents were asked to provide all their answers with reference to the Guangdong pilot. The detailed survey design is described in section 2.

1.1. Interactions across low-carbon incentive policies

Since the launch of the EU ETS in 2005, emissions trading has become a popular instrument to encourage climate mitigation globally (Brouwers et al., 2016; Yang et al., 2016; Wang et al., 2015; ECCC, 2015; Cui et al., 2014). However, the collapse of EU allowances (EUAs) prices in 2008 following the global financial crisis significantly weakened incentives to continue reducing emissions. Although the financial crisis of 2008-2009 and overly generous national allowance allocations (IETA, 2014; Zhang and Wei, 2010; Schleich, et al., 2009) were generally recognized as the principal causes for the drop, further studies have shown that the interactions between the emissions trading market and competing energy and low-carbon policies also contributed to weakening impact on the ETS.

Hone (2013) argues the EU ETS, in combination with other low-carbon policies (notably binding European commitments on renewables) has 'distorted emissions mitigation economics across the EU, and the recession has further exacerbated the situation'. Figure 2 demonstrates the shift of the abatement curve driven by parallel low-carbon policies: the marginal abatement cost curve (MACC) is a set of points reflecting the options with marginal costs and emission reductions (Ellerman and Decaux, 1998). With the increasing emission reductions, the option with the lower marginal abatement cost sets the price for emission permits. Total emission reductions will be achieved at least cost until the equilibrium market price has been reached (Ekins, et al., 2012) (Figure 2(a)). In principle, if a country adopts a stringent mandatory policy to promote low-carbon technologies through parallel energy and low carbon policies (such as an ambitious renewable obligation target, a mandatory energy efficiency program, or a high carbon tax), the MACC would shift to the right (as illustrated in Figure 2(b)) and thereby the carbon price visible in the market will fall.

Table 1 Overview of ETS pilots in China

	Shenzhen	Shanghai	Beijing	Guangdong	Tianjin	Hubei	Chongqing
General Information							
Starting Date	18 Jun. 2013	26 Nov. 2013	28 Nov. 2013	19 Dec. 2013	26 Dec. 2013	2 Apr. 2014	19 Jun. 2014
Reduction Target[5]	21%	20.5%	20.5%	20.5%	20.5%	19.5%	19.5%
GHG emissions[6] ($MtCO_2e$)	153	297.7	188.1	610.5	215	463.1	243.1
Per Capita GDP (2013)	CNY 136,947 (EUR 18,727)	CNY 90,092 (EUR 12,320)	CNY 93, 213 (EUR 12,746)	CNY 58,540 (EUR 8,005)	CNY 99,607 (EUR 13,621)	CNY 42,613 (EUR 5,827)	CNY 42,795 (EUR 5,852)
Per Capita GDP Growth (2013)	11.5%	6.1%	5.2%	7.8%	7.9%	9.7%	11.3%
ETS Size							
Absolute Cap ($MtCO_2$)	34.78 (2015)	155 (2016)	46 (2016)	422 (2016)	160-170 (2016)	253 (2016)	100.4 (2016)
Estimated Coverage	40%	57%	45%	60%	60%	35%	40%
Scope	Industry; Power; Buildings	Industry; Transport; Aviation; Buildings	Industry; Power; Buildings	Industry; Power	Industry; Power; Buildings	Industry; Power	Industry; Power
Firm or facility-level threshold for inclusion in ETS	Enterprise: 5,000 tCO_2e/year; public buildings: 20,000 m^2; government buildings: 10,000 m^2	Power and industry: 20,000 tCO_2/year; non-industry: 10,000 tCO_2/year	5,000 tCO_2/year, considering both direct and indirect emissions	20,000 tCO_2/year or 10,000 tce/year energy consumption	20,000 tCO_2/year considering both direct and indirect emissions	10,000 tce/year energy consumption	20,000 tCO_2e/year

5 Carbon intensity reduction target by 2020 (end of the 13th Five-Year Plan), based on carbon intensity level in 2015.
6 Overall GHG emissions excluding LULUCF in 2012.

Allocation and Purchase							
Allocation methodology	Bench-marking	Bench-marking and Grand-fathering[7]	Bench-marking and Grand-fathering[8]	Bench-marking and Grand-fathering[9]	Bench-marking and Grand-fathering	Grand-fathering	Grand-fathering
Purchase allowance	Auction (3% of allowances in 2014)	One-off action before compliance deadline	Buy or auction allowances in order to stabilize the market.	Auction (3% in 2013 and 10% in 2015, 2016)	Buy or sell allowances in order to stabilize the market	Auction (small proportion)	Free allocation; reduction factors will be applied if allocation exceeds the cap;
Flexibility							
Banking	Allowed						
Borrowing	Not allowed						
Offsetting[10]	Domestic offsets						
Offset Limitation[11]	10%	5%	5%	10%	10%	10%	8%
Compliance							
Compliance period	one year						
MRV	Annual reporting of CO_2; third-party verification is required						
Penalties for non-compliance	CNY 50,000-150,000 (EUR 6,544-19,632)	CNY 10,000-50,000 (EUR 1,308-6,544)	up to 50,000 (EUR 6,544)	CNY 10,000-50,000 (EUR 1,308-6,544)	No financial penalties	CNY 10,000-150,000 (EUR 1,309-19,632)	No financial penalties
Penalties for failing to surrender enough allowances	3 times the average market price	N/A	3-5 times of average market price	2 times of allowances deducted from allocation for the following year	Disqualified for preferential financial support and policies for 3 years	1-3 times of the average market price	Disqualified for preferential financial support and policies for 3 years

Sources: NDRC, 2013; ICAP, 2018; China Statistical Yearbook, 2014

7 Mainly free allocation through grandfathering based on 2009-2012 emissions or emissions intensity; Bench-marking is for specific entities.
8 Mainly free allocation through grandfathering based on 2009-2012 emissions or emissions intensity; Bench-marking for new entrants and entities with expanded capacity.
9 Mainly free allocation through grandfathering based on 2009-2012 emissions or emissions intensity; Bench-marking for electricity generators, certain cement and iron and steel industrial processes and new entrants.
10 Domestic project-based carbon offset credits - China Certified Emission Reductions (CCER) are allowed.
11 The use of CCER credits is limited to corresponding proportion of the annual compliance obligation.

In theory, energy and low-carbon policies could act in a complementary manner: for instance, renewable energy obligations could contribute to carbon emission reduction targets while carbon abatement instruments should stimulate renewable energy deployment (Fischer and Preonas, 2010). However, a number of studies highlight that in practice there has been duplication and conflict between different policies that are all nominally meant to work together to incentivize emission reductions: Sorrell (2003) points out that the UK renewable obligation would interact with the EU ETS such that emissions reductions would be double counted and no extra reduction would be achieved. Furthermore, other studies show how a renewable obligation can depress emission prices in an ETS (Pethig and Wittlich, 2009; Bohringer and Resendahl, 2010; Sijm, 2011; Richstein et al., 2015), and do not contribute to long-term emissions reductions (Syri and Cross, 2013). Although a number of studies on interactions have focused on Europe, there are few studies of potential interactions between different climate change and renewables policies in China.

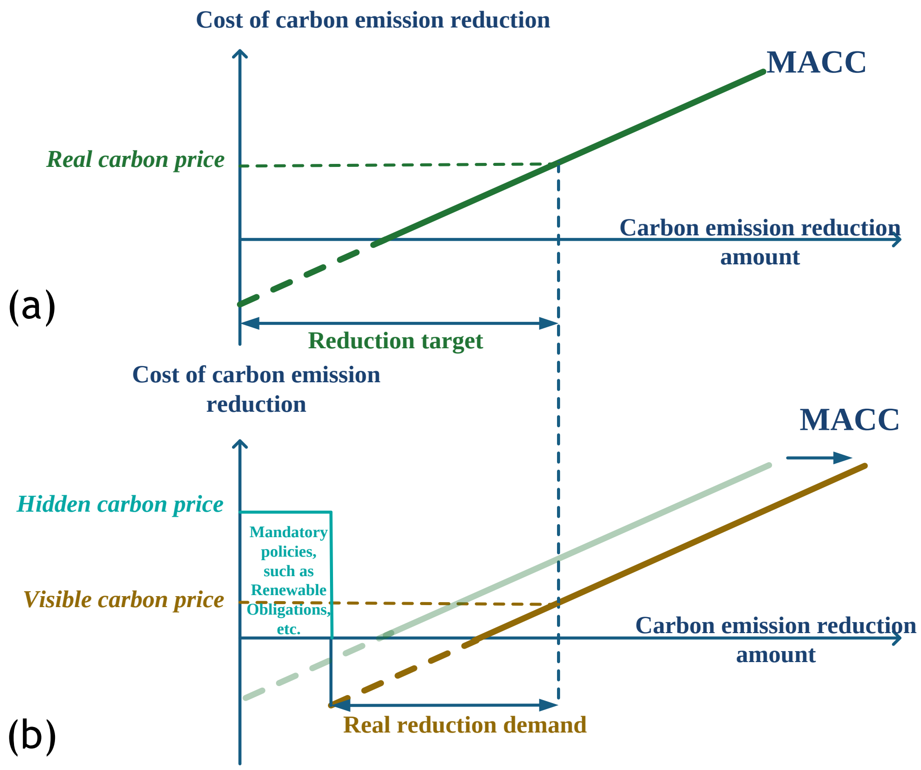

Figure 2 Impact of parallel low-carbon policies on marginal abatement cost curve (MACC) (adopted from Hone, 2013)

1.2. Motivation and contribution

China is still at an early stage in establishing a functional and effective emission trading system to facilitate GHG emissions reductions, so existing studies mainly describe the market features and characteristics (Cheng and Zhang, 2011; Zhou and Duan, 2011; Zhang, et al., 2014; Duan et al., 2014), market design and relevant legal and regulatory issues (Fan and Wang, 2014; Wu et al., 2014; Jiang et al., 2016; Qi et al, 2014a), or model the economic performance and impact of emission trading in China at some point in the future (Zhou, et al., 2013; Qi, et al., 2014b). The history of potentially competing policies, such as renewable energy support, is longer in China, but has taken many forms over the past decade and has not settled into as clear a policy signal as, for example, the Renewable Energy Directive in the European Union (Ragwitz and Steinhilber, 2014).

The design and implementation of carbon market are influenced by different stakeholders: government and industry who are directly involved in the markets, academics and non-government organizations (NGOs) who have relevant expertise or experience and will also contribute to market design and functioning. Consequently, it is critically important to investigate stakeholder views on the Chinese carbon market because policy construction would benefit from greater participant confidence, which would contribute to wider public acceptance.

Although previous studies suggest parallel low-carbon policies could influence allowance prices in the ETS and send industry the wrong signals, there has been little work on the potential interactions between low-carbon policies and the pilot ETSs in China and on related stakeholder views. Identifying policy interactions is vital for the emerging carbon market in China, as a common understanding between stakeholders would help improve national climate change (and energy) policy planning and avoid some of the problems experienced in other countries and systems.

