Harvard-Tsinghua Workshop on Low-Carbon Development and Public Policy
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POST-WORKSHOP SUMMARY
BEIJING, CHINA | 2–3 JUNE 2016
The Environment and Natural Resources Program (ENRP)

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Preface

The Harvard-Tsinghua Workshop on Low-Carbon Development and Public Policy is the third annual joint workshop between the Harvard Kennedy School’s Environment and Natural Resources Program and the Sustainability Science Program and the Center for Science, Technology, and Education Policy at Tsinghua University. The workshop convened prominent members of the academic and policy communities from China and the United States at Tsinghua University in Beijing, China, on June 2-3, 2016. In addition to off-the-record discussion among the participants, the workshop also included keynote addresses attended by students and the media.

The three closed sessions were on: 1) Market Mechanisms to Reduce Carbon Emissions, 2) Role of Local Government in Low-Carbon Development, and 3) Energy Technology Innovation in the Transportation Sector. The discussion sessions followed Chatham House Rule: nothing discussed can be attributed to individuals or organizations. The report represents a synthesis of the main points and arguments that emerged from the discussion. It is not a consensus document, since no effort was made to arrive at a single view. Rather, the report reviews the major themes discussed and where there was significant disagreement, we attempted to present both sides of the argument. Any errors or misrepresentations are the authors’ responsibility.

Financial support for the workshop was provided by the Center for Science, Technology, and Education Policy at Tsinghua University, the Sustainability Science Program, and the Hui Fund for Generating Powerful Ideas at the Ash Center for Democratic Governance and Innovation at the Harvard Kennedy School.
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Linemen work on an electricity pylon near the smoking chimney of a heating plant in Beijing, 18 Nov. 2008. (AP Photo/Alexander F. Yuan)
Introduction

Two recent international events have shaped the direction of low carbon policy in both the United States and China. The first is Presidents Xi Jinping and Barack Obama’s joint statement setting targets for reducing carbon emissions in their respective countries and the second is the 2015 Paris Agreement. 176 United Nations member states and the European Union signed the Agreement on greenhouse gas emission mitigation, adaptation, and finance. Both China and the United States submitted ambitious Intended Nationally Determined Contributions (INDC) setting national targets. Now the task before each country is to reach those ambitious goals.

The United States intends to achieve an economy-wide target of reducing its greenhouse gas emissions by 26-28% below its 2005 level in 2025. The United States will double the pace of CO$_2$ emission reduction from the historic average rate of 1.2% per year between 2005 and 2020 to 2.3-2.8% per year between 2020 and 2025. China pledged to reduce CO$_2$ emissions per unit of GDP (carbon intensity) by 60-65% below 2005 levels by 2030; peak CO$_2$ emissions around 2030; and increase the share of non-fossil fuels in primary energy consumption to approximately 20%. The carbon intensity goal will require a 4% annual decrease in carbon emissions– a higher rate than the United States or Europe will need to meet their respective goals.

The workshop keynote addresses laid out the challenges and opportunities for the United States and China to meet its climate change mitigation commitments. Non-fossil fuel generated energy must reach 30% of the U.S. energy portfolio and this goal depends heavily on increasing nuclear and renewable energy capacity.

The core of China’s energy strategy is to develop a new energy system dominated by nuclear power, renewable energy, and energy efficiency investment. In both China and the United States, electrification of the transportation sector is an important component. China has promoted electric vehicles (EVs) as a national strategy to transform its transportation energy structure while fulfilling consumer desire to own cars. The
subsequent workshop sessions focused on the policy options to meet these climate mitigation and energy transformation goals.

**Session 1**  
**Market Mechanisms to Reduce Carbon Emissions**

Session 1 focused on the application of market mechanisms in reducing carbon emissions in China. In particular, the participants extensively discussed the potential and challenges of China’s national cap-and-trade program (or ETS: emission trading system), which is scheduled to launch in 2017. This program is projected to become the cornerstone of China’s national climate policy to achieve the main goal in its Intended Nationally Determined Contribution (INDC): lower CO₂ emissions intensity by 60-65% from the 2005 level.

Cap-and-trade programs are favored by policymakers and analysts worldwide as a meaningful approach to achieving emissions reduction goals. A cap-and-trade scheme has several advantages compared to other policy instruments. First, it caps the total emissions from the covered sources, and once determined, the total emission level is not affected by economic fluctuations, so the fulfillment of the mitigation objective can be guaranteed. Second, emission mitigation usually involves a large number of emitting sources with heterogeneous abatement costs, so it is very expensive to regulate these sources through command-and-control methods. A cap-and-trade scheme can achieve the mitigation goal cost-effectively by allowing facilities to trade emission allowances, so that emission reductions are undertaken at facilities with the lowest abatement costs. Third, a cap-and-trade program provides economic incentives for the innovation and diffusion of clean technologies, which will reduce abatement costs in the longer term. Fourth, a cap-and-trade program can address equity concerns without sacrificing the mitigation goal: emission allowances can be allocated strategically to reflect different impacts on economic production across regions or industrial sectors. And fifth, it
offers the ability to link with other cap-and-trade systems inter-regionally or internationally, and thus broadens collaborative mitigation efforts.

Despite all the above advantages, the participants recognized the complexities in the design and implementation of such programs, which are highly context-dependent. It is crucial to tailor a cap-and-trade program according to China’s specific socioeconomic and institutional conditions. Moreover, by learning lessons from existing programs, China has the opportunity to build a more successful national cap-and-trade program. Based on these understandings, the discussion in Session 1 was organized around three topics: the development of cap-and-trade programs in China, the debates on the key design features of the national cap-and-trade program, and the lessons learned from international experience.

