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China's energy reform and climate policy: The ideas motivating change

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Abstract

China has embarked on an ambitious and unprecedented programme of energy reform and climate change mitigation. Yet the motivations for this important shift remain unclear. This paper surveys key central government documents and articles by China's leading energy academics to investigate the ideas influencing China's new energy and climate policies. Three key ideas in particular are supportive of greater climate mitigation than in the past. First, domestic energy security concerns have risen on the central government agenda as a result of electricity shortages and rapidly rising energy consumption. Such concerns have deeply influenced China's ambitious and largely successful energy efficiency policies. Second, growing awareness of the environmental constraints on economic growth in general, and the potential damages of dangerous climate change in particular, has prompted stronger official rhetoric in favour of green development. The appearance of targets and policies that specifically target carbon emissions reductions in the 12th FYP for the first time suggests that climate change mitigation is becoming a motivation for policy action in its own right, rather than simply a co-benefit of policies enacted for other purposes. Third, a conviction that the world is moving towards low-carbon energy forms has given rise to the belief that China must become a technological and economic leader in this transition. Large levels of public financing to support the development of China's wind power and solar PV sectors suggests that the Chinese government has strong vested interests in seeing China successfully compete and lead in global low-carbon energy markets. In order to understand the shift in China's approach to climate change since the 11th FYP, it is important to understand how new ideas such as these have reframed and reshaped the Chinese government's interests and objectives.

Keywords: China, climate change, mitigation, energy policy, environment, renewable energy, energy efficiency, carbon market, pollution, reform.

JEL Classification: Q54, Q48, Q58, P28

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1. Introduction

The first years of the 21st century have witnessed a remarkable shift in China's role in global climate change mitigation. In this period China has emerged as a global titan in terms of energy use and greenhouse gas (GHG) emissions. As China's growth rates surged from 8.4% GDP growth in 2000 to peak at 14.7% in 2007, the period from 2002 to 2005 saw a greater expansion in energy demand than any other nation at any other time in history (D. Levine cited in Xin, 2010, p. 1216). In 2007 China overtook the United States as the largest emitter of greenhouse gasses in the world (Morton, 2009, p. 3).

Even as China has emerged as the largest energy consumer and GHG emitter, the Chinese government's policy response to climate change has also shifted markedly. Until the 11th Five Year Plan (FYP) China's energy efficiency targets were fairly small or non-existent, renewable energy policies were minimal and there was little mention of controlling carbon dioxide (CO_2) emissions in Chinese government documents (Yuan and Zuo, 2011, pp. 3857-3858; Halding *et al.*, 2009, p. 125). By contrast, in the 11th FYP (2006-2010) energy efficiency, renewable energy, and pollution control targets featured prominently. In this period, China stopped just shy of achieving its ambitious target of a 20% decrease in national energy intensity (tonnes of energy emitted in standard coal or oil equivalent per unit of GDP output), and it's renewable energy markets expanded exponentially (National Bureau of Statistics and National Development and Reform Commission [NDRC], 2011). In the current 12th FYP, China is targeting a 17% reduction in CO_2 intensity (tonnes of carbon dioxide emitted per unit of GDP output) between 2011 and 2015 and is preparing to pilot carbon trading in a number of cities and provinces (Government of the People's Republic of China, 2011, p. 5; National Development and Reform Commission [NDRC], 2007, p. 18). At the international level, China has altered its past insistence that developing countries should not take action until developed countries have met their emissions reductions commitments, although its objection to legally binding commitments for developing countries remains unchanged. In 2009 at the Copenhagen Climate Summit, China pledged to achieve a carbon intensity reduction of 40-45% by 2020 (Department of Climate Change, NDRC, 2011).

What have been the key motivations for this important shift in China's approach to energy reform and climate change mitigation? Why has China implemented emissions-reducing energy and climate policy, when until only a few years ago it seemed headed towards a path of unmitigated growth in energy consumption and GHG emissions?

Current Approaches

A number of approaches have evolved in the literature examining the motivations behind China's climate policy. One common approach seeks to weigh the costs and benefits of mitigation, often by analysing: (1) China's interest in continued strong economic growth; (2) the domestic damages China may result from climate change; (3) the different costs that China is likely to incur from different levels of commitment to emissions reductions; and (4) how the actions of other major emitters might influence China's perception of the costs and benefits of its own mitigation commitments.[1] A second prominent approach stresses the importance of domestic interest groups in shaping China's climate change policies, especially the role of power politics between different ministries and agencies within the central government.[2] A third common approach examines how interactions with the international community affect China's climate policy. This includes both the ways in which China's broader foreign policy concerns have affected its international climate policy, and the way in which

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[1] See Bosetti *et al.*, 2009, pp. 149-150; Heggelund, 2007, pp. 158-162, p. 178 Hepburn and Ward, 2010, pp. 2-3; Lewis, 2007, p. 156, pp. 165-169; Nordhaus, 2010, pp. 11725-11726; Schroeder, 2008, p. 522; Sunstein, 2007-2008, pp. 1675-1700; Vanderbergh, 2008, pp. 917-923, p. 929-258; Wiener, 2007-2008, pp. 1805-1826; Zhang and Morton, 2011.

[2] See Hatch, 2003, pp. 44-49; Heggelund, 2007, p. 158, pp. 168-174; Jeon and Yoon, 2006, p. 849, pp. 861-865; Marks, 2010, pp. 976-978; Richerzhagen and Scholtz, 2008, pp. 316-322.

international architecture, such as the United Nations Framework Convention on Climate Change (UNFCCC), has influenced China's approach to climate change mitigation.[3]

While these three approaches offer important insights, they do not provide the complete picture. Domestic ideas circulating amongst China's policy elite remain under-analysed in efforts to understand the motivations underlying China's climate policy.[4] As Max Weber pointed out over 60 years ago, ideas can have a profound effect on the course of events, acting like switchmen on a railway line, to direct interest-based actions down one track or another (M. Weber cited in Campbell, 2002, p. 21). This has important applications to the three approaches outlined above. The ideas that influence Chinese policy elites are important in understanding how China views its own balance of costs and benefits in terms of reducing GHG emissions. Ideas are important in understanding how the vested interests influencing China's domestic politics may evolve and change. Domestic ideas are also important in understanding why changes in domestic policy may occur and how this might affect China's international engagement on climate change.

Based on a survey of key central government documents and articles by China's leading energy scholars, this paper finds that three new ideas in particular are supportive of greater climate change mitigation than in the past. First, Chinese energy security has been redefined to include domestic sources of energy insecurity that have arisen as a result of China's high energy consumption. This has had an important influence on China's ambitious energy efficiency policies. Second, growing awareness of the environmental constraints on economic growth in general, and the potential damages of dangerous climate change in particular, has prompted stronger official rhetoric in favour of green development. Carbon-focussed intensity targets and carbon pricing policies in the 12th FYP suggest that climate change may be becoming a motivation for policy action in its own right, rather than simply a co-benefit of policies enacted for other purposes. Third, the idea of low-carbon leadership has reframed China's global role and supported China's emergence at the forefront of low-carbon markets. Large levels of public financing to support the development of China's wind power and solar PV sectors suggests that the Chinese government has strong vested interests in seeing China successfully compete and lead in global low-carbon energy markets.