This is the first survey with a focus on the interaction of low-carbon and energy policies interaction in China, which we hope can open the discussion and provide policy-makers with a better understanding of some of the built-in biases and perceptions of key actors. The structure of our study is as follows: section 2 describes the survey methodology Section 3 presents the survey results and the last section provides discussion, conclusions and policy recommendations.

2. Methodology and Demographic Information

A number of studies on both stakeholder and public perspectives towards climate change issues have been conducted in a range of topics including stakeholder perceptions on Carbon Capture and Storage (Liang and Reiner, 2013; Reiner and Liang, 2011; Li, et al., 2012, etc.), mandatory reporting of GHG emissions (Lai, 2014) or climate adaptation (O'keeffe, et al., 2016). On the question of policy interactions, Fischer and Preonas (2010) provide a theoretical rationale for why overlapping low-carbon policies will have a depressing effect on emission markets, which have been confirmed in empirical studies (Koch, et al., 2014) and economic models (Morris, et al., 2010). However, there has been no studies at the intersection of stakeholder studies and policy interaction, to determine, for example, whether analysts have effectively conveyed the potential impact of these interactions and whether this has been appreciated by stakeholders. Therefore, we adopt a survey approach to help examine stakeholder awareness of policy interactions.

We employed a two-stage survey consisting of a questionnaire and follow-up interviews. 100 internet-based questionnaires were sent out to stakeholders involved in the Guangdong pilot ETS in June 2014, followed by semi-structured telephone interviews with a subset of 10 respondents for a deeper understanding of stakeholder views in August 2014.

2.1 Internet-based questionnaire design

The online survey system Wenjuan was adopted as the survey platform. The internet-based questionnaire was made up of 22 questions, involving a combination of multiple-choice, ranking and open-ended questions to obtain stakeholder views on a range of issues including Chinese emission reduction policies and carbon markets, understandings of the interactions between policies as well as views on potential challenges in the implementation of the Chinese carbon markets. All stakeholders were asked to respond based on their personal opinions, knowledge and experience.

The pool of respondents drew upon those with significant involvement in the Guangdong pilot ETS with respect to market design and policy making, market participation and relevant research. Specifically, we adopted an expert sampling approach, selecting equal numbers of senior stakeholders from each of the key groups, i.e., 25 government stakeholders of at least at director level within the relevant ministry; 25 industry stakeholders of at least deputy general manager level in listed companies in the energy sector; 25 academic stakeholders that are lecturers or above working in energy and environment; and another 25 stakeholders that work at managerial level in environmental NGOs. An invitation letter and a participant information letter were sent to each stakeholder by email at the same time describing the purpose of the study, and the principle of anonymity and confidentiality that would be employed.

The questionnaire began with a set of general questions about their role and experience of participants before turning to their evaluation of low-carbon policies and incentives. The next set of questions focused on their perspectives regarding Chinese carbon emission reductions including emissions trading and other emission reduction instruments. Specifically, respondents were asked to estimate and rate the likelihood of China achieving deep cuts in GHGs over the next 10 years, and to select the most cost-effective policy instruments to reduce GHGs in China. We also asked how respondents explained the collapse of the carbon price in the EU ETS as well as their assessment and expectations of the pilot carbon markets in China.

Subsequently, what-if scenario questions were designed to explore stakeholder opinions on the interactions between other low-carbon policies and the Guangdong pilot ETS. They were asked to consider the most likely immediate impact on the carbon price in the Guangdong pilot ETS if either a new short-term renewable energy obligation or a carbon tax were to be enacted. Furthermore, stakeholders were asked for their views on potential conflicts between energy saving and emission reduction measures on the one hand, and between a national ETS and international systems on the other. The last few questions covered issues associated with building markets, including potential challenges for market regulation and implementation barriers.

2.2 Semi-structured telecom interview design

As a follow up to the questionnaire, we conducted semi-structured interviews to obtain more detailed views. The main selection criterion was that the respondents indicated that they spent more than 50% of their working time on energy saving and emission reduction policies in China in the past year to be able to realistically have a more in-depth discussion about the issues involved. Interviewees were asked to provide:

- A brief overview and outlook for Chinese pilot carbon markets;
- More detailed reasons to explain the options they chose in the what-if scenario questions;
- Opinions on the main challenges for implementation of Chinese carbon market.

2.3 Demographic information of respondents

We received 30 responses out of a total of 91 internet-based questionnaires delivered (for a response rate of 33%). The sectoral distribution of respondents was: industry (26.7%), finance (20%), consulting (16.7%), government (10%), academia (13.3%) and NGOs (10%) (Figure 3).

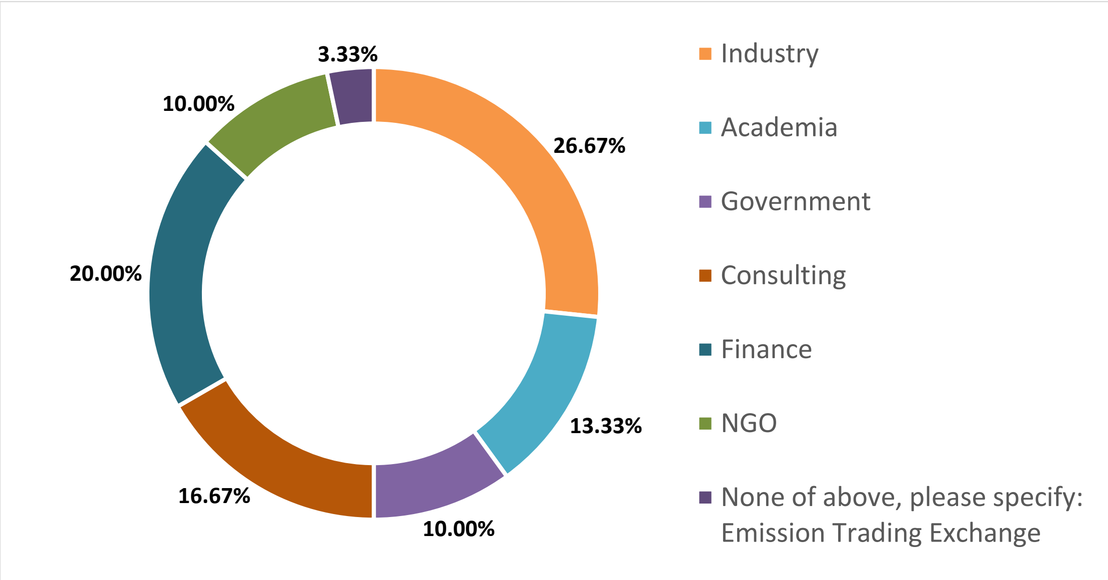

Figure 3 Sectoral breakdown of respondents

In the past year, one third (33.3%) of respondents spent more than 50% of their working time on energy and climate policy although none of them spent 90% or more of their working time on the subject. A further 30% spent from 20-50% of their working time and over one third (36.7%) of them spent less than 20% of their time on relevant policy issues. The Internet, conferences and newspapers were the main channels that a large majority of respondents used to obtain up-to-date information about the Chinese carbon market, followed by TV news and personal networks.

3. Results and Findings

3.1. Perspectives on emissions reduction and carbon market in China

3.1.1 Predictions about emissions reductions in China

As the world's largest emitter, China has started to develop low-carbon economy since 1990s: the first White Paper regarding sustainable development was published in 1994, followed by the 'Program of Action for Sustainable Development in China in the early 21st Century' in 2003. China enacted its first 'Renewable Energy Law' in 2005, soon to be followed by 'Energy-saving and Emission Reduction' national programme from 2006 (Wu et.al, 2012). It was not until the energy plan proposed in the Eleventh and Twelfth Five-Year Plans in 2006 and 2011 that specific quantitative emission reduction targets were set: reduce 40-45% GHG intensity by 2020 base on 2005 level (Hu and Monroy, 2012; Yuan and Zuo, 2011). In the Thirteenth Five-Year Plan (2015-2020), China has set a stronger and more ambitious reduction target of 48% reduction in GHG intensity from 2005 levels by 2020, in line with China's pledge at the CoP21 conference in Paris in December 2015, where the Chinese government promised to peak carbon emissions by 2030 as well as to lower GHG intensity by 60-65% below 2005 levels (NDRC, 2015).

Asked about expectations on whether current climate policies in China could achieve deep cuts in GHG intensity in the next 10 years, most respondents were pessimistic: half (50%) considered it difficult to reach a stringent target, and another 20% of stakeholders were not sure, although over one quarter (26.7%) of stakeholders believed such reductions were likely, and one stakeholder (3.3%) believed it was 'very likely' (Figure 4). The results are consistent with a previous survey conducted in 2009, where more than 80% of respondents believed it would be 'difficult' or 'very difficult' to achieve deep cuts in GHG in the next 20 years (Liang et al., 2011).

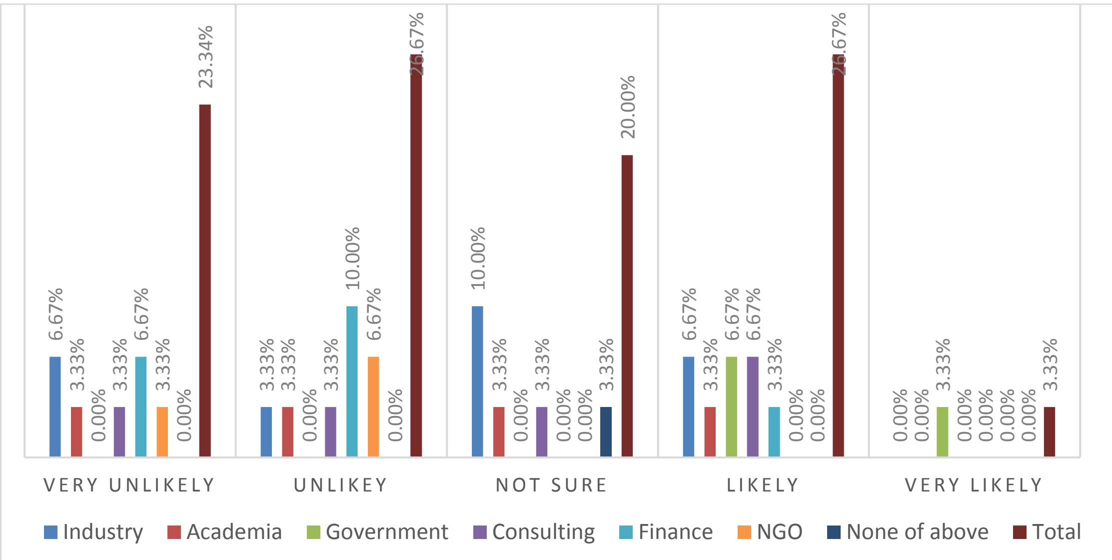

Figure 4 Expectation of deep cuts in GHG intensity in China by sector of respondent

Recent studies on emissions reductions in China may offer some reasons for the somewhat bearish expectations. Empirical results show obvious inefficiency in China's regional energy saving and emission reduction (Guo et al., 2017), China's carbon emissions are still driven by significant longstanding inefficiencies in key industrial sectors (Zhang et al., 2016), and the impact of recent low-carbon policies suffers from a lag effect (Zhang et al., 2017). Nonetheless, Yi et al. (2016) indicate that the 40-45% carbon intensity target is very likely to be achieved by 2020 if Chinese government put more efforts in adjusting the industrial structure and primary energy mix, as well as promoting energy efficiency during the 13^{th} FYP. Green and Stern (2017) describe important structural changes in the economy that are underway, which will enable Chinese emissions to peak well before 2030.