1. The development of cap-and-trade programs in China

Addressing the challenges posed by climate change has become a national priority in China, exemplified by the 13th Five Year Plan, the highest-level national plan for social and economic development, which dedicated a whole chapter to climate change issues. In particular, China has favored cap-and-trade systems as one of the most important means to control GHG emissions. The transition from traditional command-and-control policies to a market-based approach is regarded as an example of China’s broader efforts in “deepening the comprehensive reforms.”

In 2011, China’s Twelfth Five-Year Plan (Chapter 21) stated that China should “actively cope with global climate change…and gradually establish carbon emissions trading.” In the same year, the National Development and Reform Commission (NDRC) approved seven carbon emission trading pilot programs in five cities (Beijing, Shanghai, Tianjin, Chongqing, Shenzhen) and two provinces (Guangdong and Hubei). The seven pilots cover a population of 260 million, energy consumption of 830 million tce (tonne coal equivalent), and GDP of 14 trillion Yuan RMB. In principle, the NDRC supervises the design and implementation of all the ETS pilots. In practice, the NDRC delegates the power to provincial and municipal
Development and Reform Commissions (DRCs) to make their own rules. Therefore, the pilot programs have different implementation plans, legislations, and government regulations. The key features of ETS, including cap-setting, coverage of industries, allocation of allowances, measurable, verifiable, and reportable (MRV) rules, and tradable products, all vary in different pilots. One of the distinctive features of the ETS pilots is that they cover both direct emissions, such as emissions from power plants, and indirect emissions, such as emissions embodied in the consumption of heat and electricity. This method causes double counting for some emission sources, but it is necessary at the current stage, because China’s electricity price is highly regulated. If a market reform is conducted in the power sector in the near future, the national program would no longer need to cover the indirect emissions.

The seven ETS pilots have achieved multiple policy goals since their establishment. They have covered major emission sectors and enterprises in the pilot regions, and have played important roles in reaching local carbon intensity targets and controlling GHG emissions. The operation of the programs has helped build technical foundations and institutional capacities, and also shaped the first carbon markets and revealed a price for carbon in China. The capacity of enterprises in emission reduction and the public awareness on climate change issues have been enhanced through these programs. There are, however, noticeable shortcomings with the pilot ETS programs. The disparities among the pilots in terms of registry and trading standards, MRV rules, and other aspects yield significant challenges for linkage and implementation of the future national program. The pilots also featured weak legal enforcement, lack of basic data and scientific methods, and lack of supervision on market operations. More importantly, the effectiveness of the programs was to a certain extent paralyzed by policy uncertainty and lack of transparency.

The seven pilot programs have accumulated rich empirical experience, both positive and negative, for the future national cap-and-trade program. By the time of the workshop, the design details of the national program were still unclear to the public. But according to available information, the participants presumed that the national program would have the following key features. First, the government is likely to take a top-down approach
to establishing the program, meaning that the central agencies will make unified rules for all provinces, instead of letting the provinces make their own rules like in the pilot programs. Second, the national program is likely to adopt a two-level management system, in which the central agencies, particularly NDRC, are responsible for designing the general rules for coverage, thresholds, trading rules, etc.; and provincial DRCs are responsible for the implementation of these rules. The provincial DRCs may be allowed to adopt stricter rules than the national policy, such as extending the scope of the program to cover more enterprises or industries, and using less free allocation. Third, the national program will adopt comprehensive compliance rules, including strict rules for MRV and financial penalties.

The participants identified the major challenges for the national program. First, establishing reliable and verifiable emission data at the facility level is one of the most significant challenges. Obtaining accurate and credible emission data is the prerequisite condition for allowance trading and establishing a cap, but the current foundation of data collection and processing is weak. Second, China will need to invest considerable financial and human resources in MRV capacity building, given the huge number of emission sources covered by the national program. Third, the administration of carbon markets is highly complicated, which poses challenges to the technical and institutional capacities of the relevant government agencies, particularly at the local level. Fourth, the legal basis for a national program is still quite weak, and there are no immediate plans to pass a law for carbon emission trading at the national level to strengthen the enforcement of the program. Finally, since the program will involve numerous government and market agencies at multi-levels, the coordination of different authorities and policies will be challenging.
2. The debates around a national cap-and-trade program

Most participants believe that market mechanisms have great potential in achieving China’s climate mitigation goals. However, considerable differences emerged among the participants regarding the proper design and implementation of the national cap-and-trade program.

Is China ready for the national cap-and-trade program?

A number of participants questioned if China can launch a fully functioning national cap-and-trade program next year, given the currently weak data and institutional foundations. The first concern is that the current emissions database is highly inaccurate, even at the national and provincial levels, and emissions trading requires reliable emissions data at the facility level. The current technical and institutional gaps in measuring, reporting, and verifying data are large. Second, some participants pointed out that China’s economy is still in the process of transitioning from a central planning system to a market economy. Many features of a planned economy still remain. For example, the electricity sector is heavily regulated by the government. When the market mechanisms are paralyzed, the effectiveness of the cap-and-trade system cannot be guaranteed. And third, the legal basis of the cap-and-trade system is lacking. CO₂ is not categorized as a type of pollutant under China’s current law, and China has no plans to pass a national law on carbon emissions control in the near future. Most of the current carbon related policies are based on documents issued by government agencies, such as the NDRC. This would pose a potential threat to the enforcement of the cap-and-trade system.