China's Energy and Climate Policy 'Agenda-Setting Process'

Ideas can influence policy at a number of levels and at a number of different stages of policy creation and implementation. This study will focus in particular on the role of ideas in agenda-setting: the process by which a set of subjects and potential priorities are narrowed down to those that are seen to be most important and most pressing (Béland, 2005, p. 6). Sometimes the appearance of a new idea by itself can affect a change in what is considered to be pressing and important (Andrews-Speed, 2010, p. 8). However, more often it is the perceived failure of old ideas and the policies that flowed from them that make different ideas seem newly important and relevant (Andrews-Speed, 2010, p. 8). The actors that play an influential role in pushing a new idea to the fore are an essential part of this process. These actors must be adept at framing new ideas so that they maintain some sense of continuity with the established way of doing things. However, these actors must balance this with the need to "shake up the existing policy monopoly" (Béland, 2005, pp. 11) that lends strength to institutional inertia and old ideological justifications (Lieberman, 2002, pp. 700-702; Andrews-Speed, 2010, pp. 8-9).

By seeking out the most influential and informative actors in the agenda-setting process that defines China's climate and energy policy, this paper maps out key domestic ideas that have influenced recent energy and climate policy change. Climate change as a policy issue remains dominated by the Chinese government elite. While increasing political pluralism over the past few decades has allowed the public and mass media to influence public policy at times, climate change does not appear to excite public passions in the way that other issues do, such as

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[3] See Heggelund, 2007, pp. 168-157; Jeon and Yoon, 2006, p. 851; Richerzhagen and Scholtz, 2008, p. 318; Howes, 2010, pp. 410-411; Kasa *et al.*, 2008, pp. 121-125; Lewis, 2008, p. 162; Morton, 2009, pp. 74-78; Zhang, 2003, pp. 67-80

[4] For an exception to this, see Urban *et al.*'s analysis of wind energy innovation (2012, pp. 111-130)

Sino-Japanese relations or corruption. As a result, climate change policy-making in China is not strongly influenced by public opinion, and the role that civil society pressure groups and NGOs play remains limited (Richerzhagen and Scholtz, 2008, p. 319; Marks, 2010, p. 983; Lo, 2010, pp. 1012-1017; Schroeder, 2008, pp. 505-525; Pei, 2006, pp.45-47).

With such considerations in mind, this paper uses key policy documents from the Chinese central government as one source in its study of agenda-setting ideas. While these documents stick to the 'official line', in fields such as energy policy central government documents are nonetheless a relatively reliable source of information. One reason for this is that such documents constitute an important form of communication between the central and local governments. Previously, the often arbitrary proliferation of 'classified information' created informational bottlenecks that both inhibited local governments from being made fully aware of central government policy, and hampered the flow of information from the local level to the centre (Zhang, 2002, pp. 116-117; Kluver, 2005, pp. 76-81; Seifert and Chung, 2009, pp. 4-16). Publishing key government documents online has been an important avenue through which local government have been made aware of which issues sit at the top of the central government's agenda and what policies are considered to be most important in Beijing. Therefore, publicly available central government energy and climate change documents are a fairly reliable source of information because the local and provincial governments that will enact central government policies are often the main intended audience.

Chinese academic discourse offers a second window into the agenda-setting ideas that have influenced energy and climate policy-making. Social science research in China remains managed by the State, with clear boundaries demarcating the limits of political acceptability (Brady, 2008, pp. 117-119). Consequently, academic articles are useful because they often reflect dominant ideas within the government. At the same time, elite academics in China tend to have more intellectual independence, and even exert some policy influence, compared to their less luminary peers. For the Hu Jintao-Wen Jiabao 'fourth generation' of Chinese leadership, seeking informed advice from prominent scholars has become a hallmark of the 'scientific development' approach to policy-making, especially in areas relating to energy policy (Meidan *et al.* 2009, p. 592; Glaser and Saunders, 2002, p. 598; Shambaugh, 2002, pp. 575-576). As a result, the works of elite academics not only reflect the dominant official discourse, they can also help to define the motivations and objectives of reform. This analysis has supplemented its survey of key government documents with a further analysis of the recent works of six of China's leading energy and climate change scholars. The importance of these particular academics has been determined based upon the advice of a number of China energy specialists, and by examining author publication and citation statistics.[5] The six leading energy scholars surveyed here were drawn from a range of disciplines including economics, political science and engineering, with some belonging to universities, and some belonging to central government research institutes.[6]

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[6] The six authors chosen for this survey are: 1. *Hu Angang*, a Chinese economist and scholar of public policy from Tsinghua University, director and founder of the Centre for China Studies, who has in the past advised the government on energy policy; 2. *Pan Jiahua*, an environmental economist at the Chinese Academy of Social Sciences, who has served as a lead author on Intergovernmental Panel on Climate Change (IPCC) reports and sits on a number of Chinese government advisory panels for climate change, foreign policy, and environmental protection; 3. *Zhou Dadi*, Emeritus Professor and Vice President of the Energy Research Institute of the National Development and Reform Commission, and lead author on the third IPCC report, who publishes prolifically on China's national energy strategy and security; 4. *Zhu Chengzhang*, an electricity engineer, retired from the former Ministry of Energy, who is currently serving on a number of energy research councils and advising the state grid. He is a very prolific academic writer on China's electricity sector; 5. *Zha Daojiong*, a scholar of international relations at Peking University, specialising in non-traditional security and energy security; 6. *Jiang Kejun*, an internationally recognised energy and climate policy analyst, director at the Energy Research Institute, and a lead author on the third and fourth IPCC report.

2. Domestic Energy Security

The Insecurity of Energy-Intensive Development

In the 1990s, China's increasing oil imports spurred the growth of Chinese scholarship examining energy security through the lens of international energy markets and oil import dependence (Kennedy, 2010, pp. 138-143; Downs, 2004, p. 23). Recently another wave of academic debate has redefined energy security to encompass the dangers of rapidly rising domestic energy demand and poor systems of energy supply. Large-scale blackouts and power shortages, which re-emerged in 2002 after several years of adequate power supply, were the spark that set off this debate. From 2002 up to the present, recurring periods of coal and electricity shortages have meant that factories, enterprises, and sometimes even entire local grids have undergone electricity rationing. Some areas have experienced planned blackouts for several days at a time, at great cost to local economies (Fisher-Vanden *et al.*, 2010, pp. 4-7; Mitchell, 2003, p. 18). While the imbalance between energy supply and demand seemed to ease between 2005 and 2007, during the 2008 Spring Festival the energy shortfall surged (NDRC, May 2007, p. 1). In this period 19 provinces experienced power disruptions and large-scale blackouts that brought areas of China's south to a standstill, amid bitter and sometimes deadly winter snow storms (Zha, 2008a, p. 80; Zhu, 2008, pp. 1-2). The China Electricity Council estimates that China's electricity supply will fall short of demand by roughly 3000-4000 million kilowatts (kW) in 2012 (China Electricity Council, 2012).

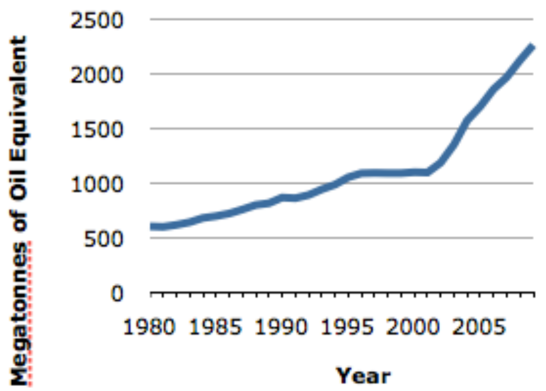
Reflecting upon China's electricity shortages, China's leading energy scholars now argue that "the key threat [to China's energy security] is ever-growing consumption without significant improvements in energy efficiency," as a result of the internal failures of China's energy system and economic structure (Zha, 2006, p. 187; Zha, 2008a, pp. 79-80; Zhu, October 2008, pp. 3-4). Zha Daojiong of Remin University argues that questions of energy security must be grounded in the impacts that energy security has on the daily life of China's ordinary citizens (Zha, 2008b, p. 39). China's energy scholars point out that the security of China's domestic energy systems have a far greater effect on everyday economic activity, political stability, and quality of life in China than fluctuating international oil prices or the remote possibility of foreign resource wars (Zhu, 2008, pp. 2-3; Zha, 2008b, p. 39). This has led some to argue that domestic 'coal security' and 'electricity security' are just as important as international oil security (Zhu, 2008, pp. 1-3; Zhu, 2009, pp. 15-18). Moreover, by framing these as issues of 'security', China's energy scholars have consciously sought to cement them on the central government's policy agenda. According to Zha Daojiong:

> In the context of Chinese academic and policy discussions, whether or not a type of energy is raised to the level of energy security, makes a difference as to the extent to which it receives government policy support ... If electricity security was, like oil security, raised to the level of national security, [this issue] would probably have greater force in terms of policy reform and action, and legal resources (Zha, 2008a, p. 80).