Through a univariate regression using least squares method, where *Gov* stands for dummy variables that take the value of 1, if the respondent is from government sector and 0 otherwise. *Expect* are ordinal variables defining respondents' expectation levels from 1 to 5, while *Expect* =1 means one consider it is very unlikely to achieve deep cuts in GHG intensity in the next 10 years and *Expect* =5 implies very likely. To regress *Expect* against *Gov* , we find significant results that government stakeholders generally believed that deep cuts in GHG intensity will likely be achieved (Table 2). It implies that rather than stakeholders from other sectors, government stakeholders tend to be more hopeful of success in slashing GHG emissions in China in the future.

Table 2 Output of univariate regression model *Expect - Gov*

VARIABLE	Model *Expect - Gov*
Gov	1.593**
	[2.428]
Constant	2.407***
	[11.608]
Observations	30
R-squared	0.174
Adj. R-squared	0.144

t-statistics significance
*** p<0.01, ** p<0.05, * p<0.1

To achieve deep emissions reductions, fully 60% of respondents preferred a market-based instrument – an emission trading scheme was viewed as the most cost-effective policy instrument to slash GHG emissions in China (33.3%), followed by carbon taxation (26.7%), even though historically the Chinese government has used non-market-based forms of regulation to achieve its environmental goals (Lo, 2014). 16.7% of the respondents preferred renewable energy subsidies/binding obligations or industrial emission performance standards. Feed-in tariffs (FITs) and preferential policies favoring natural gas and nuclear power were considered to be the least cost-effective measures as only a single stakeholder (3.3%) voted for each (Figure 5).

Energy and low-carbon policies in China have gradually been switching from command-and-control policy to market-based approaches (Wang and Chen, 2015). There is no single policy, whether command-and-control or market-based, which has all the characteristics needed to mitigate emissions and address the full range of energy policy priorities including efficiency, effectiveness, promoting innovation, and security of supply. However, empirical studies have shown that market-based instruments will have significant impacts on efficiency improvement and emission reductions (Zhao et al., 2015), although there may be regional differences in the effectiveness of different instruments (Ren et al., 2016). Despite operating for only a short time and the immature market environment, the pilot ETS in China appear relatively promising with regard to carbon emissions reduction. (Zhang et al., 2017).

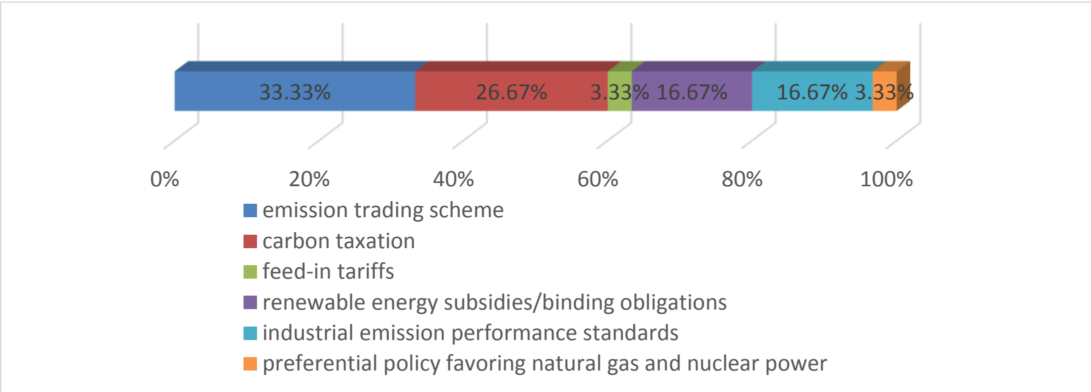

Figure 5 Belief in most cost-effective policy instrument to cut GHG emissions

3.1.2 Assessment on progress of Chinese pilot ETS

Media coverage and many international observers have described Chinese carbon markets as moving quickly since the pilot ETS policy was launched by the NDRC in 2010 (Zhang et al., 2014). By contrast, the bell shape of the solid line in Figure 6 demonstrates that there are approximately equal shares of respondents who consider the development speed of ETS in China to be fast or slow: 36.7% of respondents agree the progress has been fast (26.7%) or even too fast (10%); another 40% have the opposite view and take progress to be slow (26.7%) or too slow (13.3%).

After further investigation of respondents' sectoral affiliations, a trend can be found as academic stakeholders tend to consider the development progress of ETS in China to be slow (dashed line in Figure 6). A univariate regression of *Assess* on *Acad* confirms the tendency (Table 3), where ACA are dummy variables that take the value of 1 if the respondent is from academia sector and 0 otherwise and *Assess* are ordinal variables defining respondents' assessment levels from 1 to 5. *Assess*=1 means the respondent considers progress to be too slow and 5 implies too fast.

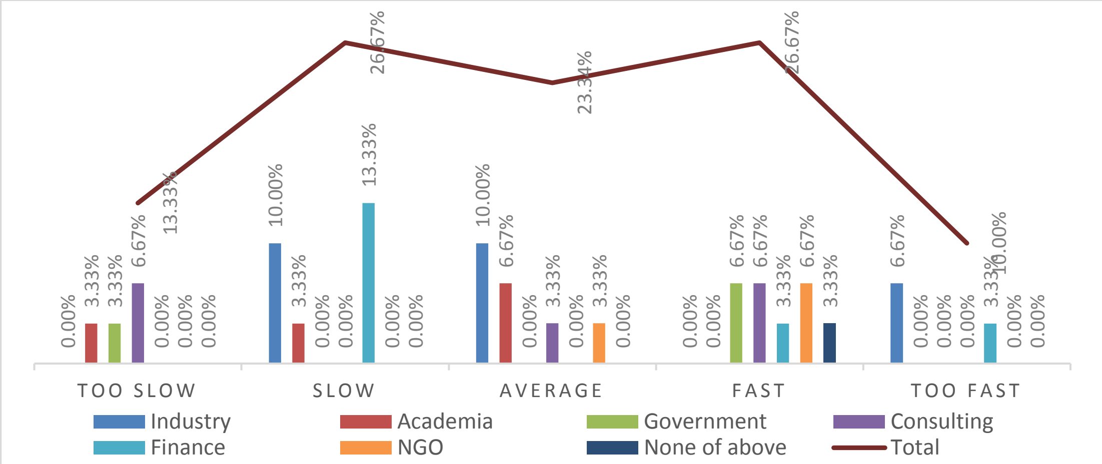

Figure 6 Stakeholders' assessment of progress of Chinese pilot ETS

Table 3 Output of univariate regression model *Assess-Acad*

VARIABLE	Model Assess-Acad
Acad	-1.040*
	[-1.791]
Constant	3.240***
	[13.664]
Observations	30
R-squared	0.103
Adj. R-squared	0.0707

t-statistics significance
*** p<0.01, ** p<0.05, * p<0.1

Accordingly, there are approximately equal shares of respondents that are pessimistic (30%) or optimistic (33.3%) about the future of Chinese pilot ETS with another 23% describing progress as 'average'. The fact that the largest single response was 'not sure' (36.7%) reveals the large uncertainties over the future of ETS in China. Using different shades to present assessment of progress, where lighter blue denotes slower and darker blue denotes faster, correlation between stakeholder assessment and perspectives can be visually observed from Figure 7: respondents who believed the progress was too slow felt pessimistic or even very pessimistic while respondent assessments of too fast lead to relatively optimistic perspectives. In a univariate regression of *Prospect* on *Assess*, where *Prospect* and *Assess* are both ordinal variables that 1 means very pessimistic and too slow respectively while 5 means very optimistic and too fast respectively, the output confirms our observations by indicating a significant positive correlation between these two variables (Table 4).

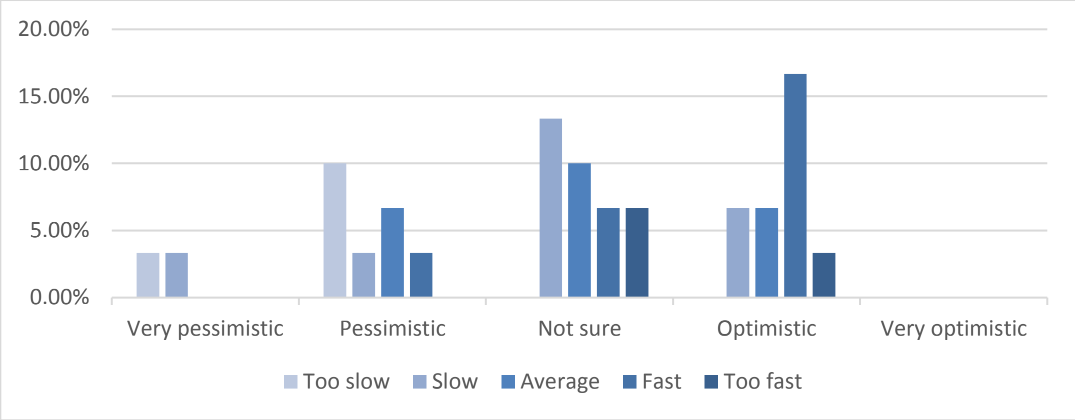

Figure 7 Cross tabulation of stakeholder perspectives and assessment on Chinese carbon market

Table 4 output of univariate regression model Prospect-Assess

VARIABLE	Model Prospect-Assess
Assess	0.298**
	[2.274]
Constant	2.053***
	[4.755]
Observations	30
R-squared	0.156
Adj. R-squared	0.126

t-statistics in brackets
*** p<0.01, ** p<0.05, * p<0.1

As a matter of fact, the preparatory stage for the Chinese pilot carbon markets was relatively short compared with other ETS developed around the world. Seven pilot ETS were launched in China within two years, whereas it took almost five years for the EU ETS (European Commission, 2015). The rapid development of ETS in China is largely the result of the strong political will of the government. Although all pilots have been launched, some of their design details have yet to be finalized, for instance, the monitoring, reporting and verification (MRV) guidelines and regulations (ICAP, 2016). Nonetheless, Chinese stakeholders tend to equate "speed of development" with the rapid economic transition over the last few decades, which is overwhelmingly seen as beneficial (Lo, 2014).