Some participants were relatively optimistic about China’s national program. They asserted that China is ready for the program, because China has planned for emissions trading for several years, has rich experience in the pilot programs, and has also learned valuable lessons from similar programs in the United States and Europe. Moreover, they argued that markets are always imperfect, and indeed many conditions will never be ready until the cap-and-trade program is put into operation. The risks of
implementing the program will be under control, and actually the biggest risk is not moving forward. Most importantly, since China has already decided to build the national program, the focus should be on the design and implementation of the program, rather than whether to launch the program or not.

**Should China take a top-down or bottom-up approach?**

The second issue debated among the participants concerns whether China’s national cap-and-trade program should take a top-down approach, meaning that the central government makes unified rules for all provinces, or a bottom-up approach, which allows the provinces to design their own rules, like in the pilot programs. Advocates of the top-down approach argued that the disparities among the pilot programs in registry, trading rules, and MRV have posed significant challenges for linkage and implementation of the national program. So the national program should adopt more unified rules to ensure the allowances can be traded freely across the country, and the economic efficiency of the program can be maximized.

Participants who support the bottom-up approach argued that China has highly heterogeneous social and economic development across regions. While the coastal provinces are facing the pressure of excess production capacity, the inland provinces are still in the process of rapid industrialization and urbanization. Therefore, China’s cap-and-trade system should adopt differentiated policies in different provinces in order to reflect the regional disparities. Moreover, the bottom-up approach emphasizes capacity building at the provincial level, which is critical for the successful implementation of the program.

**Should carbon tax be considered as a complementary policy?**

Some participants pointed out that the central government has never officially ruled out the possibility of a carbon tax and put forward the question, is it possible that both a cap-and-trade and carbon tax program be implemented? The national cap-and-trade program would only cover
approximately 40% of China’s CO₂ emissions. Furthermore, the program covers only the large emission sources, which are relatively energy efficient. But it is the numerous small, unregulated, and energy inefficient emission sources that represent the biggest challenge for China’s emissions reduction goals. Also, the transportation sector is not covered by the cap-and-trade program, and emissions from transportation are expected to grow rapidly. Therefore, a carbon tax imposed on small enterprises and the sectors not covered by the cap-and-trade program would make a significant contribution to China’s emissions mitigation. But other participants argued that applying the cap-and-trade and carbon tax in different situations would cause heterogeneous marginal abatement costs across sectors, which is not economically efficient. A more efficient way to combine cap-and-trade and carbon tax would be adopting an upstream cap-and-trade program, with a price collar to reduce price volatility and uncertainty. An upstream system would have economy-wide coverage, and would be more effective than the downstream system with limited scope. However, in many cases the upstream system is perceived as an energy tax, which may be politically infeasible.

3. Lessons learned from international experience

Even though cap-and-trade is a relatively new concept for China, it has been widely studied and implemented in other countries for more than three decades. China has the advantage of learning from the experience of existing cap-and-trade systems in order to avoid the major pitfalls encountered by other programs and adopt the strategies that proved to be most effective. In particular, the participants discussed lessons from two cap-and-trade programs in the United States, namely the Regional Greenhouse Gas Initiative (RGGI) and California’s cap-and-trade program.

RGGI was established in nine states in the Northeastern United States in 2009 to address CO₂ emissions from electricity generation. The goal of the program is to cap emissions from covered sources to 91 million short tons in 2014, and the cap decreases by 2.5% annually from 2015 to 2019. Since RGGI is a downstream program with limited geographic scope, it
initially distributed allowances to the enterprises generously, in the hope of
avoiding leakage. But due to over-allocation and changing socioeconomic
contexts, it was barely binding in the first several years and had little direct
emissions impact, even though the auctions raised a substantial amount
of revenue for the participating states. There are two major lessons from
the RGGI case. First, the changing economic conditions can render a cap
non-binding or too strict, so the adoption of a price ceiling and a price
floor (together called a price collar) is important. The price collar can limit
the range of price fluctuation and give the businesses more confidence
in holding allowances, thus enhancing the effectiveness of the program.
Second, the best way to address leakage is to have broader collaboration
to expand the scope of the program. RGGI tried to avoid leakage through
setting a modest target, but that also undermines the effectiveness of the
program in emissions reduction.

California’s cap-and-trade system is a component of the Global Warming
Solutions Act, or Assembly Bill (AB) 32, which was passed by the state in
2006. AB 32 sets the goal to cut the state’s GHG emissions to the 1990 level
by the year 2020. Besides the cap-and-trade system, AB 32 also includes a
set of other components, including energy efficiency standards, renewable
portfolio standards, and low carbon fuel standards. The cap-and-trade
system was launched in 2013, and currently covers approximately 85%
of the state’s total GHG emissions. Three important lessons can be drawn
from the California case. First, complementary policies can be counterpro-
ductive. It is recognized that some complementary policies are beneficial in
addressing other market failures, such as in the well-known principal-agent
problem with energy efficiency investments in renter-occupied residences.
But some complementary policies can conflict rather than be complemen-
tary, such as the low carbon fuel standards in the California case. Some
participants argued that low carbon fuel standards cause 100% leakage
and can achieve no additional emission reduction. Furthermore, it ren-
ders unequal marginal abatement costs, increases the aggregate abatement
costs, and suppresses the allowance price. The second lesson is that the
California case proved that an economy-wide cap-and-trade system is fea-
sible, and is much more effective than a system with more limited coverage.
And third, free allocation can help gather political support, but free alloca-
tion per se does not address leakage or competitiveness issues, because it is
infra-marginal (inside of, rather than at the margin). Ultimately, the only way to address leakage and competitiveness issues is through broader collaborative actions across regions and countries.