The influence of poor systems of energy supply on domestic energy insecurity is a major source of concern for the central government. Given that China's has one of the most coal-dependent energy sectors in the world, maintaining consistent and adequate coal supply is viewed by the central government as an "assurance of development" and "a foundation of China's national wealth and energy security" (IEA, 2011, p. 592). However, China's strained infrastructure has been unable to cope with moving vast quantities of coal from China's mines in the north and west to the centres of economic activity in the south and east. This has been a major cause of electricity shortages (State Council, 2007, p. 5; NDRC, January 2007, p.1, p. 4; Zhu, 2008, p. 5). China has become a net importer of coal, not because it lacks coal resources, but because of the vast logistical difficulties involved in supplying China's booming demand in a secure and reliable manner (Leung, 2011, p. 1331). Moreover, government documents express deep concerns over the impacts of coal extraction and consumption on the environment, especially in terms of acute air pollution, tainted water resources and acid rain (NDRC, January 2007, p. 4; NDRC, September 2007, pp. 14-15; NDRC, 2004, p. 2, p. 5). These issues have led policy-makers to the conclusion that simply increasing coal supply without controlling demand will be inadequate to address the imbalance between energy supply and demand (State Council, 2007, p. 9).

China's rapid growth in energy consumption and the resulting power shortages emerge as a strong motivation for reform in central government documents. The growth rate of China's energy consumption exceeded GDP growth by as much as 5% in the early-2000s, energy consumption was 4 times higher between 2000 and 2008 than the previous decade, and energy intensity increased by 2.3% every year between 2002 and 2005, reversing average annual intensity reductions of 6.4% between 1990 and 2002 (IEA, 2010, pp. 9798; Price *et al.*, 2010, p. 2165). Looking at future energy use in 2004, as China's energy intensity was rapidly rising, the NDRC estimated that China's energy consumption in 2020, in the absence of further efforts to control demand, would amount to 4 billion tonnes of coal equivalent, with serious implications for China's domestic energy security (NDRC, 2004, p. 5). Based on these projections, the NDRC argued that "no matter whether we increase domestic energy supply or use international markets to access resources abroad, [China's energy system] will still be under massive pressure" (NDRC, 2004, p. 5). As a result, the State Council Energy White Paper summarises China's overall energy strategy as "stress[ing] both development and saving [of energy resources], with priority given to saving" (State Council, December 2007, p. 12). More recently, Zhou Dadi of the NDRC's Energy Research Institute China could account for as much as 50% of world energy demand by 2020 if current trends continue unabated, highlighting both the severe energy constraints upon China's future growth as well as the potential international tensions that China's huge energy demand could excite (Zhou, 2010a, p. 38).

Fig. 1: China's Energy Use from the Reform Era to 2009



Source: World Bank. 2011, *World Development Indicators*

Both Chinese energy scholars and central government documents criticise the model of economic development that formed unsustainable patterns of energy use in the first place. Chinese academics argue that the natural advantages that propelled China's economic rise - such as cheap and abundant labour; low costs for land and resources; the uninhibited exploitation of China's natural environment; and subsidised, cheap energy - are now being either expended or have become a burden on the Chinese economy (Pan, 2011a; Jiang *et al*., 2009, p. 11; Pan, 2010, p. 3; Zhou, 2009, pp. 41-42). The economic patterns that these past natural advantages produced - large levels of investment with low productivity; over-investment in export-oriented heavy industry and low-level manufacturing; reliance on cheaply priced energy; and inefficient energy use - is thus unsustainable and must change (Hu, 2011a, p. 15; Zhou, 2009, p. 42; Zha, 2008b, pp. 36-37). China's rising energy intensity has been driven in large part by the boom in heavy industry that followed the policies of the 9th and 10th FYPs (State Council, 2007, p. 12; NDRC, 2004, pp. 3-4; Liu *et al.*, 2010, pp. 370-371; Zhou, 2010a, p. 38; Zhou, 2007, p. 52; Hu, 2010, p. 30; Lu *et al.*, 2006, pp. 89-90). By comparison, China's per capita and household energy consumption has remained low, reflecting the fact that the benefits of economic growth have been spread unevenly in Chinese society (NDRC, 2004, p. 3; State Council, 2007, p. 4). Official ideologies associated with the Hu-Wen 'fourth generation' of Chinese leadership have in general sought to reduce income inequality, stimulate domestic consumption and move away from export-oriented growth and reduce China's reliance on manufacturing and heavy industry as a main source of economic growth (Government of the People's Republic of China, 2011, pp. 1-7; Halding *et al.*, 2011, pp. 123-125; Yeh and Lewis, 2004, pp. 455-456). This marks a significant shift away from China's previous style of economic growth, which was largely fixated upon GDP growth figures as a sign of success, to a model of development that is more firmly focussed upon economic, environmental and social sustainability. The government's main policy response to domestic energy insecurity - vigorous energy efficiency policies - must be seen in the context of this broader effort to change the structure of China's economic development.

Energy Efficiency Policies

Controlling energy demand to ensure the security of domestic energy supply has been a primary motivation for energy efficiency policies. Top-down target setting has been a key feature of China's energy efficiency drive. However, until recently, energy efficiency targets in the five-year plans were either small or non-existent.

Fig. 2: Energy Efficiency Targets by Five Year Plan

Year	Plan	Target
1953-1980	1st to 5th FYP	no targets
1981-1985	6th FYP	energy intensity reduction of 2.3-3.5%
1986-1990	7th FYP	energy consumption per 1000 RMB to be cut from 1.29-1.14 tce
1991-1995	8th FYP	energy intensity reduction of 2.2%
1996-2000	9th FYP	no target, aim to cut overall energy consumption by 1.45 tce
2001-2005	10th FYP	no target
2006-2010	11th FYP	energy intensity reduction of 20%
2011-2015	12th FYP	energy intensity reduction of 16%

Source: Yuan and Zuo, 2011, p. 3857

As can be seen from the above table, the 11th FYP marked a turning point in energy efficiency target-setting. In this period the central government targeted a 20% reduction in energy intensity from 2005 levels, followed by a further 16% reduction in energy intensity during the 12th FYP. These targets have not been easy to achieve. Many of the energy efficiency gains to be had from the dismantling of central planning were already slowing towards the end of the 1990s, when energy intensity suddenly began to increase (Garnaut, 2011, p. 26). When they were initially tabled, 11th FYP energy intensity targets faced some opposition from China's top economic advisors because they were thought to be attainable only at unacceptable cost to economic growth (Garnaut, 2011, p. 25). The 11th FYP target reflected a significant change in the level of ambition to address the energy intensity of the Chinese economy.