3.1.3 Expectation on Guangdong pilot ETS market price

A quarter of the stakeholders were uncertain about the expected range of the average carbon price in Guangdong market. Nearly half (45.8%) expected the carbon price to be between 51-100 CNY/t CO_2 (7-14 EUR/t CO_2), which is higher than the 32 CNY/t CO_2 (4 EUR/t CO_2) found in the October, 2013 China Carbon Price Survey. Moreover, one-sixth (16.7%) of respondents proposed an even higher range of 101-200 CNY/t

CO_2 (14-27 EUR/t CO_2), while another third (33.3%) expected it to be lower, at 26-50 CNY/t CO_2 (3.5-7 EUR/t CO_2). Only 4.2% believe the price range would be as low as 0-25 CNY/tCO_2 (3.5 EUR/t CO_2) (Figure 8).

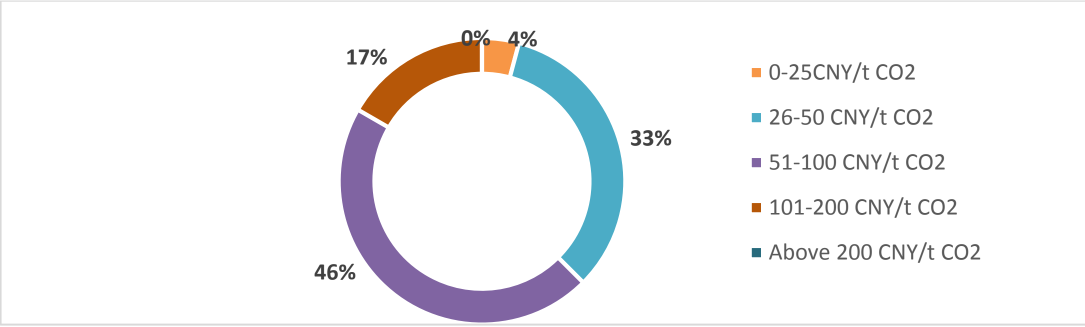

Figure 8 Perceived expectation on average carbon price in Guangdong pilot ETS

At the time of the survey, in mid-2014, the Guangdong market price was around 60 CNY/tCO_2 (8 EUR/t CO_2) with very low turnover (Figure 9). After decreasing over the latter half of 2014, the price in the Guangdong ETS dropped to around 15 CNY/t CO_2 (2 EUR/t CO_2), which is consistent with the expectation of only a small fraction (4.2%) of respondents.

Figure 9 Price and volume in Guangdong pilot ETS (1 Jan, 2016- 1 Sept, 2017)

Source: ChinaCarbon.net.cn

During follow-up interviews, stakeholders expressed mixed views on the impact of carbon pricing through ETS in China. Government officials were far more confident than industrial and academic stakeholders. One government official considered the carbon market pilot in the province would be robust in response to the economic cycle, and he believed the intensity allowance cap scheme would adjust automatically. An official from Guangdong (the largest pilot scheme with an absolute cap) suggested the carbon price in Guangdong could be supported through a floor price in the auctioning scheme, as a carbon floor price would create more certainty about the minimum price, providing a clearer signal for investors.

Three stakeholders from carbon-intensive industries expressed some concern during follow-up interviews about the impact of the economic cycle on carbon allowance prices, but in general, they preferred retaining allowances for future compliance periods. Through cross tabulation of stakeholder expectations on carbon price in Guangdong ETS with respondents' sectors, we see that industrial stakeholders are more likely to expect the price to stay the same or fall.

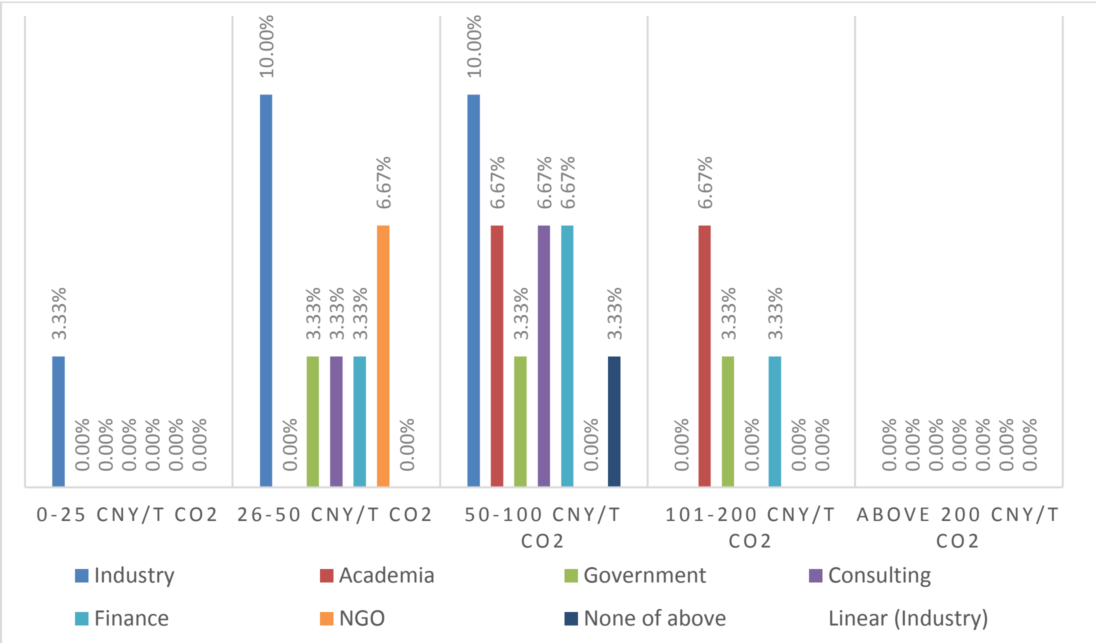

Figure 10 Cross tabulation of stakeholders' sectors and expectation on average carbon price in Guangdong pilot ETS

Conversely, through a univariate regression of *Price*, ordinal variables representing respondents' price expectations (1 = 0-25 CNY/t CO_2 while 5 = above 200 CNY/t CO_2), on *Acad*, whether the respondent is from academia (*Acad*=1 means respondents are from academia while *Acad*=0 reflects non-academic respondents), we find that academic stakeholders significantly expected (at 90% confidence level) the price to be relatively high compared with other stakeholders (Table 5).

Table 5 Output of univariate regression model *Price-Acad*

VARIABLE	model Price-Acad
Acad	1.200*
	[1.936]
Constant	2.000***

	[7.906]
Observations	30
R-squared	0.118
Adj. R-squared	0.0866

t-statistics in brackets
*** p<0.01, ** p<0.05, * p<0.1

Still, one academic stakeholder involved in setting up the rules for one of the pilot carbon markets believed there was significant over-allocation of allowances in most pilot markets in China, and negative impacts would result during the compliance stage. Another academic was concerned that the quality of the initial reporting of emissions could damage the reputation of emissions trading more generally in China, and that this effect was not been widely appreciated (i.e., there was significant over-reporting of emissions at the initial stages).

3.2. Perceptions of interactions between incentives

In spite of the high political priority given to ETS as a policy instrument, the Chinese energy system is primarily regulated by administrative measures rather than market-based instruments (Lo, 2014). For example, China's electricity market is not fully liberalised and the electricity tariff is set by government, and industries suffering higher cost in paying for carbon allowance or emission reductions cannot directly pass the cost through to consumers. Meanwhile, in recent years, a range of policies including carbon taxation, renewable obligations and energy efficiency quota trading mechanisms have been mentioned by both government officials and leading academics in China. All such parallel mechanisms could reduce the implied allowance price in the ETS and give investors a misleading signal over the value of carbon in longer-term investments. Figure 11 summarizes the existing low-carbon policies developed by central government and the specific implementation plans in Guangdong Province.

Even though earlier literature indicates Chinese stakeholders preferred market-based instruments such as emissions trading over regulation (Lo, 2014; Liang and Reiner, 2011) and in spite of the current moves towards a national emissions trading scheme building on the seven pilots, a carbon tax is still being actively considered as a major policy option by the Ministry of Finance in China. There have also been longstanding discussions on how best to encourage renewable energy in China and having a binding national renewable target is one of the options that has been discussed. Consequently, for the case of Guangdong ETS Pilot, we have sought to explore opinions regarding the interactions between the ETS and parallel carbon and energy policies.

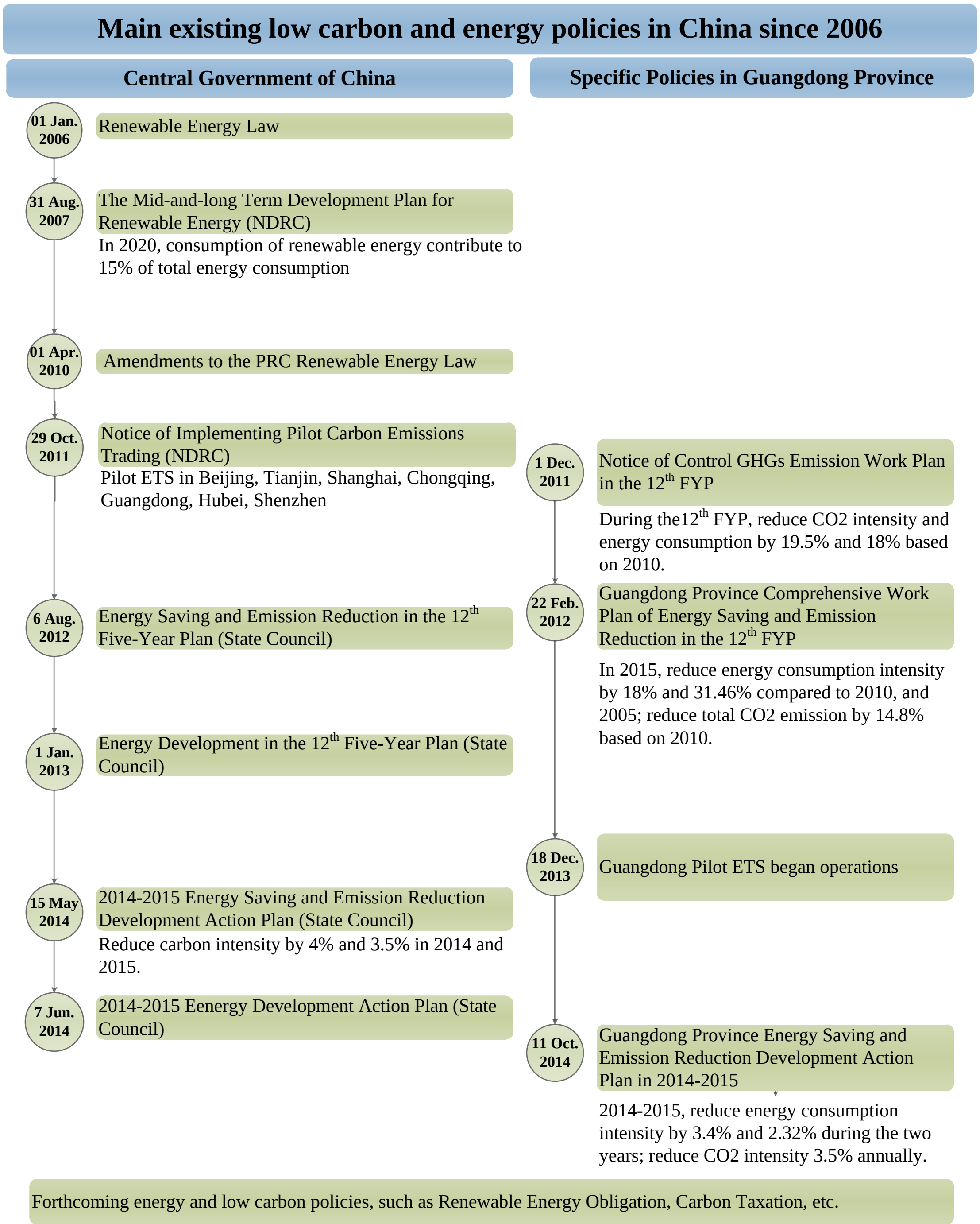

Figure 11 existing main national and Guangdong province climate change policies (Sources: www.ndrc.gov.cn; www.gov.cn)