Session 2
Role of Local Government in Low-Carbon Development

Local governments can play a critical role in achieving a sustainable low carbon economy since national, and even global, polices will be implemented at the local level. Local governments tend to be more knowledgeable about their needs, and are best positioned to shape programs and policies to leverage local institutions and stakeholders. The 2015 Paris Agreement recognizes the significance of subnational level actors in dealing with global climate change. Session 2 explored the role of local government in low-carbon development as well as the problems and challenges local jurisdictions face in China and the United States. Pilot cases were presented to show that local governments in China can take the lead on meeting low-carbon development goals, but complaints about lack of data and legislative support still exist.

1. Testing new policies and technologies

In the “bottom-up” framework of United States, the federal government is mainly responsible for pledging, reviewing, and revising policy while state governments act as experimental zones for policy innovation, since state governments have greater autonomy and flexibility under the federal system. In spite of the strong authority of central government in China, provinces and cities are given the right to explore approaches to low-carbon development that meet their actual conditions and needs. In addition to implementing policies and laws, local governments play a crucial role in experimenting with emerging technologies, such as alternative fuel
vehicle fleets and micro-grids. Both the testing of polices and piloting of technologies improve knowledge about the efficacy of policies and encourage further technology diffusion, potentially across the country. Session 2’s presentations focused on the successful implementation of low-carbon development policy at the local level.

In Xiamen, a coastal city in southeastern China, policies focused on optimizing intra- and inter-city planning resulted in real energy-saving and carbon-reduction. The local government designed and built 15-minute walkable zones consisting of government offices, financial services, entertainment areas, and other public facilities. This design reduced transportation costs and increased the time available for local enterprises to conduct business. Natural landscapes, such as creeks, are treated and restored ecosystems are used as a productive force to boost the local economy. Newly developed technologies have been applied to transform and upgrade industries as well as reduce energy consumption and carbon emissions. For example, an exclusively electric-powered port compared to a conventionally-powered port can reduce carbon emissions by more than 20% while reducing costs by a similar percentage. The Xiamen example shows local governments can incorporate low carbon technologies into their efforts to spur local development initiatives, ranging from new neighborhoods to new enterprises.

In the United States, innovative state policies have also provided an effective model for actions by other states and the federal government. For example, California is allowed under the federal Clean Air Act to adopt its own vehicle emissions standards that are more stringent than the federal standard, which it did in 2004. California’s leadership and ambition on regulating GHG emissions from automobiles led to a tightening of nationwide fuel economy standards in 2009. In addition, California has implemented a Zero Emissions Vehicle standard where automakers are required to sell non-emitting vehicles within the state. Nine states have joined California in enacting that standard, and in 2013, the governors of California and seven of these states agreed to work together to put 3.3 million zero-emission vehicles on the road by 2025.
2. Understanding the drivers of local level efforts in China and the United States

The transition to a low-carbon economy is difficult and may sometimes harm local economic development. Therefore the drivers of local-level efforts are worth further observation, especially in developing countries like China. Directives from the central government are the principal reason that local governments are pursuing low-carbon initiatives. Targets for low-carbon development are put forward in the guiding principles in national-level plans stimulating several provinces and cities to amend their attitudes toward the goals of local economic growth. Participants pointed out that increased pressure and growing expectation from the public can influence local governments.

Addressing climate change is treated as a necessity as well as opportunity by local governments. Participants held up examples in both China and the United States of the way local governments lead in developing a sustainable and green economy. In some cases, the motivation is not to fulfill the central government’s target, but to restore or conserve the beauty of the local environment. A Chinese pilot program, the Chang-zhu-tan City Cluster, was launched to construct a two-oriented society (resource-conserving and environment-friendly), which has transformed a heavily polluted region into a model for low-carbon development.

Another example is Xiamen, where local governments follow the three steps of planning, technology, and public participation to achieve local low-carbon development. Several co-benefits have been achieved in the form of an improved ecosystem and an enhanced economy. Public participation is also viewed as an important element in achieving low-carbon development, and in Xiamen, modest government subsidies are leveraged by voluntary public participation to transform rural regions into an organic element of the city. Several participants called for more research on the significance of public participation in curbing carbon emissions.
3. Local policy initiatives

Government intervention primarily relies on influencing markets in the United States, including standard setting, subsidies, and regulation. However, in China, regulatory interventions such as closing down outdated production facilities, especially those which are highly polluting and high energy-consuming, are favored by local governments. The session examined the effectiveness of these different policy instruments.

In the United States, state action can play an important complementary role in meeting climate challenges while providing co-benefits. Efforts in low-carbon development allows states to inform the federal government planners and policy makers and improve final federal regulations. In the United States, the federal government often sets the “floor” for environmental policies, while the states are allowed to go beyond that floor. On climate change, in particular, federal standards have yet to take force, but a number of states have acted independently. Renewable energy, for example, has been driven in large part by the widespread adoption of state Renewable Portfolio Standards (RPS) and other renewable subsidy policies. Recently, several states have set ambitious long- and medium-term renewable energy targets. California set a RPS of 50% by 2030 through legislation (SB 350) in October 2015; Oregon established a 50% RPS for 2040 and required coal phase-out for two investor owned utilities; Vermont set a 75% RPS for 2032 in 2015 legislation (Act 56) as part of broader utility modernization program; Hawaii became the first state to set a 100% RPS target for 2045. In addition, states have widely implemented energy efficiency programs that reduce energy use and established mid-term emissions reduction goals.