China's national energy targets have been supported by a complex hierarchy of energy intensity targets, along with systems of penalties and rewards to ensure compliance. First, government documents set out sector-specific targets for the most energy intensive sectors of the economy, such as heavy industry, construction, electrical power generation, the oil and petroleum industry, chemical engineering, vehicles and transport, government procurement, lighting, and household appliances (NDRC, 2004, pp. 6-12; State Council, 2010; State Council, 2006).

Second, national energy intensity targets have been delegated to provincial and local levels. In many cases, local and provincial government leaders sign annual contracts with the central government that contain economic and developmental targets. This directly links achieving central government targets with job performance, while at the same time imposing harsh punishments for misreporting (Mintzer *et al.*, 2010, p. 15).

Third, the central government has laid out energy intensity targets for individual *danwei* (work units). Failure to meet these targets is accompanied by a system of penalites, blocked or reduced access to government investment, and an injunction to submit a programme of monitored policy changes to a higher level of government (State Council, December 2007; Government of the People's Republic of China, 2011, p. 22). For individual *danwei,* these documents make clear the central government's determination to close down large numbers of smaller and more ‘backward’ enterprises that fail to meet pollution and energy use targets (State Council, December 2007; State Council, 2010).

Fourth, the central government has been able to use energy efficiency targets as a vehicle to affect a broader economic shift away from heavy industry and manufacturing and to increase the share of tertiary industries and services in China’s GDP. Prerogatives to shift local economies away from heavy industry towards less energy-intensive tertiary industries have been heavily weighted in the target-responsibility assessments for local government in the energy sector (State Council, December 2007, pp. 8-9).

Targets have been supported by investment in energy efficiency through a number of programmes. The Ten Key Projects has focussed on largely technology-based efficiency improvements through initiatives such as retrofitting inefficient industrial coal-fired boilers, green lighting, energy conservation monitoring and testing, and a range of other projects (State Council, December, 2007, p. 17). The Top-1000 Enterprises programme has set rolling energy intensity targets for more than 1000 enterprises that consume over ten thousand tonnes of standard coal per year, as well as conducting regular energy auditing, energy education and capacity building (State Council, December 2007, pp. 16-17). The ‘Large Substitute for Small’ programme has closed small and inefficient power plants, with missing capacity to be replaced by larger, more efficient plants. The systematic closure of small and inefficient facilities has been one of the most important and successful components of China’s increasing energy efficiency (Price *et al.*, 2011, p. 2173; Held *et al*., 2011, p. 27). Research and development programmes, energy efficiency building standards, the retrofitting of inefficient buildings, and energy rating labelling for appliances have also been important and fairly successful components of the central government’s energy efficiency drive (Government of the People’s Republic of China, 2011, p. 22; Price *et al.*, 2010, pp 2167-2171).

The central government is increasingly turning to market reforms to establish incentives for reduced energy use. Subsidies have been removed for coal, oil, and gas, raising the prices of these fossil fuels, and the government has successfully imposed a resources tax on coal mining in selected regions (NDRC, January 2007, pp. 23-24; Held *et al*., 2011, p. 29). New taxes and tariffs have been imposed on energy intensive goods, to create disincentives for high rates of investment in energy intensive industries. For example, new tariffs have been imposed on all steel exports that are roughly equal to a charge of $US50 per tonne of CO_2 embedded in the steel manufacturing process (Houser *et al.*, 2008, p. xix). The government has also lightened the tax burden of *danwei* who make large improvements in energy efficiency (State Council, 2007, p. 18). Raising the electricity price for certain high energy-consuming end-users has also played a role in the energy efficiency drive. Industry pays higher electricity prices than households, while energy intensive industries and high energy-consuming *danwei* pay an even higher rate for electricity use (Howes and Dobes, 2010, p. 45; NDRC, January, 2007, pp. 22-23; Government of the People’s Republic of China, 2011, p. 6; State Council, 2006). Market reforms such as the removal of subsidies, price reform and taxation policies played only a limited role in achieving the 11th FYP energy intensity target. However, the expense and inefficiency of many ‘command-and-control’ policies has prompted a deepening of market mechanisms in the 12th FYP (Han *et al.*, 2012, p. 3).

The cumulative effect of these energy efficiency policies has already altered the trajectory of China’s GHG emissions growth since the beginning of the 11th FYP. According to the Climate Policy Initiative, China reduced CO_2 emissions by 1550 megatonnes (Mt) from its business-as-usual trajectory over the course of the 11th FYP. Energy efficiency gains accounted for 87% or roughly 1000 Mt of China’s relative CO_2 reduction during this period (Climate Policy Initiative, 2012, p. 1). Another report from the Australian Productivity Commission estimates that the closure of small and inefficient power generation units alone resulted in 119-174 Mt of avoided CO_2 over the years 2009 to 2010 (Australian Productivity Commission, 2011, p. 86). These energy efficiency policies and the resulting reductions in relative emissions have been strongly influenced by the perceived danger that high levels of domestic energy consumption pose to China’s energy security.

3. Green Development

The True Cost of Pollution

Throughout the 1980s and for much of the 1990s, the often repeated phrase 'first development, then environment, first pollute, then clean-up' reflected the reality that China consciously traded its environment for economic growth (Economy, 2004, p. 18). However, as China's environmental degradation has become more severe, the toll that pollution has exacted both on the living standards of ordinary Chinese and on China's economic growth has become more widely accepted (Zhuang *et al.*, 2011, p. 133; Hu, 2011a). Awareness of this worsening environmental crisis has prompted the rise of 'green development' as an important concept in China's official discourse. In 2004, the State Environment Protection Administration (SEPA, now Ministry of Environmental Protection) attempted to implement the world's most ambitious exercise in environmental accounting, the 'Green GDP' (Li and Lang, 2010, p. 47). SEPA estimated the cost of environmental damage and pollution to be 3.05% of total GDP, or one third of the total GDP growth for that year (State Environmental Protection Administration, 2006). SEPA qualified this by stressing that "this accounting is only a fraction of [the] ultimate green GDP calculation result" as many important environmental indicators were not included (State Environmental Protection Administration, 2006). More recently, Wang Yuqin, former deputy director of SEPA, estimated that environmental damage in 2011 amounted to 5-6% of GDP loss (Watts, 2012). Key government energy policy documents now routinely express concern for the environmental constraints on China's economic growth (State Council, 2010b; NDRC, January 2007, p. 4; NDRC, September 2007, p. 4; NDRC, 2004, pp. 1-2; Government of the People's Republic of China, 2011, p. 4, p. 21). More recently, the 12th FYP has unambiguously stated the need for China to follow a greener developmental path:

> Facing increasingly strong environmental and resource restraints, we must strengthen our consciousness of crisis. [We must] establish the idea of green, low carbon development, with an emphasis on energy efficiency and emissions reductions, with sound incentive mechanisms and constraining mechanisms, [we must] hasten the construction of energy saving and environmentally friendly modes of production and modes of consumption, strengthen our sustainable development abilities, increase our level of ecological civilisation (Government of the People's Republic of China, 2011, p. 21).

Many from within and outside of China have hailed the 12th FYP as a definitive transition from growth-focussed development to a new developmental model that places social and environmental concerns at the centre (Hu and Liang, 2011, pp. 20-21; Hilton, 2011, p. 5; Hannon *et al.*, 2011, p. 1).