3.2.1 Perceptions of the permit price collapse in the EU ETS

Before moving to the Chinese situation in detail, we asked how stakeholders viewed the price collapse in the EU ETS. The EU allowance price experienced high volatility (both in phase I before crashing in 2006 and in phase II the price again started relatively high but then crashed by 2009,) the widely-held view for the causes are over-allocation of permits to legacy emitters (Hintermann, 2010), the effects of the Global Financial Crisis on economic growth and the weakness of its regulation, etc. (Perthuis and

Trotignon, 2014). Recent studies have found the overlapped public policies such as renewable policies and use of international credits also helped to explain the price plunge (Koch et al., 2014).

No surprise that litter awareness of overlapped low-carbon policies would impact the price is also reflected in our survey. Global economic downturn was blamed by the majority (18 out of 30 respondents), followed by excess emission allowance allocations (12/30) and failure to reach binding international targets in the international negotiations (9/30). Only a relatively small number blamed alternative emission reduction mechanisms or increased volumes of Certified Emission Reductions (CERs) from the Clean Development Mechanism.

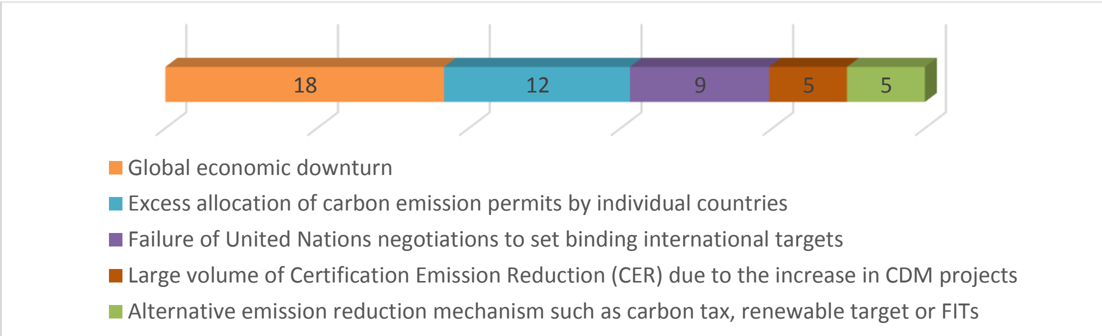

Figure 12 Main reasons for collapse of carbon price in EU ETS

3.2.2 Attitudes onwards possible conflicts between multiple incentives

Accordingly, we designed two what-if scenario questions and two statement acceptance questions to explore reactions to hypothetical major policy announcements that we would expect to adversely affect the carbon price by reducing demand for allowances.

Firstly, stakeholders were asked to consider, if a higher than expected short-term renewable energy target were enacted in the pilot cities (e.g. renewable energy target increases from 10% to 15%), what would be the most likely impact on carbon price in the pilot carbon market? Nearly half (48.3%) of respondents expected the carbon price in these pilot carbon markets to decrease by a small amount, and a further 3.5% expected a large decrease in the carbon price. However, almost a quarter (24.1%) of respondents believed there would be a small increase in carbon price, and 3.5% thought it would be a large increase. Over one fifth (20.7%) anticipated that the price would remain the same and a renewable energy target would not impact on the carbon price in the pilot carbon market (blue bar in Figure 13).

By contrast, when stakeholders were asked if an unexpected national carbon tax were suddenly announced for immediate implementation across all major industry sectors, surprisingly, a large majority (59.3%) of respondents believed the carbon price in the ETS would increase and almost one fifth of the total sample (18.5%) thought it would be a large increase. Only 25.9% of stakeholders believed that the carbon price would decrease if a carbon tax were to be introduced (orange bar in Figure 13). Three respondents skipped the question.

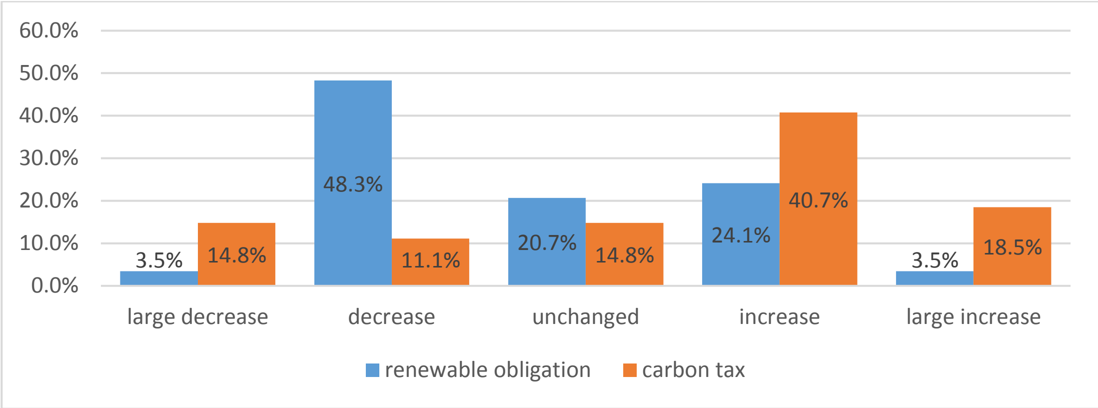

Figure 13 Stakeholder expectations of carbon market response to imposing new ambitious energy and climate policies

It is striking that the majority of stakeholders believed that the impact of introducing a renewable target would be to depress carbon prices, while a new carbon tax was seen as lifting the carbon allowance price. The reactions to introducing a tougher renewable energy target and an unexpected national carbon tax provide contrasting results. In theory at least, all else being equal, introducing either measure in addition to the carbon market would reduce the allowance price in the ETS scheme.

The majority of stakeholders in follow-up interviews, appreciated that introducing low-carbon policies in parallel (such as a carbon tax or renewable obligations) would affect the carbon allowance price in the ETS but differed on both the likely magnitude and direction. Two industry and two academic stakeholders during follow-up questioning suggested that renewable energy targets might increase carbon reductions and in turn increase the carbon allowance price, but that carbon taxation policies could provide a 'carbon price floor' to support the allowance prices. Another academic stakeholder believed raising the renewable energy target by 5% could reduce total carbon emissions, while a carbon tax could shift the ETS abatement cost curve to the right, and both measures could significantly reduce the demand and price of carbon allowances in the Chinese ETS.

In the follow-up interviews, two government stakeholders and one stakeholder from the financial sector still did not believe the impact of other mechanisms on carbon pricing mechanisms would be substantial. The two government officials, though recognizing the potential impact of parallel low-carbon incentives on carbon allowance pricing, believed that it was important to introduce more market-based instruments for emission reductions and environmental protection in China, such as trading in energy efficiency quota and water rights trading.

To further testify whether stakeholders would recognize possible conflicts that might emerge when there are multiple incentives. Specifically, we asked about the extent to which they agreed that "incentives, such as 'cap and trade' systems, carbon taxation, renewable energy obligations, and emission performance standard etc., may conflict, and generate different costs and benefits in different situations". A significant fraction (43.3%) of respondents agreed with the statement, while 23.3% disagreed (Figure 14).

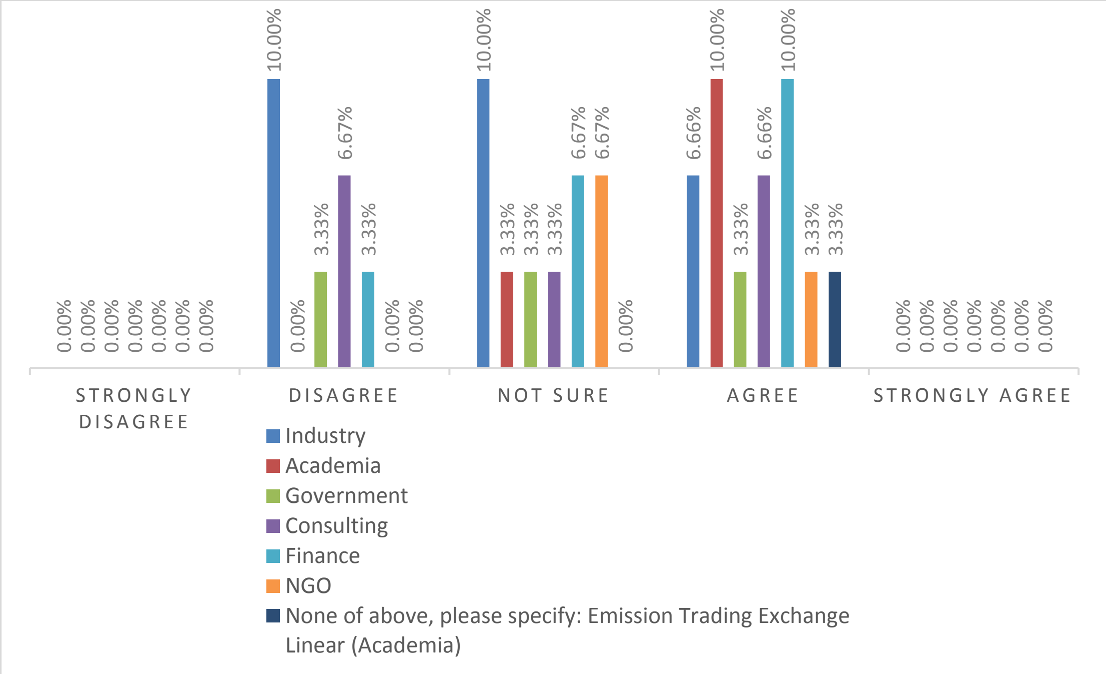

Figure 14 Respondent attitudes on statement of policy interactions

As Figure 14 reveals, there is a slight tendency for stakeholders to recognize the possible conflicts between carbon markets and overlapped climate change policies and that academic stakeholders are slig. Take *Attit* as ordinal variables representing the extent of agreement or disagreement with the statement, where 1 = strongly disagree and 5 = strongly agree, significant result can be discovered from a univariate regression of *Attit* on *Acad* (Table 6). The idea is generally more widely accepted among academics than by stakeholders in other sectors.