At the same time, China’s central and local governments have rolled out many systematic arrangements and policies on low-carbon development at local level. Of more than 5,000 central government low-carbon policies, more than 500 stem from the Ministry of Agriculture, on rural energy in particular. Central government concerns have gradually shifted to renewable energy, such as wind and geothermal energy, and returning farmland to forestry and pasture, and rural low-carbon and green development demonstration areas. Local policies are inconsistent across provinces;
developed provinces have more low-carbon policies. Guangdong has the largest number of policies followed by Jiangsu and Shanghai. Provinces characterized by traditional agricultural have released more rural energy-related policies and some local governments have issued fewer guidelines as a selective response to central government policies.

4. Preparation for a large-scale operation of nation-wide carbon market

Participants pointed out that China must address several challenges before it can achieve the goal of a national carbon market. First, the data issue. That is, whether there is sufficient statistical data to support the trading decisions in the carbon market. Another essential issue is the institutional infrastructure for the market, both at the central and local level. Although a large number of laws and policies are now under trial implementation in pilot cities, their effectiveness across the whole country will need further examination. These are keys to the success of the operation of the carbon market in China.

Participants pointed to two examples of regional carbon markets in the United States. Nine states in the northeast and mid-Atlantic region currently participate in the Regional Greenhouse Gas Initiative (RGGI), which is a CO$_2$ cap-and-trade program for the power sector. RGGI uses a significant portion of the proceeds from auctioning allowances for public benefit programs like weatherization and assistance with energy bills. California has implemented an economy-wide cap-and-trade program that includes the power sector and transportation fuels. The program compliance requirement began in 2013 for the power sector; in 2014, California linked its cap-and-trade program with the Canadian province of Quebec through the Western Climate Initiative; and in 2015 the program expanded to include transportation fuels as planned. The program cap will result in approximately a 3% annual reduction from 2015 to 2020. At the same time, the program is showing that emission reductions can occur along with economic growth. Regional programs such as RGGI and the California cap-and-trade program served as models for one potential flexible compliance pathway under Clean Power Plan, which regulates carbon dioxide from existing power plants nationally. State and local leaders at COP 21
served as points of contact for U.S. State Department and governors and mayors convened to share efforts and promote international cooperation on carbon markets.

5. Bridging the gap between national and local level government

Much of Session 2’s discussion focused on low-carbon policy implementation. National, and most likely global, policies will be implemented on the ground in specific localities. Chinese participants spoke highly of the local government’s role in carbon emission reduction while pointing out the divergence of effect and focus across regions, due to the vast regional and economic development differences in China.

As was discussed in Session 1, the central agency, NDRC, is responsible for designing low-carbon policy and setting rules, and the provincial and municipal Development and Reform Commissions (DRCs) are responsible for the implementation of the policies. Participants pointed out that climate change departments in China’s DRCs play a dual role as macro-economic regulators and implementing agents. They serve as a connector between the central government and local regions. However, there are two points of confusion on the provincial level. One is lack of effective systematic financial, technical, and political support from the central government. For example, in terms of a carbon market, participants argued that legislation should be developed ahead of practice; however, the opposite is occurring. And in most cases, there is no operational process and support, such as for statistical data gathering. Provincial governments lack enforcement capacity and do not have the legal standing to impel the government to provide data. The other challenge is the large gap between national and local levels on communicating the importance of climate change mitigation. Climate change mitigation has been a hot topic at the national level, but the concept has yet to penetrate into some local governments. Low-carbon development has been included as one important index for promotion. At the same time, several other mechanisms are being implemented to enact promised climate policies and targets.
Session 3
Energy Technology Innovation in the Transportation Sector

Session 3 focused on the questions around how to promote technology innovation in China’s transportation sector, with a specific emphasis on alternative fuel vehicles. The majority of the discussion centered on electric vehicles (EVs).

Starting with the 11th five-year plan, China has aggressively designed policies to develop and deploy EVs. Both the 11th and 12th five year plans established pilots where significant subsidies to promote EVs were made available to both consumers and producers. There is a concern about heavy dependence on government subsidies; the Chinese automobile market has been policy-driven, not consumer or technology-driven. EV policy has transitioned from pure financial subsidies to a comprehensive policy toolkit, including tax rebates, financial support for charging infrastructure, and other policies encouraging purchase and usage of EVs.

The success of these efforts is mixed. On the one hand, China has the largest EV fleet in the world and is number one in annual passenger EV sales and production, surpassing the United States in 2015. On the other hand, China did not come close to meeting the targets set forth by the government.

1. Why should China pursue electric vehicles?

One participant posed the question – why should China pursue electric vehicles? While there was no consensus as to the answer, most participants raised two principle reasons: 1) to stimulate technological innovation, and 2) to improve the environment and meet China’s low-carbon development goals.
Technology advancement

The strongest advocate of electric vehicles in China has been the Ministry of Science and Technology (MOST). Initially electric cars were seen as a way to leapfrog existing automobile technologies and allow China to become a major global producer in what was seen as a new growth industry. As one participant pointed out, the Chinese automobile manufacturing sector was too fragmented to take on the role of EV technology leader. Another participant noted that low oil prices have reduced the market for EVs.

Further EV development will stimulate technology innovation in several other technologies along the value chain—including battery technology and autonomous vehicles. China has made significant investment in battery technology and is beginning to look at the development of driverless vehicles and a shared vehicle transportation structure.