As the above excerpt from the 12th FYP indicates, increasing concern for the effects of climate change has been an important part of the rhetoric of green development. There is a clear consensus amongst China's leading natural and social scientists that climate change damages seriously threaten China's future development, prosperity and stability (Pan *et al.* 2007, pp. 187-194). This consensus is shared by the Chinese government. In particular, the *National Assessment Report on Climate Change* and China's climate change *White Paper* highlight the following potential damages to China from climate change: (1) the damage that extreme and unpredictable weather will pose to already declining crop yields and livestock; (2) large-scale biodiversity loss; (3) melting permafrost and glaciers, resulting in an overall decline in ice cover in the Tibetan Plateau, with major effects on the water resources of almost all of China's major river systems; (4) greater incidence and severity of both floods and droughts, but with an overall decline in already stressed water resources; (5) rising sea levels, threatening China's populous and rich coastal areas, and; (6) enhanced social and economic costs due to the fact that widespread poverty and underdevelopment will exacerbate the difficulties of adapting to climate change (State Council, 2008, pp. 1-3; Government of the People's Republic of China, 2007, pp. 182-190). Although economic development and growth remains a primary aim for the Chinese government, there is an increasing realisation that dangerous climate change poses a clear threat to China's developmental goals.

Controlling Carbon Emissions in the 12th FYP

While many of China's climate-related policies have been largely motivated by a combination of other policy goals, recent policy announcements suggest that concern over the impacts of climate change may be emerging as a stronger motivation for policy action. China's Copenhagen pledge to reduce its carbon intensity 40-45% by 2020 was a striking symbolic commitment to addressing climate change. However, up until recently, China's efforts to address climate change have largely been a 'repackaging' of energy, environmental and transport policies undertaken for a number of different purposes (Halding *et al.*, 2009, pp. 129-130; Richerzhagen and Scholtz, 2008, p. 311). For example, while energy efficiency policies have been the main source of avoided CO_2 emissions thus far, these policies were enacted more in reaction to domestic energy insecurity rather than to address climate change. China has pledged to increase forest cover by 40 million hectares on 2005 levels by 2020, which will draw some of China's carbon emissions out of the atmosphere to be sequestered in forests (Department of Climate Change, NDRC, 2010). However, these policies were initially put in place in 2000, well before China released its climate mitigation policies, to address local environmental degradation such as soil erosion, desertification, flooding, dust storms and food security concerns (Howes and Wyrwoll, 2012, p. 18). Similarly, while government policies to support renewable energy are a vital step in shifting China's energy mix away from fossil fuels, renewable energy policies have also served a range of other agendas. In addition to reducing China's GHG emissions, renewable energy policy has also served to strengthen China's economic competitiveness in a crucial emerging market, stimulate new domestic sources of growth, address poverty in remote areas by providing off-grid electricity access, and protect the local environmental by displacing coal-fired power generation (State Council, December 2007, p. 12; Government of the People's Republic of China, 2011, p. 14; NDRC, September 2007, p. 7, pp. 13-15).

By contrast, recent policy announcements as part of the 12th FYP suggest that climate change may be moving higher on the central government's policy agenda (Government of the People's Republic of China, 2011, p. 5). Unlike the 11th FYP, which only set an energy intensity target, the 12th FYP has targeted an energy intensity reduction of 16% and a carbon intensity reduction of 17% (Government of the People's Republic of China, p. 5). The similarity between these two targets suggests that energy efficiency will remain the primary source of China's GHG emissions reductions in the near future. Efforts to reduce carbon intensity will also aid China's efforts to limit energy consumption and lower its energy intensity. Clearly, China's climate policies still serve a number of different agendas. However, for the first time the 12th FYP includes targets and policies that specifically aim to reduce GHG emissions. This suggests that climate change mitigation may be becoming a motivation for policy action in its own right, rather than being simply a co-benefit of policies enacted for other purposes.

Fig. 3: The Evolution of China's Climate Policy

Year	Event	Policy
1988	China joins IPCC	no domestic climate policy
1992	China joins UNFCCC	no domestic climate policy - China active in establishing the UNFCCC
1991-2005	8th to 10th FYP	no domestic climate policy - govt. documents focus on China's right to develop free of emissions constraints
2006	11th FYP	general statements that GHG emissions should be controlled
2007	National Assessment Report on Climate Change released	National Assessment Report outlines potential damages from climate change
2007	National Action Plan on Climate Change released	plan to address climate change released for the first time, with a focus on pre-existing, climate-related policies
2008	White Paper on China's Climate Change Actions and Policies released	re-iterates potential damages and pre-existing climate-related policies
2009	UNFCCC COP 15 Copenhagen Conference	voluntary pledge to reduce emissions intensity 40-45% by 2020
2011	12th FYP	emissions intensity reduction of 17%; pilot trials of carbon pricing schemes; forest coverage to increase by 21.6%
2011	Second White Paper of China's Climate Change Actions and Policies released	summarises existing climate-related policies and additional policies as a result of the 12th FYP

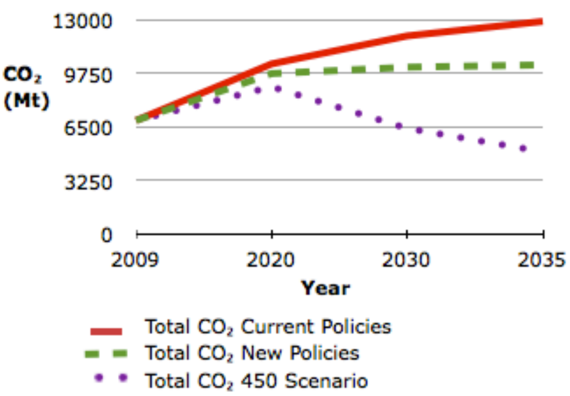
Sources: Yuan and Zuo, 2011, p. 3858; Jeon and Yoon, 2006, pp. 851-854; State Council, 2008; State Council, 2007; Government of the People's Republic of China, 2011; Halding *et al.*, 2009, pp. 129-130;

The most significant of these new carbon policies is carbon pricing. Seven provinces and cities (Beijing, Tianjin, Shanghai, Chongqing, Hubei, Guangdong and Shenzhen) will pilot carbon trading schemes, to begin in 2013, with the pilot areas trialling different international carbon pricing models, such as the EU ETS and the Australian 'tax and trade' model (NDRC, 2011; China Climate Change Info-Net, 2012; China Cement Network, 2012). The scope and ambition of these pilots are are significantly different to already existing carbon markets in China. Pre-existing markets have been completely voluntary, limited in scope to Beijing, Tianjin and Shanghai, and actual trades have been few in number and largely symbolic (Han *et al.*, 2012, p. xx). In addition to city- and province-level pilots, the government will also experiment with sectoral carbon pricing. For example, the central government is preparing to pilot carbon cap and trade and taxations systems in sections of China's electrical power generation, cement manufacturing and building sectors (Han *et al.* 2012, pp. 30-32; Rushan Municipal Department of Finance, 2012).

The central government has also made clear its intention to implement a nation-wide carbon-pricing scheme. Official announcements of the pilot trading schemes have indicated that an ETS may be extended to the national level starting around 2015 (China Climate Change Info-Net, 2012). In 2010, the Ministry of Finance and the NDRC's Energy Research Institute jointly published a report calling for the introduction of a carbon tax at a proposed rate of 10 yuan ($US1.59) per tonne of CO_2. In this proposal a carbon tax would begin before the end of the 12th FYP in 2015, then gradually increase over time to between 48RMB and 390 RMB ($US7.30 and $US59) (China Climate Change Info-Net, 2010; Wei, 2012; Hannon *et al.*, 2011, p. 14). When and if it is implemented, a nation-wide carbon-pricing scheme in China will be the largest endeavour in climate economics ever attempted (Han *et al.*, 2012, p. xi).