Table 6 output of univariate regression model *Attit-Acad*

VARIABLE	model *Attit-Acad*
Acad	0.720*
	[1.906]
Constant	3.080***
	[19.977]
Observations	30
R-squared	0.115
Adj. R-squared	0.0833

t-statistics in brackets
*** p<0.01, ** p<0.05, * p<0.1

Furthermore, it is interesting to find out that there is relationship between their attitudes on the statement and how much time they claimed have been spent on energy saving and emission reduction policies in the past year. Taking different shades to present the time spent on climate change-related policies, the positive correlation between time spent and respondents' attitudes on the statement is apparent in Figure 11. Again, according to the regression of Attit on Time, which is a set of ordinal variables representing time spent working on climate change-related policies, the result further supported our finding.

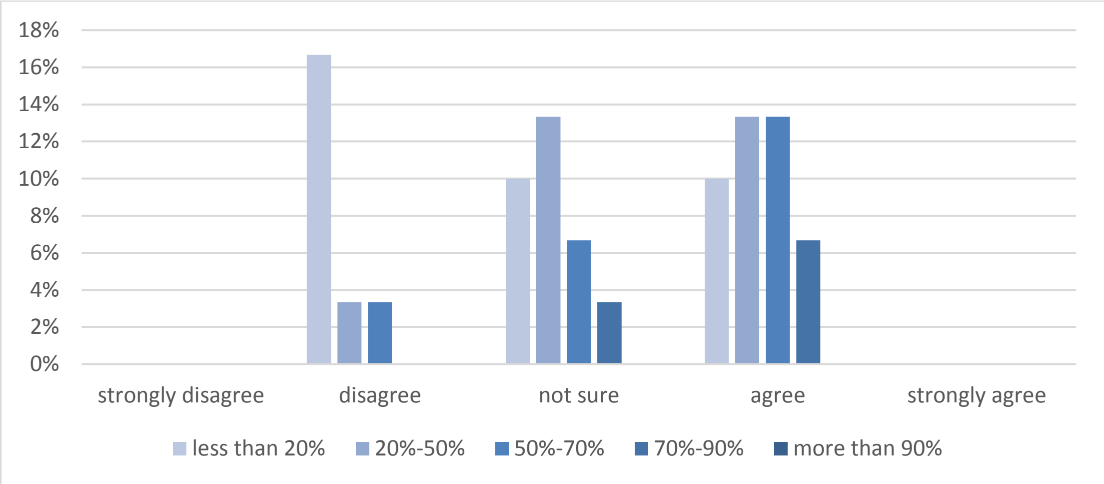

Figure 11 Comparison of stakeholder views of possible conflicts between multiple incentives and time spent working on energy saving and emission reduction policies.

Table 7 Output of univariate regression model *Attit-Time*

VARIABLE	model Attit-Time
Time	0.288**
	[2.061]
Constant	2.605***
	[8.124]
Observations	30
R-squared	0.132
Adj. R-squared	0.101

t-statistics in brackets
*** p<0.01, ** p<0.05, * p<0.1

The follow-up interviews also demonstrated divergent views on the compatibility of multiple low-carbon incentive policies. Two government stakeholders considered multiple policy instruments to be better than a single mechanism. However, all academics surveyed were concerned that multiple mechanisms could distort the price signal for environmental goods, and provide incorrect signals. Although quite a few respondents (33.3%) selected the carbon market as their preferred mechanism in an earlier question, no stakeholder in the follow-up interviews believed that the ETS by itself could completely replace other parallel low-carbon incentives in China.

The situation in Europe is very similar. Most stakeholders perceive the trading scheme as the main instrument to cut down GHGs, but there is a growing view that the ETS is not the only instrument required and will need to be combined with other instruments (Fujiwara, 2016). Many stakeholders expressed concern at the negative impact that policies had on carbon prices, especially stakeholders from the power and energy trading sectors (Gaast et al., 2016), and most welcomed the Market Stability Reserve (MSR) as a means of addressing the surplus of allowances. Others still believe though that policies supporting renewables have only limited negative impacts on the EU ETS (Marcantonini et al., 2017).

3.2.3 Attitudes on linkages to international carbon markets

There have been many studies on the potential to link national and subnational emission trading schemes, as in the case o Quebec and California, and as was explored for Australia and the European Union (Ranson and Stavins, 2016; Mehling and Haites, 2009). With regard to the statement that 'integrating the Chinese carbon trading market into the international trading system could help reduce the adverse impact on carbon price from the interactions of other national carbon reduction incentive mechanisms', a large number (36.7%) of stakeholders supported it, whereas only 13.3% did not. Nevertheless, for both statements, a relatively large proportion (33.3% and 50% respectively) could not decide and no stakeholder expressed a strongly-held attitude (i.e. strongly agreed or strongly disagreed).

In follow-up interviews, one government official and two academic stakeholders emphasized the importance of linking the Chinese carbon market with international carbon markets, arguing that such links could help improve the design and operation of the domestic carbon market in the long-term. Another government official was unsure about the need for international linkages but believed that such linkage could boost the liquidity of the pilot schemes. Industry stakeholders were also unsure about linkage but two were very interested in the impact linkage would have on allowance prices in the long-term. One academic strongly opposed linkage on the grounds that international linkages might reduce the freedom of Chinese climate policy and constrain the Chinese position in future international climate policy negotiations.

3.3. Challenges for Chinese carbon markets

3.3.1 MRV system in Chinese carbon markets

We asked stakeholders to rank potential problems with the monitoring, reporting and verification (MRV) system that they believed could negatively affect the carbon market. Technical issues aroused the greatest concern. The top challenge was viewed as incorrect and incomplete historical databases, followed by incorrect carbon auditing methodologies. The lack of third party verification and auditing organizations ranked the third. A lack of skilled workers for carbon auditing and corruption during the auditing process were at the bottom of the list (Table 8).

Table 8 Ranking of potential challenges with regards to MRV system

	1	2	3	4	5	Average ranking
Incorrect and incomplete historical database	62%	15%	12%	4%	8%	1.81
Incorrect carbon auditing methodology	19%	38%	19%	12%	12%	2.58
Lack of third party verification and auditing organizations	19%	22%	22%	30%	7%	2.85
Lack of skilled workers in carbon auditing	4%	15%	23%	19%	38%	3.73
Corruption during auditing process	0%	8%	23%	35%	35%	3.96

3.3.2 Implementation of Chinese carbon trading market

In terms of potential implementation challenges, the pervasive lack of accurate and relevant information and knowledge on the subject ranked first, as most respondents agreed that 'enterprises were still confused about carbon emission trading and worried it might increase costs'. Concerns about potential negative impacts on GDP growth (i.e., that the 'cap' implied reduced energy consumption) came second. Stakeholders ranked the challenge of limited financial instruments and the absence of derivatives in carbon credit third, followed by impacts of other energy and low-carbon policies (e.g., emission performance standards and renewable energy obligations may reduce demand for emissions reductions in carbon markets). Finally, limited financial instruments and institutions were viewed as the least significant challenge of the five listed.

Table 9 Ranking potential challenges with regards to implementation

	1	2	3	4	5	Average ranking
Enterprises still confused about carbon emission trading, and worried it may increase costs	44%	44%	7%	4%	0%	1.7
The 'Cap' implies decreased energy consumption, which may negatively influence GDP growth	42%	19%	23%	0%	15%	2.27
Limited financial instruments; Lack of carbon credit derivatives	8%	15%	31%	23%	23%	3.38
Limited relevant financial institutions	0%	12%	35%	27%	27%	3.69
Other energy and low-carbon policies such as Emission Performance Standards and Renewable Energy obligation may decrease demand for emission reduction in carbon trading markets	8%	8%	4%	46%	35%	3.92

Stakeholders also suggested other challenges for the Chinese carbon market including: (a) absence of strong regulatory support from the central government; (b) the need to develop novel carbon emission reduction technologies; (c) increased production costs for business; (d) the difficulty of setting a ‘cap’ in any emission trading system; and (e) the need for a comprehensive Chinese carbon market, which they felt would inevitably prove costly.

During follow-up interviews, both government and industry stakeholders considered the major challenge for the Chinese ETS to be how it might evolve towards a comprehensive national scheme. Government officials considered the lack of trading activities to be a short-term constraint on the carbon market. Two academic stakeholders were concerned about the quality of data based on initial auditing, and cited the limitations of budget, time and capacity to address these problems, noting there was sometimes less than CNY 100,000 (approximately EUR 13,500) available for an initial survey and audit at a large conglomerate or energy company. One academic claimed the poor quality of initial data could pose serious challenges and lead to a crisis of confidence affecting future development. An industry stakeholder suggested that a professional standards institute should be established to better regulate the quality of MRV.

4. Conclusions and Policy Recommendations

Given expectations of continued high levels of economic and energy demand growth in China, half of the stakeholders surveyed considered a deep cut in emissions in the next decade to be unlikely. Government stakeholders generally were more hopeful of success in slashing GHG emissions in China and were far more confident than industrial and academic stakeholders in the potential benefits from carbon pricing in China.

Academic stakeholders tended to consider the progress of ETS development in China to be slow, and generally felt pessimistic about the potential of Chinese carbon markets to reduce emissions due to over-allocation of permits and imperfect auditing regulations, even though their expectations on the future market price in the Guangdong pilot were relatively high compared with other stakeholders.

Analogously, industrial stakeholders also expressed concern over the impact of the economic cycle on carbon allowance prices. Although there was a wide range of views future carbon price, overall more expected the price to drop, led by industrial sector stakeholders. Possible reasons for the bearish attitudes include concerns over an incomplete MRV system, lack of awareness among many enterprises of the benefits of carbon markets, they consider participation in the market as merely fulfilling the need for governments’ encouragement, social responsibility or corporate strategy (Yang, et al., 2016). By contrast, academic stakeholders were more bullish in their expectations.

There is relatively limited understanding of how other mechanisms might affect the price of carbon allowances, even though more than one-third of respondents considered the interaction to be a significant challenge. In theory, both a new additional carbon tax and a more stringent renewable target would shift the abatement curve to the right thereby reducing the allowance price. In our survey however, many stakeholders believed that renewable targets would dampen the carbon price, but a majority expected a carbon tax to actually boost the carbon price seen in the market. Most academic respondents recognized that interactions between the carbon market and other energy and low-carbon policies may decrease “demand” in emission trading markets. It is noteworthy that the degree of understanding of interactions between instruments was positively associated with claimed time spent working on energy saving and emission reduction policies.