Some participants were concerned about the negative consequences of local government policies. There are about 70 companies in China producing EVs, compared with only a few in Western countries. Another participant explained the reason behind this fragmentation. In China, local government varies in terms of GDP targets, financial ability, resources, and political will, but many wish to support their own local EV companies, even as they set up roadblocks for non-local EV companies. Protectionism inhibits a national EV market and further fragments the EV market.

Environmental benefits

On the question of whether or not electric vehicles actually reduce carbon emissions and conventional pollutants, there was less consensus. Several participants commented that as long as coal plants generate most of China’s electricity, significant penetration of EVs is not likely to improve public health or even reduce carbon emissions. Others argued that China’s energy mix is moving toward greater non-fossil fuel capacity, including increased use of renewables, nuclear, and hydro-electric facilities. Furthermore, new coals plants are being built farther from cities and are much more efficient than the older plants that are being shut down. As China’s electric
generating capacity changes, the environmental benefits of EVs or other non-fossil fueled vehicles will improve. Finally, one participant pointed out that it was much more difficult to reduce emissions from mobile sources than their stationary counterparts, thus moving to greater reliance on EVs would provide greater benefits over time if the electricity comes from low-carbon sources.

Despite the above disagreements, most participants seem to be optimistic about the future of EVs. If EV deployment is accompanied by smart grid technology and renewable energy, EVs can introduce more environmental benefits. EVs that charge at off-peak time and discharge at peak-time can smooth diurnal cycles of electricity consumption, require fewer fossil-fuel peaking facilities, further reducing carbon emissions.

The discussion about whether EVs can reduce carbon emissions was challenged by one participant who reminded everyone that the global climate system cares about cumulative emissions (the total amount of carbon dioxide in the atmosphere) not just annual emissions. Unless we achieve zero carbon emissions, promoting EV does not help to address the climate problem.

2. Barriers to wide adoption of EVs

If governments decide to push for greater use of EVs – what are the principal challenges and what are the policies that will allow governments to overcome those challenges? Participants mentioned a number of barriers, including range, battery technology, low petroleum prices, and consumer preferences. They supplemented this list with four additional challenges: building human capital, overcoming fragmented domestic markets for cars and light vehicles, changing the consumer behavior, and developing a Chinese solution to the charging infrastructure issue.

One participant pointed out that 80% of Tesla’s engineers have degrees in computer science and engineering with a strong background in IT, while 80% of the engineers in Chinese automobile companies are mechanical engineers with almost no background in IT. The engineering schools at the
university level need to adjust to this new demand by producing engineers with inter-disciplinary expertise. This will mean broadening and expanding existing university engineering departments beyond their narrow disciplines.

Another participant disagreed, arguing that China would never catch up if it tried to completely overhaul its engineering structure. It would be better served by adopting the same outsourcing strategies embraced by Apple. Most of the parts are outsourced, while headquarters is only responsible for design and R&D.

Local governments promote their own state companies for job creation, revenues, and prestige. To protect these companies, they often engage in protectionism, restricting the sale of vehicles manufactured elsewhere in China. The lack of scale and the lack of the development of an inter-provincial market are major barriers to an effective EV industry. Chinese officials recognize these problems and are working to change the structure of the industry.

Several participants argued that in addition to advancing the technologies, China needs to change the way consumers think about vehicles and particularly electric vehicles. They pointed out that the younger generations purchase iPhones even though they are more expensive than other cellphone models with similar functions. Owning an iPhone is considered “cool”. Would it be possible to convince citizens that owning smaller electric vehicles is cool or fashionable? In other words, can government provide marketing support for efforts to change consumer behavior?

In the United States, most people live in suburban areas with homes that include attached garages so installing charging equipment in each home is relatively inexpensive. The situation in China is quite different. Most people live in cities and do not have personal garages. Both their homes and their jobs are located within the city. Hence designing effective charging infrastructure in China will not resemble what is installed in the United States.
The discussion about the structural transportation differences in China and United States led to questions about China’s EV path dependence. In the United States, EVs are similar in size and performance to the gasoline-powered vehicles that people already own and use. There is an open question as to whether China will choose a Western-like path of car ownership, or go down a different path by adopting a range of specialized vehicles such as low-speed EVs, light-duty EVs, three-wheeled EVs, and E-bikes. Many American cities are automobile-centric and a personal conventional car is necessary; while Chinese urbanization and Chinese cities are quite different and could accommodate different vehicle types and ownership models (car sharing, driverless vehicles, etc.). This major difference is worth considering when making EV policy. There are benefits and concerns to the adoption of non-mainstream EVs. They are inexpensive and are making inroads without subsidies (half of China’s EV fleet are low-speed EVs). And participants were sure to point out a major concern – safety, both passenger and pedestrian.

3. Subsidies

While time did not allow for an extensive discussion about the ideal policies to promote EVs, there was a debate on the role of subsidies. Several participants made the argument that subsidies are needed to stimulate the market in the short run and should give way to tax adjustments. Governments simply cannot afford to subsidize EVs at the present rate if the market matures. Others pointed out that subsidies can distort the technology innovation process by trying to pick winning technologies, when often the best technologies can evolve outside the subsidy regime. Government’s ability to prejudge the innovation process is replete with failures.

Some participants went one step further and discussed alternative policy options for supporting EVs. Carbon trading, such as California’s zero-emission credit system, and other non-monetary tools have performed better than subsidies according to most empirical evidence. Some participants envisioned a comprehensive EV policy with subsidies for short-term stimulus; tax adjustment in the medium-term; and long-term climate policy, such as carbon tax, to promote higher EV penetration. However, not all
participants were optimistic about the carbon tax. One participant argued that the carbon tax may be a possible option, but consumers do not receive signals about externalities; and most importantly, policy-makers usually lack the political will to enforce a carbon tax.