China's carbon pricing policies are in the initial stages of experimentation and it is difficult to say with any certainty how effective carbon pricing in China will be. However, certain features of the pilot schemes suggest that China is sincere and ambitious in its efforts to price carbon. First, the price of carbon in some of China's pilot and proposed schemes has potential to affect changes in China's emissions path, dependent upon further policy action. Adjusted for purchasing power party (PPP) China's carbon prices are higher than they first appear.[7] When prices floated in China's national carbon tax proposal are adjusted for PPP in 2010 terms, the initial proposed price of $US1.59 starting around 2015 is roughly equal to $US2.70, while the eventual price range of $US7.3 to $US59 is equal to between $US12.5 and $US101.23. Another carbon price of $US4.8-6.3, shortly to be trialled in parts of the cement sector, amounts to roughly $US8.2-$US10.8 in PPP terms (Rushan Municipal Department of Finance, 2012).[8] The International Energy Agency has modelled the projected implications of the introduction of a $US10 carbon price in China nationally (dollars are also in 2010 PPP) by 2020. It finds that this price range, along with other accompanying mitigation policies, may well produce significant emissions reductions out to 2035. Specifically, the IEA examines three different scenarios for China's future emissions: the 'current policies scenario' in which all mitigation policies up to mid-2011 are implemented with no further mitigation action; the 'new policies scenario' in which both current policies and recent policy commitments are implemented in a cautious manner; and a '450 scenario' in which the ambitious mitigation policies needed to control global warming at 2ºC or 450 ppm are implemented (IEA, 2011a, p. 39). Significantly, both the 'new policies scenario' and the '450 scenario' see a carbon price of roughly $US10 implemented nation-wide by 2020, although the carbon price in the two scenarios rise at different rates following 2020.

Fig 4: IEA Projections for Total CO_2 Emissions in China Under Three Mitigation Scenarios and Assumed Carbon Prices



Year	Current Policies Scenario	New Policies Scenario	450 Senario
2020	no carbon price	$US10/t	$US10/t
2030	no carbon price	$US23/t	$US65/t
2035	no carbon price	$US30/t	$US95/t

Source: IEA. 2011, *World Energy Outlook*, OECD Publishing, France, p. 66, pp. 594-595

Although not all of China's current and proposed carbon prices are in this range, IEA modelling suggests that some of the higher pilot and proposed prices do hold out the promise of a relatively effective response to climate change, if they area implemented nation-wide by 2020 and rise sufficiently over the following decades.

Second, implementing carbon-pricing pilots will require significant government investment in the infrastructure of an entirely new market. There are currently over a hundred carbon and environmental 'exchanges' already in existence or under development, which are to provide the platforms carbon trading, run registries to monitor companies' emissions and emissions reductions, and build up systems and standards to regulate the market (Han *et al.* 2012, pp. 19-20). A survey of these exchanges has shown that all of these exchanges have strong government backing (Han *et al.*, 2012, p. 18). These and other infrastructure such as third party verification will need to be developed almost from scratch to service China's new carbon markets.

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[7] Purchasing power parity (PPP) measures the amount of a given currency needed to buy the same basket of goods and services as one unit of reference currency. The market exchanges within China that may be affected by a carbon price can be more accurately estimated by using PPP, rather than nominal prices.

[8] According to the World Bank Development Index, in 2010 China's nominal GDP was $US5927 billion while GDP adjusted for PPP was $US-international 10170 billion, yielding a factor of approximately 1.7158 to convert nominal prices to PPP in 2010 pricing

Third, carbon pricing for both pilot schemes and a future national scheme will require overcoming significant barriers to effective GHG data collection, a challenge to which the government has already dedicated considerable resources. China is establishing a GHG inventory management system that will bring together five sub-sectoral inventories into a national GHG database and which will define the procedures and standards for related data-gathering government departments (Mintzer *et al.*, 2010, p. 12). Based on this national database, China will shortly release its second National Communication to the UNFCCC providing a national GHG inventory for 2005 emissions, after releasing the first national inventory in 2004 for 1994 emissions levels (Mintzer *et al.*, 2010, p. 12). Following the release of the second inventory the government has committed to update its inventory and report to the UNFCCC every two years (Mintzer *et al.* 2010, p. vi). However, the challenges to effective data collection remain great. Addressing the issues China faces collecting accurate coal data will be particularly difficult in the development of China's GHG inventory. Energy consumption for other fuel sources is relatively reliable, but data for coal consumption is less so. The coal consumption of small and local companies, and sales through informal coal markets (which often service small companies in times of shortages in addition to families and households) are very difficult to track (Mintzer *et al.*, 2010, p. 14). Moreover, detailed information on the carbon content of different types of coal is often not collected at all, making it difficult to calculate carbon dioxide emissions from the consumption of different types of coal (Wang and Chandler, 2011, p. 16).

Fourth, effective carbon trading will necessitate wider and more difficult market reform. In particular, government control of energy prices will have to be altered. While progress has been made in marketising the cost of commodities such as gas, coal and oil, the government keeps electricity prices artificially low. As a result, price increases in electricity generation as a result of a carbon price cannot be passed through to end-users. This stunts both the ability of a carbon price to affect changes in the behaviour of end-users and the ability of electrical utilities to use extra capital to upgrade the efficiency of their generators (Howes and Dobes, 2010, pp. 61-68). The challenges of implementing an effective carbon market in a transitional market economy will be a major test of the government's dedication and ability to make carbon trading work in China (Han *et al.*, 2012, p. xxiii). Nonetheless, the fact that carbon pricing and carbon intensity targets are being pursued despite the difficulties involved suggests that reducing GHG emissions to address climate change is emerging as a significant motivation for policy action.

4. Low-Carbon Leadership

A conviction that China has an historic opportunity to position itself as an economic and technological leader in a global transition towards low-carbon energy is widely accepted both amongst Chinese energy scholars and within central government documents. The need for China to remain internationally competitive is a major driver of this ambition. Zhou Dadi of the NDRC argues that developed countries have already begun to de-carbonise their energy structures. He claims that their efforts will intensify as low-carbon technologies become cheaper, the multiple benefits of a low-carbon economy become clearer, and the threat of climate change becomes more evident. Therefore, China will also need to transition to low-carbon energy in order to remain competitive into the future, or be left struggling to catch up (Zhou, 2009, p. 44; Zhou, 2010a, p. 38; Zhou, 2010b, p. 24, also Pan, 2010a, p. 11). Hu Angang of Tsinghua University puts low-carbon leadership in the context of China's geopolitical rise. He notes that different waves of industrialisation and modernisation have been tied to the emergence of important new energy technologies. Historically, the countries that have been able to effectively exploit these new energy technologies before anyone else have succeeded in increasing their influence and changing the balance of power in the international system (Hu, 2008, pp. 24-25; Hu, 2011a, pp. 13-15). Hu argues that China has consistently failed to position itself at the forefront of these crucial technological breakthroughs, and as a result, has remained politically marginalised for much of its modern history. China must not "make the same mistakes once again", but must rather "have a strong sense of crisis" in order to become an economic and political leader in the 'next wave' of modernisation, which will be defined by low-carbon energy technologies (Hu, 2008, pp. 24-25; Hu, April 2010, pp. 5-6; Hu, 2011a, pp. 13-14).

China's leading energy academics argue that China also has comparative advantages that make it uniquely placed to seize the opportunity of global low-carbon leadership. This is because China's economy is already in a state of transition. As the process of urban migration begins to slow down, China's population begins to age, and per capita wealth rises, the abundance of cheap labour on which China's export-oriented growth model has relied will diminish (Pan, 2011a, p. 11). As energy security becomes more of a concern and the marketisation of China's energy sector continues to deepen, the cheaply priced energy, upon which the expansion of energy-intensive export-oriented industries have relied, will no longer be viable (Hu, 2011b, p. 46; Zhou, 2007, pp. 52-53; Pan, 2011a, pp. 12-13). China's GDP growth rate will slow as the main sources of growth shift from labour-intensive manufacturing to rising productivity and the greater quality and competitiveness of Chinese goods and services (Pan, 2010b, p. 23; Zhou, 2009, p. 44). For China's energy scholars, these and other factors signify that the internal momentum of large-scale reform towards a less energy-intensive economy is already in place. Seizing the opportunities involved in low-carbon leadership will mean harnessing this transformative momentum and speeding up the rate at which China de-carbonises its economy (Zha, 2009, p. 35; Pan, October, 2010, p. 3; Jiang, 2009, pp. 11-19).