Energy and low-carbon policies in China has been shifting from command-and-control policies to more market-based approaches. Past studies have indicated that a large majority of Chinese stakeholders would prefer market-based instruments to control GHGs (Liu et al., 2013; Lo, 2014). This enthusiasm for markets is consistent with our results, as an emission trading mechanism was deemed the most cost-effective instrument to achieve deep cuts in emissions in China. Therefore, disagreements over the perceived interaction between overlapping energy and low-carbon policies may undermine the ETS carbon price, even though in committing to launch a unified national carbon market by 2017, support for an ETS was unequivocally and repeatedly confirmed at the highest political level.

Objectively, the preparatory stage for the Chinese pilot carbon markets has been relatively short compared with the systems in Korea, Quebec, and California (World Bank, 2014), but very few stakeholders considered the pace to be “too fast”. The development of a national ETS has taken place in parallel with the pilot schemes and momentum has been growing in China toward a national ETS with the government originally committing to a multi-sector ETS being up and running in 2017. While discussion of whether Chinese national ETS should ultimately employ a top-down or bottom-up approach is still ongoing, and the road map has not yet formally announced beyond the initial announcement in December 2017, the NDRC has at least initially adopted a top-down approach towards developing a national system. Moreover, the effort to get a national system up and running so quickly may explain some of the problems and delays encountered by the national ETS driven primarily by the lack of baseline data and the need for an operational data collection system (Feng, 2017).

Our findings suggest there are still some important unresolved issues confronting the new national system. It would have been more desirable if in the process of implementing the national ETS, the Chinese authorities were able to learn lessons from the pilot systems. The lack of transparency in disclosing market information, a lack of knowledge among market participants, and an immature MRV system poses uncertainties for carbon price setting. Fuss et al. (2008) claimed that climate change policy uncertainties would induce industries to wait and see whether strong interests in effective and efficient investment response to its policy signals will be brought out by the government, which implies the degree of market information obtained would influence industries’ investment decisions on carbon-saving technologies. In addition, the diversity of stakeholders’ predictions of the carbon price reflect a lack of consensus.

Drawing on the findings of our study, we offer the following policy recommendations:

- Government and other key stakeholders have placed too much focus on the price and volume of carbon allowances in the China's pilot ETS schemes; stakeholders and policymakers should seek to continuously assess and improve the quality of regulation, market integrity and information disclosure.
- The inability of many stakeholders to understand that other low-carbon and renewable policies would reduce the price in the carbon market, reflects the need for capacity building among current and future market participants.
- As the carbon market is not likely to be the only major low-carbon policy instrument in China, the ETS carbon price needs to be interpreted cautiously.
- Alternative carbon pricing signals, such as a government shadow carbon price should be proposed alongside a carbon market allowance price to signal to industry the short-term and long-term costs of CO_2 emissions.
- Regulators and carbon exchanges should provide more transparent, real-time information for market participants to facilitate price setting.
- The Chinese government should invest heavily in MRV systems, and establish a set of best practices, to provide greater confidence for market participants.
- In the process of moving to a national carbon market, more effort should be placed on improving the compatibility of carbon market pilots. China has the relatively rare benefit of having conducted seven pilots with varying specifications, so it is important that time is taken to learn from the different pilots. We have conducted an in-depth assessment of only one of the seven pilots from the perspective of different key stakeholders and before fully launching a national system, a comprehensive review across all seven pilots would be very beneficial.

References

1. Bohringer, C., Rosendahl, K., E., 2010. Green promotes the dirtiest: on the interaction between black and green quotas in energy markets. Journal of Regulatory Economics 37: 316-325. http://dx.doi.org/10.1007/s11149-010-9116-1
2. Brouwers, R., Schoubben, F., Hulle, C. V. and Uytbergen, S. V., 2016. The initial impact of EU ETS verification events on stock prices. Energy Policy 94: 138-149. http://dx.doi.org/10.1016/j.enpol.2016.04.006
3. Cheng, C., Zhang, X., 2011. A study on the construction of China's carbon emission trading system. Energy Procedia 5: 1037-1043. http://dx.doi.org/10.1016/j.egypro.2011.03.183
4. Cui, L. B., Fan, Y., Zhu, L., Bi, Q. H., 2014. How will emission trading scheme save costs for achieving China's 2020 carbon intensity reduction target. Applied Energy 136: 1043-1052. http://dx.doi.org/10.1016/j.apenergy.2014.05.021

5. Duan, M., Pang, T., Zhang, X., 2014. Review of carbon emissions trading pilots in China. Energy and Environment 25: 527-549. http://eae.sagepub.com/content/25/3-4/527.full.pdf
6. Ellerman, A. D. and Decaux, A., 1998. Analysis of Post-Kyoto CO_2 Emissions Trading Using Marginal Abatement Curves. MIT Joint Program on the Science and Policy of Global Change. http://hdl.handle.net/1721.1/3608
7. Energy and Climate Change Committee (ECC), 2015. Linking emissions trading systems. House of Commons Energy and Climate Change Committee. http://www.publications.parliament.uk/pa/cm201415/cmselect/cmenergy/739/739.pdf
8. Ekins, P., Kesicki, F., Smith, A. Z. P., 2012. Marginal Abatement Cost Curves: A call for caution. Climate Policy 12(2). http://dx.doi.org/10.1080/14693062.2011.582347
9. Ernst & Young, 2014. Understanding China's Emissions Trading Schemes and Emissions Reporting. http://www.ey.com/Publication/vwLUAssets/EY-Understanding_Chinas_Emissions_Trading_Schemes_and_Emissions_Reporting/$FILE/EY-Understanding-Chinas-ETS-and-Emissions-Reporting.pdf
10. European Commission, 2015. EU ETS Handbook. https://ec.europa.eu/clima/publications/docs/ets_handbook_en.pdf
11. Fan, Y. and Wang, X., 2014. Which sector should be included in the ETS in the context of a unified carbon market in China? Energy and Environment 25 (3-4): 613-634. http://dx.doi.org/10.1260/0958-305X.25.3-4.613
12. Feng, E., 2017. China moves towards launch of carbon trading scheme. Financial Times, 19 December. https://www.ft.com/content/cd549b9a-e088-11e7-a8a4-0a1e63a52f9c
13. Feng, Z. H., Zou, L. L., Wei, Y. M., 2011. Carbon price volatility: Evidence from the EU ETS, Applied Energy 88(3): 590-598. http://dx.doi.org/10.1016/j.apenergy.2010.06.017
14. Fischer, C., Preonas, L., 2010. Combining Policies for Renewable Energy: Is the Whole Less Than the Sum of Its Parts? International Review of Environmental and Resource Economics, 4: 51-92. http://dx.doi.org/10.1561/101.00000030
15. Fujiwara, N. (2016). Policy interaction between the EU Emissions Trading System and the Renewable Energy Directive. CARISMA Working Documents Series No. 2. file:///C:/Users/M/Downloads/SSRN-id2861124.pdf
16. Fuss, S., Szolgayova, J., Obersteiner, M., Gusti, M., 2008. Investment under market and climate policy uncertainty. Applied Energy 85(8): 708-721. http://dx.doi.org/10.1016/j.apenergy.2008.01.005
17. Gaast, W., Clochard, G., Alberola, E., Türk, A., Fujiwara, N. and Spyridaki, N., 2016. Effects of Interactions between EU Climate and Energy Policies. CARISMA Working Documents No. 3. https://www.i4ce.org/wp-core/wp-content/uploads/2017/06/CARISMA-Working-Document-3-Policy-Interactions.pdf

18. Green, F. and Stern, N., 2017. China's changing economy: implications for its carbon dioxide emissions, Climate Policy 17(4): 423-442. https://doi.org/10.1080/14693062.2016.1156515
19. Guan, D., Hubacek, K., Weber, C. L., Peters, G. P., & Reiner, D. M. (2008). The drivers of Chinese CO2 emissions from 1980 to 2030. Global Environmental Change 18(4): 626-634. http://dx.doi.org/10.1016/j.gloenvcha.2008.08.001
20. Guo, X., Zhu, Q., Lv, L., Chu, J. and Wu, J., 2017. Efficiency evaluation of regional energy saving and emission reduction in China: A modified slacks-based measure approach. Journal of Cleaner Production 140(3): 1313-1321. http://dx.doi.org/10.1016/j.jclepro.2016.10.021
21. Hone, D., 2013. The real price of CO_2 in the EU. Shell Climate Change Blog. http://blogs.shell.com/climatechange/2013/01/co2price/.
22. Hintermann, B., 2010. Allowance price drivers in the first phase of the EU ETS. Journal of Environmental Economics and Management 59(1): 43-56. http://dx.doi.org/10.1016/j.jeem.2009.07.002
23. Hu, Y., Monroy, C. R., 2012. Chinese energy and climate policies after Durban: Save the Kyoto Protocol. Renewable and Sustainable Energy Reviews 16: 3243-3250. http://dx.doi.org/10.1016/j.rser.2012.02.048
24. ICAP (International Carbon Action Partnership), 2015. Emission Trading Worldwide: Status Report 2015. https://icapcarbonaction.com/images/StatusReport2015/ICAP_Report_2015_02_10_online_version.pdf
25. ICAP (International Carbon Action Partnership), 2016. Emissions Trading Worldwide: Status Report 2016. https://icapcarbonaction.com/images/StatusReport2016/ICAP_Status_Report_2016_Online.pdf
26. International Energy Agency (IEA), 2016. World Energy Statistics and Balances 2016 Edition: II39-41&II242-244. https://www.iea.org/statistics/relateddatabases/worldenergystatisticsandbalances/
27. IETA, 2014. GHG Market Sentiment Survey 2014 9th Edition: A survey of current market sentiment among IETA members. Geneva: International Emissions Trading Association. http://www.ieta.org/Annual-GHG-Market-Sentiment-Survey
28. Jiang, J., Xie, D., Ye, B., Shen B. and Chen, Z., 2016. Research on China's cap-and-trade carbon emission trading scheme: Overview and outlook. Applied Energy 178: 902-917. http://dx.doi.org/10.1016/j.apenergy.2016.06.100
29. Koch, N., Fuss, S., Grosjean, G. and Edenhofer, O., 2014. Causes of the EU ETS price drop: Recession, CDM, renewable policies or a bit of everything? – New evidence. Energy Policy 73: 676-685. http://dx.doi.org/10.1016/j.enpol.2014.06.024