These statements are not meant to criticize subsidies, but demonstrate that governments should be careful in how these subsidies are designed and implemented.

In summary, participants were optimistic that if EVs were to gain a measurable share of the motor vehicle fleet anywhere, it would happen in China. However, if China is to realize this potential, it must address the industrial structure of its automobile manufacturing industry, improve and enhance its technology innovation process, broaden the portfolio of alternative fuel vehicles, and reduce emissions from its power sector.
Appendix A
Acronyms and Abbreviations

DRC: Development and Reform Commission(s)
EV: electric vehicle
ETS: emission trading system
GHG: greenhouse gas
INDC: Intended Nationally Determined Contribution
MOST: Ministry of Science and Technology
MRV: measurable, verifiable, and reportable (rules)
NDRC: National Development and Reform Commission
RGGI: Regional Greenhouse Gas Initiative
RPS: renewable portfolio standard
# Appendix B

## Agenda

### June 1

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
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<tbody>
<tr>
<td>10:00-18:00</td>
<td>Registration</td>
<td>Lobby, Wenjin Hotel</td>
</tr>
<tr>
<td>18:00-20:00</td>
<td>Welcome Reception</td>
<td>Salon Bar, Wenjin Hotel</td>
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</tbody>
</table>

### June 2

**Open Session 1: Welcome Speeches**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
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<tbody>
<tr>
<td>9:00-9:40</td>
<td>Moderator: Jun Su; Speakers: Zongkai Shi, Venkatesh Narayanamurti, Ganjie Li, Meng Li, Minghong He</td>
<td>Reception Hall, Tsinghua Main Building</td>
</tr>
<tr>
<td>9:40-10:00</td>
<td>Break (Photography for guests)</td>
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**Open Session 2: Keynote Speeches**

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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>10:00-11:30</td>
<td>Moderator: Henry Lee; Speakers: Jiankun He, Daniel Schrag, Qingtai Chen</td>
<td>Reception Hall, Tsinghua Main Building</td>
</tr>
<tr>
<td>11:30-11:50</td>
<td>Q&amp;A by Media and Audience</td>
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<tr>
<td>12:00-13:40</td>
<td>Buffet</td>
<td>Yiduo Café, Wenjin Hotel</td>
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**Session 1: Market Mechanisms to Reduce Carbon Emissions**

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>14:00-16:00</td>
<td>Moderator: Henry Lee; Speaker: Maosheng Duan; Respondent: Zheng Li, Dongsheng Wu</td>
<td>Reception Hall, Tsinghua Main Building</td>
</tr>
<tr>
<td>16:00-16:15</td>
<td>Tea Break</td>
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### Session 2: Role of Local Governments in Low-carbon Development

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>16:15-18:15</td>
<td>Moderator: Qiang Yao</td>
<td>Professor, Department of Thermal Engineering, Tsinghua University</td>
</tr>
<tr>
<td></td>
<td>Speaker: Xiaohong Chen</td>
<td>Professor and President, Hunan University of Commerce</td>
</tr>
<tr>
<td></td>
<td>Speaker: Vicki Arroyo</td>
<td>Professor, Executive Director of the Georgetown Climate Center at Georgetown Law</td>
</tr>
<tr>
<td></td>
<td>Speaker: Qian Meng</td>
<td>Chief Executive of Haicang District, Xiameng City; Director, Development and Reform Commission of Xiameng</td>
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<tr>
<td></td>
<td>Respondent: Cui Huang</td>
<td>Associate Professor, School of Public Policy and Management, Tsinghua University</td>
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<tr>
<td></td>
<td>Free Discussion</td>
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### June 3

#### Session 3: Energy Technology Innovation in the Transportation Sector

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<tr>
<td>9:00-11:20</td>
<td>Moderator: Venky Narayanamurti</td>
<td>Professor, Harvard Kennedy School</td>
</tr>
<tr>
<td></td>
<td>Speaker: Minggao Ouyang</td>
<td>Professor, Department of Automobile Engineering, Tsinghua University; Deputy Director, China EV100</td>
</tr>
<tr>
<td></td>
<td>Speaker: Deron Lovaas</td>
<td>Senior Policy Advisor, Natural Resources Defense Council</td>
</tr>
<tr>
<td></td>
<td>Speaker: Yanan Zuo</td>
<td>Former Chairman of the Board, Jianghuai Automobile Co., Ltd.</td>
</tr>
<tr>
<td></td>
<td>Respondent: Henry Lee</td>
<td>Senior Lecturer, Harvard Kennedy School</td>
</tr>
<tr>
<td></td>
<td>Respondent: Yongwei Zhang</td>
<td>Research Fellow, Development Research Center of the State Council; Chief Expert of China EV100</td>
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<tr>
<td></td>
<td>Free Discussion</td>
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#### June 3

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<td>11:20-11:30</td>
<td>Tea Break</td>
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#### Closing Session

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<tr>
<td>11:30-12:00</td>
<td>Moderator: Jun Su</td>
<td>Professor, School of Public Policy and Management, Tsinghua University</td>
</tr>
<tr>
<td></td>
<td>Moderator: Henry Lee</td>
<td>Senior Lecturer, Harvard Kennedy School</td>
</tr>
<tr>
<td></td>
<td>Closing remarks: Jiankun He</td>
<td>Vice Chairman of Advisory Committee of Climate Change in China, Former Executive Vice President of Tsinghua University</td>
</tr>
<tr>
<td></td>
<td>Closing remarks: Daniel Schrag</td>
<td>Professor, Harvard Kennedy School</td>
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### June 3