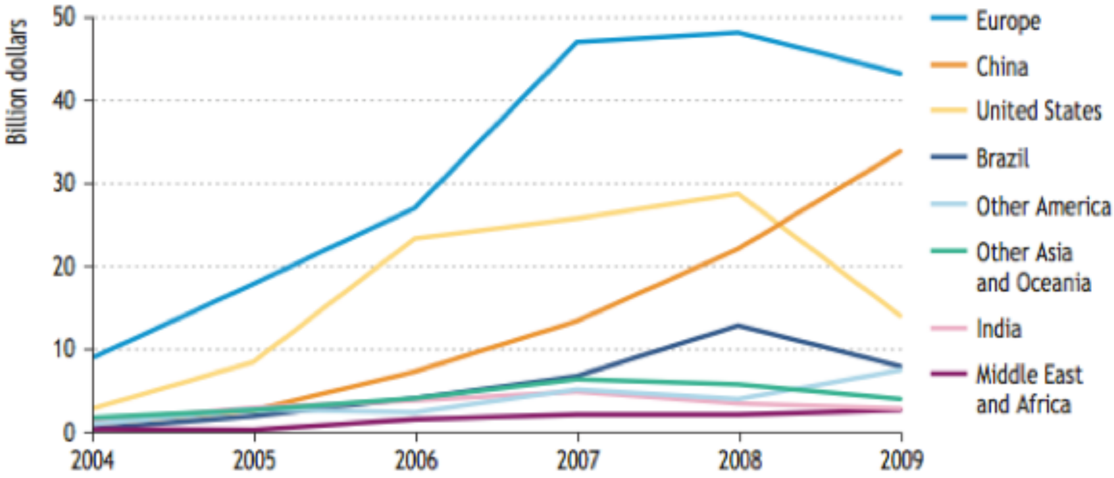
Government policy documents also highlight the need for China to remain competitive and seize the economic opportunities in emerging low-carbon markets. The *Medium to Long Term Renewable Energy Development Plan* expresses an expectation that "each country will ... hasten their development of renewable energy," and goes into great detail in describing the policies, laws, targets, research and development, and market mechanisms that other countries have put into place to expand their renewable energy industry. As the market for renewable energy is expanding, the price of renewable technologies are being driven down by international innovation and investment, further fuelling growth (NDRC, September 2007, pp. 7-9). Moreover, the plan predicts that after 2020, the international renewables market will continue to expand even more rapidly, gradually overtaking fossil fuels to become the world's primary form of energy supply. Therefore, opportunities for sustained, long-term growth in this market are very great (NDRC, September, 2007, p. 7). When introducing China's plan to develop 'strategic emerging industries' which includes renewable energy, energy efficiency technologies, electric vehicles and other low-carbon energy technologies, the State Council argues that China can gain a "first mover advantage" and "seize a historic opportunity" by using the development of low-carbon technologies to forge a new comparative advantage in international trade (State Council, 2010b). For the central government, such concerns have heightened the imperative to 'catch-up' technologically to developed countries (NDRC, September, 2007, p. 12).

While international markets are important, using low-carbon energy to service China's huge domestic electricity demand alone would suffice to make China a global leader in terms of market share. Currently China's electrical power generation accounts for roughly 20% of the global total (IEA, 2011a, p. 544, p. 952). Government documents see the realisation of this potential for leadership in the domestic low-carbon market as another important source of long-term growth (State Council, 2010b; Government of the People's Republic of China, 2011, p. 4). This brings the added benefit of providing a large pool of highly-skilled jobs for China's citizens, and aiding the broader shift away from export-oriented to consumption-driven growth (NDRC, 2007, p. 15; State Council, 2010b; Government of the People's Republic of China, 2011, p. 4). In the 12th FYP the government established a target for strategic emerging industries such as renewable energy, energy efficiency and low-carbon transportation to constitute 8% of China's overall gross national product (GNP) by the end of 2015 and 20% of GNP by 2020 (Government of the People's Republic of China, 2011, p. 11). Non-fossil fuel energy is set to constitute 11.4% of energy use by 2015, while renewable energy should provide 15% of total energy consumption by 2020 (NDRC, 2007, p. 15; Government of the People's Republic of China, 2011, p. 5; Department of Climate Change NDRC, 2010). Leadership in low-carbon markets is certainly not the only reason for measures such as these. Government documents highlight energy security, alleviating local environmental damage, and addressing rural poverty as other important motivations for low-carbon energy policy (State Council, December 2007, p. 12; Government of the People's Republic of China, 2011, p. 14; NDRC, September 2007, p. 7, pp. 13-15). However, patterns of government investment in low-carbon energies suggest that ambitions for Chinese leadership have indeed stimulated significant policy action.

Government-Supported Expansion of Wind Energy and Solar PV Energy

Large volumes of government financing and investment has underpinned the rapid development of China's wind and solar PV markets from a position of global insignificance to market leadership in less than a decade. Overall investment in renewable energy in China has grown exponentially since the Renewable Energy Law of 2004 and the Medium to Long Term Renewable Energy Development Plan in 2007 set up the overall framework for the growth of the renewables market (Held *et al.*, 2011, pp. 30-32; Gordon *et al.*, 2010, p. 25). The following graph demonstrates the steep ascent of renewable energy investments over the 11th FYP period. As a result of this China is now the largest single-country investor in renewable energy (Pew Charitable Trust, 2012, p. 10):

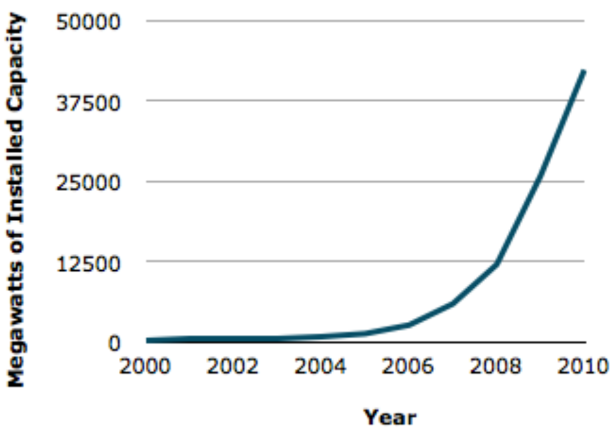
Fig. 5: Annual Investments in Renewable Energy Assets by Region



Source: IEA. 2010, *IEA World Energy Outlook*, p. 286

The growth of China's wind energy market has focussed on investment in the domestic market. However, the growth of China's domestic wind market alone has made a global leader in wind power markets. Domestic wind capacity has grown from less than 1 gigawatt of installed power in 2004 to between 42 and 44 gigawatts at the end of 2010 (China Greentech Initiative, 2011, p. 77; Hannon *et al.*, 2011, p. 21). As a result China's installed wind capacity is the largest in the world (IEA, 2012, p. 27). The Global Wind Energy Council estimates that China's wind capacity development will exceed its 2020 150GW target, to achieve between 200GW and 240GW of installed capacity by 2020 (Hannon *et al.*, 2011, p. 21). While 25.6% of this capacity remained unconnected to the grid at the end of 2011, the Chinese government is taking steps to moderate the expansion of capacity and increase grid connectivity (IEA, 2012, p. 27).