30. Lai, J. H. K., 2014. Mandatory reporting of greenhouse gas emissions from buildings: Stakeholders' opinions in Hong Kong. Energy Policy 75: 278-288. http://dx.doi.org/10.1016/j.enpol.2014.10.004
31. Lee, M., Zhang, N., 2012. Technical efficiency, shadow price of carbon dioxide emissions, and substitutability for energy in the Chinese manufacturing industries. Energy Economics 34 (5): 1492-1497. http://dx.doi.org/10.1016/j.eneco.2012.06.023
32. Li, J., Liang, X., Cockerill, T., Gibbins, J. and Reiner, D., 2012. Opportunities and barriers for implementing CO2 capture ready designs: A case study of stakeholder perceptions in Guangdong, China. Energy Policy 45: 243-251. http://dx.doi.org/10.1016/j.enpol.2012.02.025
33. Liang, X. and Reiner, D.M., 2013. The Evolution of Stakeholder Perceptions of Deploying CCS Technologies in China: Survey Results from Three Stakeholder Consultations in 2006, 2009 and 2012. Energy Procedia 37: 7361-7368. http://dx.doi.org/10.1016/j.egypro.2013.06.677
34. Liang, X., Reiner, D.M., Li, J., 2011. Perceptions of opinion leaders towards CCS demonstration projects in China. Applied Energy 88: 1873-1885. http://dx.doi.org/10.1016/j.apenergy.2010.10.034
35. Liu, M. R. and Wang, H. Y., 2014. A theoretical analysis of carbon emission trading system in China and the perfection of its rules and regulations. Applied Mechanics and Materials 448-453: 4530-4535. http://dx.doi.org/10.4028/www.scientific.net/AMM.448-453.4530
36. Liu, Z., Guan, D., Crawford-Brown, D., Zhang, Q., He, K., Liu, J., 2013. Energy Policy: A low-carbon road map for China. Nature 500, 143-145, http://dx.doi.org/10.1038/500143a
37. Lo, K., 2014. A critical review of China's rapidly developing renewable energy and energy efficiency policies. Renewable and Sustainable Energy Reviews 29: 508-516. http://dx.doi.org/10.1016/j.rser.2013.09.006
38. Marcantonini, C., Teixide-Figueras, J., Verde, S. F. and Labandeira, X., 2017. The EU ETS and its Interactions with other Climate and Energy Policies. Florence School of Regulation, RSCAS Policy Brief 2017/21. http://cadmus.eui.eu/bitstream/handle/1814/47526/RSCAS_FSR_PB_2017_21.pdf?sequence=2
39. Mehling, M. and Haites, E., 2009. Mechanisms for linking emissions trading schemes. Climate Policy 9(2): 169-184. http://dx.doi.org/10.3763/cpol.2008.0524
40. Morris, J. F., Reilly, J. M. and Paltsev, S., 2010. Combining a Renewable Portfolio Standard with a Cap-and-Trade Policy: A General Equilibrium Analysis. MIT Joint Program on the Science and Policy of Global Change, Report No. 187.
41. National Development and Reform Commission (NDRC), 2010. Letter including autonomous domestic mitigation actions. http://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/chinacphaccord_app2.pdf

42. National Development and Reform Commission (NDRC), 2011. Notice on launching carbon emissions trading pilot. http://www.sdpc.gov.cn/zcfb/zcfbtz/201201/t20120113_456506.html.
43. National Development and Reform Commission (NDRC), 2013. China's Policies and Actions for Addressing Climate Change. http://en.ndrc.gov.cn/newsrelease/201311/P020131108611533042884.pdf
44. National Development and Reform Commission (NDRC), 2015. China's Intended Nationally Determined Contribution (INDC). http://www4.unfccc.int/ndcregistry/PublishedDocuments/China%20First/China's%20First%20NDC%20Submission.pdf
45. National Development and Reform Commission (NDRC), 2016. Landmark Notice on National ETS Guidance. http://www.sdpc.gov.cn/zcfb/zcfbtz/201601/t20160122_772123.html.
46. National Development and Reform Commission (NDRC), 2017. Construction Plan of National Carbon Emission Trading Market (Electricity Sector) http://www.ndrc.gov.cn/zcfb/gfxwj/201712/W020171220566893899825.pdf
47. O'Keeffe, J. M., Cummins, V., Devoy, R. J. N., Lyons, D., Gault, J., 2016. Stakeholder awareness of climate adaptation in the commercial seaport sector: A case study from Ireland. Marine Policy. In Press. http://dx.doi.org/10.1016/j.marpol.2016.04.044
48. Pethig, R., and Wittlich, C., 2009. Interaction of Carbon Reduction and Green Energy Promotion in a Small Fossil-Fuel Importing Economy. CESifo working paper No. 2749. https://www.cesifo-group.de/pls/guestci/download/CESifo%20Working%20Papers%202009/CESifo%20Working%20Papers%20August%202009/cesifo1_wp2749.pdf
49. Perthuis. C., and Trotignon, R., 2014. Governance CO_2 markets: Lessons from the EU ETS. Energy Policy 75: 100-106. http://dx.doi.org/10.1016/j.enpol.2014.05.033
50. Qi, S., Wang, B., Zhang, J. 2014a. Policy Design of the Hubei ETS Pilot in China. Energy Policy 75: 31-38.
51. Qi, T., Zhang, X., Karplus, V. J., 2014b. The energy and CO_2 emissions impact of Renewable Energydevelopment in China. Energy Policy 68: 60-69. http://dx.doi.org/10.1016/j.enpol.2013.12.035
52. Ranson, M. and Stavins, R., 2016. Linkage of greenhouse gas emissions trading systems: Learning from experience. Climate Policy, 16(3), pp.284-300. http://dx.doi.org/10.1080/14693062.2014.997658
53. Ragwitz, M., and Steinhilber, S., 2014. Effectiveness and Efficiency of support schemes for electricity from renewable sources. Wiley Interdisciplinary Reviews: Energy and Environment 3(2): 213-229. http://dx.doi.org/10.1002/wene.85
54. Reiner, D.M. and Liang, X. 2011. Stakeholder Views on Financing Carbon Capture and Storage Demonstration Projects in China, Environmental Science & Technology 46(2):643-51.

55. Ren, S., Li, X., Yuan, B., Li, D. and Chen, X., 2018. The effects of three types of environmental regulation on eco-efficiency: A cross-region analysis in China. Journal of Cleaner Production 173: 245-255. http://dx.doi.org/10.1016/j.jclepro.2016.08.113
56. Richstein, J. C., Chappin, E. J. L. and Vries, L. J., Adjusting the CO_2 cap to subsidised RES generation: Can CO2 prices be decoupled from renewable policy? Applied Energy 156: 693-702. http://dx.doi.org/10.1016/j.apenergy.2015.07.024
57. Schleich, J., Rogge, K.S., Betz, R., 2009. Incentives for energy efficiency in the EU Emissions Trading Scheme. Energy Efficiency 2 (1): 37-67. http://dx.doi.org/10.1007/s12053-008-9029-3
58. Sijm, J., 2011. The interaction between the EU emissions trading scheme and national energy policies. Climate Policy 5(1): 79-96. http://dx.doi.org/10.1080/14693062.2005.9685542
59. Sorrell, S., 2003. Who owns the carbon? Interactions between the EU Emissions Trading Scheme and the UK Renewables Obligation and Energy Efficiency Commitment. Energy & Environment 14(5): 677-703. http://dx.doi.org/10.1260/095830503322663401
60. Syri, S., Cross, S., 2013. Weak EU emissions trading with strong renewables obligation compromises long-term CO_2 mitigation. Proceedings of the 10th International Conference on European Energy Market (EEM), Stockholm, 27-31 May 2013. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6607395
61. UNFCCC, 2015. Paris Agreement. http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf. pp: 3.
62. Wang, P., Dai, H., Ren, S., Zhao, D. and Masio, T., 2015. Achieving Copenhagen target through carbon emission trading: Economic impacts assessment in Guangdong Province in China. Energy 79: 212-227. http://dx.doi.org/10.1016/j.energy.2014.11.009
63. Wang, Q. and Chen, X., 2015. Energy policies for managing China’s carbon emission. Renewable and Sustainable Energy Reviews 50: 470-479. http://dx.doi.org/10.1016/j.rser.2015.05.033
64. Wu, L., Qian, H., Li, J., 2014. Advancing the experiment to reality: Perspectives on Shanghai pilot carbon emission trading scheme. Energy Policy 75: 22-30. http://dx.doi.org/10.1016/j.enpol.2014.04.022
65. Wu, G., Liu, L., Han, Z. and Wei, Y., 2012. Climate protection and China’s energy security: win-win or trade-off. Applied Energy 97: 157-163. http://dx.doi.org/10.1016/j.apenergy.2011.11.061
66. World Bank, 2014. State and Trends of Carbon Pricing 2014. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/505431468148506727/pdf/882840AR0REPLA00EPI2102680Box385232.pdf
67. Yang, L., Li, F. and Zhang, X., 2016. Chinese companies’ awareness and perceptions of the Emissions Trading Scheme (ETS): Evidence from a

national survey in China. Energy Policy 98: 254-265. http://dx.doi.org/10.1016/j.enpol.2016.08.039

68. Yi, B., Xu, J. and Fan, Y., 2016. Determining factor and diverse scenarios of CO_2 emissions intensity reduction to achieve the 40-45% target by 2020 in China – a historical and prospective analysis for the period 2005-2020. Journal of Cleaner Production 122. 87-101. http://dx.doi.org/10.1016/j.jclepro.2016.01.112
69. Zhang, D., Karplus, V. J., Cassisa, C., Zhang, X., 2014. Emission trading in China: Progress and prospects. Energy Policy 75:09-16. http://dx.doi.org/10.1016/j.enpol.2014.01.022
70. Zhang, Y., Hao, J. and Song, J., 2016. The CO2 emission efficiency, reduction potential and spatial clustering in China's industry: Evidence from the regional level. Applied Energy 174: 213-223. http://dx.doi.org/10.1016/j.apenergy.2016.04.109
71. Zhang, Y., Peng, Y., Ma, C., Shen, B., 2017. Can environmental innovation facilitate carbon emissions reduction? Evidence from China. Energy Policy 100: 18-28. http://dx.doi.org/10.1016/j.enpol.2016.10.005
72. Zhang, Y. and Wei, Y., 2010. An over of current research on EU ETS: Evidence from its operating mechanism and economic effect. Applied Energy 87(6): 1804-1814. http://dx.doi.org/10.1016/j.apenergy.2009.12.019
73. Zhao, X., Yin, H. and Zhao, Y., 2015. Impact of environmental regulations on the efficiency and CO_2 emissions of power plants in China. Applied Energy 149: 238-247. http://dx.doi.org/10.1016/j.apenergy.2015.03.112
74. Zhou, J. and Duan, M., 2011. Output-based Allowance Allocations under China's Carbon Intensity Target. Energy Procedia 5: 1904-1909. http://dx.doi.org/10.1016/j.egypro.2011.03.327
75. Zhou, P., Zhang, L., Zhou, D. Q., Xia, W. J., 2013. Modeling economic performance of interprovincial CO_2 emission reduction quota trading in China. Applied Energy: 112: 1518-1. http://dx.doi.org/10.1016/j.apenergy.2013.04.013