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<tbody>
<tr>
<td>12:15-13:30</td>
<td>Lunch</td>
<td>Yiduo Café, Wenjin Hotel</td>
</tr>
<tr>
<td>13:50</td>
<td>Tour</td>
<td>Meeting at the gate of Wenjin Hotel</td>
</tr>
</tbody>
</table>
Appendix C
List of Participants

Vicki Arroyo, Professor, Executive Director of the Georgetown Climate Center, Georgetown Law School

Maosheng Duan, Professor; Director, China Carbon Market Center, Tsinghua University; Chairman, CDM Executive Board of the United Nations

Changbo Bai, Vice President, BP China

Shiji Gao, Research Fellow and Director General, Institute for Resources and Environmental Policy Studies, Development Research Center of the State Council

Cong Cao, Professor, School of Contemporary Chinese Studies, University of Nottingham

Shulin Gu, Research Professor, Institute of Policy and Management, Chinese Academy of Sciences

Jia Chen, Lecturer, School of Humanities and Social Sciences, Beijing Forestry University

Zhiyong Han, Deputy Director, Office of the National Natural Science Foundation of China

Qingtai Chen, Former Deputy Director, Development Research Center of the State Council; Chairman, China EV100

Jiankun He, Professor, Director of the Institute of Low Carbon Economy, Tsinghua University; Deputy Director, National Committee of Experts on Climate Change

Xiaohong Chen, Professor and President, Hunan University of Commerce

Min Hu, Program Director, Low-Carbon Development Program, Energy Foundation China

Yantai Chen, Professor, School of Politics and Public Administration, Zhejiang University of Technology
Cui Huang, Associate Professor, School of Public Policy and Management at Tsinghua University

Henry Lee, Senior Lecturer; Director, Environment and Natural Resources Program, Harvard Kennedy School

Xing Li, Director of Carbon Emission Trading, BP Energy Asia Pte Ltd.

Huajing Li, Associate Professor, School of Economics and Management, Beijing Forestry University

Zheng Li, Professor and Dean, Department of Thermal Engineering, Tsinghua University

Zhen Lin, Professor and Vice Dean, School of Humanities and Social Sciences, Beijing Forestry University

Hengwei Liu, Executive VP for Strategy, ENGIE China

Lanjian Liu, Professor and Vice Dean, School of Politics and Administration, Chang’an University

Li Liu, Professor, School of Social Sciences, Tsinghua University

Yingqi Liu, Professor, Business School of Economics and Management, Beijing Jiaotong University

Yun Liu, Professor, School of Management and Economics, Beijing Institute of Technology

Zheng Liu, Professor, School of Finance and Economics, Yunnan University of Finance and Economics

Deron Lovaas, Senior Policy Advisor, Natural Resources Defense Council

Xi Lu, Associate Professor, School of Environment, Tsinghua University

Qian Meng, Chief Executive of Haicang District, Xiameng City

Jianing Mi, Professor, School of Management, Harbin Institute of Technology

Venkatesh Narayanamurti, Professor of Technology and Public Policy; Professor of Physics, Harvard University
Xunmin Ou, Associate Professor, Institute of Energy, Environment and Economy, Tsinghua University

Minggao Ouyang, Professor, Department of Automotive Engineering, Tsinghua University; Executive Vice Chairman, China EV100

Baozhi Qu, Associate Dean, Institute of Science, Technology & Innovation, China Merchants Group

Daniel Schrag, Professor, Harvard University; Director of Science, Technology, and Public Policy Program, Harvard Kennedy School

Robert Stavins, Professor; Director, Harvard Project on Climate Agreements, Harvard Kennedy School

Jun Su, Chang Jiang Scholar Distinguished Professor, School of Public Policy and Management, Tsinghua University; Director, Center of Think-Tank Management, Tsinghua University

Li Tang, Professor, School of International Relations and Public Affairs, Fudan University

Renhu Tang, General Manager, SinoCarbon Innovation & Investment Co., Ltd.

Chengchuan Tian, Division Director of Strategic Research and Planning, Department of Climate Change, National Development and Reform Commission

Hongbing Wang, Director, Science and Technology Bureau at the Jianggan District, Hangzhou City

Qunwei Wang, Professor, College of Economics and Management, Nanjing University of Aeronautics and Astronautics

Yi Wang, Professor and Director, Research Institute of Science and Technology Policy and Management, Chinese Academy of Sciences

Jianan Wu, Professor and Executive Vice Dean, School of International and Public Affairs, Shanghai Jiaotong University
**Dongsheng Wu**, Senior Economist and Director, Department of Climate Change, Shanxi Provincial Development and Reform Commission

**Peng Zhou**, Professor and Vice Dean, College of Economics and Management, Nanjing University of Aeronautics and Astronautics

**Xianliang Xiong**, General Manager, Strategy and Research Department, China Merchants Group

**Junming Zhu**, Assistant Professor, School of Public Policy and Management, Tsinghua University

**Xiu Yang**, Research Fellow, National Center for Climate Change Strategy and International Cooperation

**Yanan Zuo**, Former Chairman, Anhui Changjiang Automotive Group Co., Ltd.

**Qiang Yao**, Professor, Department of Thermal Engineering, Tsinghua University

**Juan Zhang**, Deputy Director, Research and Consulting Department, China EV100

**Yongwei Zhang**, Research Fellow, Development Research Center of the State Council, China; Chief Expert, China EV100