Fig. 6: The Growth of China's Domestic Wind Capacity



Source: Global Wind Energy Council, 2012

Domestic demand combined with the export of wind components has made Chinese wind power companies world leaders. The Chinese state-owned enterprises Sinovel and Goldwind are now among the top five world wind companies in terms of global market share (IEA, 2010 p. 291). With Chinese wind manufacturers rapidly increasing their production capacities, they are starting to look beyond the domestic market to aggressively pursue export opportunities (Gordon *et al.*, 2010, p. 30).

In contrast to wind, the development of China's photovoltaic solar power industry has been largely export-driven (Jiang, 2011, p. 43). In the span of a decade China's PV solar panel production has risen dramatically: from supplying 1% of world PV production to becoming the world's largest exporter of solar panels, with over 40% of global market share (Richardson, 2011). In 2009 China's domestic solar PV capacity was only 2% of world total, with the vast bulk of manufacturing bound for the international market (Hannon *et al.*, 2011, p. 21). However, the dramatic fall in global demand following the global financial crisis highlighted the dependence of China's fledgling solar PV industry on global market fluctuations. Recently 300 out of 728 solar PV manufacturers have halved their output or shut down completely (Ernst and Young, 2012, p. 18). To stimulate domestic demand, the government has announced targets to generate 15GW of power from solar capacity by 2015 and 20GW by 2020 (Ernst and Young, 2012, p. 18; Hannon *et al.*, 2011, p. 22).

China's energy policy-making elite seem to be united in the belief that the government must take a strong leading role in the expansion of Chinese renewables (State Council, December, 2007, p.12; NDRC, April 2007, p. 9; NDRC, September, 2007, pp. 13-15; Zhou, 2009, p. 44; Lu *et al*., 2006; pp. 94-95). Government financial policies have been central to the development of the wind power and solar PV industry, both in terms of fostering domestic markets and ensuring Chinese companies are competitive with international firms. Part of this financing has come through China's broader renewable energy policy. The central government has set up a range of research and development funds to spur technological innovation in the renewables industry (Gordon *et al*., 2010, p. 27; Government of the People's Republic of China, 2009; Ministry of Finance, 2011). In 2006 the government established regulations making the purchase of renewable energy mandatory for China's electricity grids (Government of the People's Republic of China, 2009, p. 1; Gordon *et al*., 2010, p. 31). In some areas, the Energy Saving Power Dispatch pilot programme has mandated that regional electricity grids buy all available renewable energy first, to meet as much base-load as possible, after which purchase of electricity to meet peaks in demand is strictly defined according to environmental and efficiency grades (Gao and Li, 2010, pp. 7350-7356). The government has also imposed a levy on electricity grids of 0.008 RMB per kW/h of electricity consumed by end-users, the revenue from which is funnelled into renewable energy research and development, setting up renewable energy-based grids in remote rural areas, and subsidising the expansion of China's domestic renewable energy capacity (Ministry of Finance, 2011). From this and other similar levies, $US320 million was distributed to renewable energy developers between 2006 and 2008 (Gordon *et al*., 2010, p. 33).

The government has also implemented a raft of policies that aimed at the wind and solar PV industries in particular. Feed-in tariffs have supported the expansion of domestic capacity. Wind power feed-in tariffs and mandatory grid access, in which electricity grids buy a guaranteed quota of wind power at higher prices, have been an important part of the expansion of China's domestic wind power sector (Worldwatch, 2010, p. 27). In the years

2005-2010 the wind sector attracted roughly 75% of all clean energy investment in China (The Pew Charitable Trusts, 2012, p. 34). In 2009 the 'Golden Sun' programme began to cover 50-70% of the installation costs for large-scale solar PV installations (over 300 kilowatts-peak) (Ministry of Finance *et al.*, 2009). Last year the government announced a similar feed-in tariff for solar power producers. This has been widely hailed as a definitive sign that the government is ready to "hit the go button" on its domestic solar market expansion (Parkinson, 2011; Hook, 2011). Overall, public financing for solar PV and wind power surged in the wake of the global financial crisis, due to the prominent role that clean energy and renewables played in the Chinese government's economic stimulus spending (Pew Center, 2010, p. 9; Worldwatch, 2010, p. 5).

Fig. 7: Grid Connected Electricity Prices in China: Solar PV, Wind and Other Sources

Energy Source	***Price RMB/kWh*** **High**	**Low**	**Average**
Solar PV	3.45	1.2	1.5
Wind	0.77	0.45	0.6
Hydropower	0.76	0.12	0.22
Coal	0.45	0.32	0.38
Natural gas	1.1	0.77	0.8

Source: Worldwatch. 2011, *Renewable Energy and Energy Efficiency in China: Current Status and Prospects for 2020*, p. 27

The government has also actively supported Chinese companies in their efforts to obtain domestic contracts and increase international cost-competitiveness. Winning almost all of the competitive bidding for renewable energy projects to date, Chinese state-owned enterprises have developed 90% of China's wind farms and all of China's solar power plants (China Greentech Initiative, 2011, p. 76). This has come at the expense of foreign firms trying to break into China's expanding domestic solar PV and wind power market, who have complained that contracts are awarded with a clear preference for SOEs, regardless of expertise and experience (Bradsher, 2009). Local content rules have also provoked ire from international competitors. A 70% local content rule for all wind power developments in China was revoked after the US challenged China's use of wind subsidies in the World Trade Organisation (Office of the United States Trade Representative, 2011). However, by then the local content rule had already served its purpose. Previously, wind power developments in China had been dominated by foreign firms both in terms of establishing wind farms and purchasing wind power components. As a result of the local content rule, wind power developers in China were required to buy components domestically, transforming the sector into one that is now dominated by Chinese firms, largely self-reliant, and ultimately export-oriented (Gordon *et al.*, 2010, p. 29; China Greentech Initiative, 2011, pp. 75-76; Urban *et al.*, 2012, p. 113). Government financing has propelled China into a position of economic and technological leadership in wind and solar PV markets. Evidence from government documents suggests that this has been the result of a deliberate strategy to ensure that China seizes the growth opportunities in rapidly expanding low-carbon markets.

5. Conclusion

Ambitious energy reform and climate policies are transforming China's place in the global response to climate change. China is the world's largest GHG emitter and its emissions are still growing rapidly, but China is also taking significant action to mitigate climate change. From a detailed survey of key central government energy documents and the discourse of China's leading energy scholars, this paper has highlighted three important ideas that have influenced this important policy shift. First, domestic energy security concerns have risen on the central government agenda as a result of electricity shortages and rapidly rising energy consumption. Such concerns have deeply influenced China's ambitious and largely successful energy efficiency policies, which has also been the main source of China's avoided GHG emissions thus far. Second, growing awareness of the environmental constraints on economic growth in general, and the potential damages of dangerous climate change in particular, have prompted stronger official rhetoric in favour of green development. The appearance of targets and policies that specifically target carbon emissions reductions in the 12th FYP for the first time suggests that climate change mitigation is becoming a motivation for policy action in its own right, rather than simply a co-benefit of policies enacted for other purposes. Third, a conviction that the world is moving towards low-carbon energy forms has given rise to the belief that China must become a technological and economic leader in this transition. Large levels of public financing to support the development of China's wind power and solar PV sectors suggests that the Chinese government has strong vested interests in seeing China successfully compete and lead in global low-carbon energy markets. Acknowledging the influence of important new ideas such as these is vital in understanding why China's energy and climate policy has shifted so markedly since the 11th FYP.

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