Strategic Policies and Demonstration Program of Electric Vehicle in China

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Abstract

Recent Chinese economic and energy policies recognize the transportation sector as a key element in the nation's effort to meet its energy and air quality goals. The development of alternative fuel vehicle (AFV) has been considered as a particularly promising strategy. AFV-related policies can be traced back to the Eighth Five-Year Plan Period (i.e., 1991-1995). All the work during the last twenty years has cumulatively prompted the transition of AFV development from policy-making to actual implementation and from research and development (R&D) to mass production. The year of 2009 is significant for the AFV industry in China in that the central government announced the "Plan on Shaping and Revitalizing the Auto Industry". This Plan launched a demonstration program of electric vehicle (EV) deployment in 13 Chinese cities and set the national goal of manufacturing 0.5 million AFVs in three years. To better understand the current status, problems and uncertainties existed in the EV deployment in China, this paper reviewed the relevant policies and reported a survey with the pilot cities during the summer of 2009. Based on the survey findings, this paper developed a number of recommendations to help address the issues found in the demonstration program to date.

Keywords: Electric Vehicle; Economic Policy; Auto Industry; China

1 Introduction

The necessity and importance of working towards a sustainable energy and environmental future is well recognized in China. In the "Eleventh Five-Year Plan (2006-2010) Compendium for the National Economic and Social Development of China", the Chinese government set the target of reducing energy use per gross domestic product (GDP) by 20% and the gross pollution level by 10% within the five-year period (Xinhuanet, 2006). The State Council, which is the chief administrative authority of China, further announced a "Decision to Enforce Energy-Conservation" in 2006 and a "Comprehensive Work Program on Energy-Conservation and Pollution Reduction" in 2007 (State Council, 2006; State Council, 2007). These policy programs identified the transportation sector as a key element in the nation's effort to meet the energy and air quality goals and highlighted transportation strategies such as developing public transit with priority, strictly enforcing the vehicle emission standard, and promoting the development and manufacturing of AFV. The abovementioned policies go hand-in-hand with recent strategies for the auto industry. Specifically, the 2004 "Development Policies for the Auto Industry" issued by the National Development and Reform Commission (NDRC) identified the development of environmentally friendly cars, including EVs and diesel cars, as a key direction for the auto industry (NDRC, 2004). The same document also stated the Chinese government's support for the R&D and manufacturing of AFV.

Of the various AFV technologies, EV has gained the most attention lately. At the beginning of 2009, the Chinese government launched a demonstration program of EV deployment into 13 Chinese cities, together with a "Plan on Shaping and Revitalizing the Auto Industry" (hereafter refer to as "Revitalization Plan") that aims at the development of the AFV industry (Ministry of Finance and Ministry of Science and Technology, 2009; General Office of the State Council, 2009). Although the Chinese government has continued to invest in the AFV industry over the last two decades, this demonstration program is distinctive in that it marks the beginning of official support for the mass deployment of AFV with substantial governmental financial subsidies.

The demonstration program has attracted attention from the World Bank (WB), which has an active program in the urban transport sector in China and provides a combination of investment, land, policy and technical supports for the Chinese government. The WB recognizes the deployment of EV as an important element of the emerging landscape of the transportation system in China. It wants to be informed of the current deployment practice of EV and to identify areas in which it could possibly support in the future. Therefore, in the late summer of 2009, the WB sponsored a survey of the 13 cities participating in the demonstration program to better understand their respective program scope and content, goals and objectives, deployment strategies, financial plan, monitoring and evaluation strategies, challenges encountered and risks perceived, and communication with fellow pilot cities.

This paper reports the background, design and findings of this WB sponsored survey. The remainder of the paper is organized as follows. Section 2 reviews the key transportation and EV policies made in the last two decades leading up to the demonstration program. Section 3 describes the demonstration program in terms of scope, rules and requirements. Section 4 describes the survey methodology. Section 5 summarizes the major findings from the survey by the six categories of questions as designed in the questionnaire. Based on the survey findings, section 6 discusses the problems and uncertainties existed in the demonstration program and recommends possible solutions.

2 Policy Background

In China, the responsibilities of the development and enforcement of AFV policies are shared by four ministries under the State Council – Ministry of Finance (MOF), Ministry of Science and Technology (MOST), Ministry of Industry and Information Technology (MIIT), and National Development and Reform Commission (NDRC). The MOF primarily provides funding for the R&D activities, vehicle demonstration and deployment efforts, and construction of supporting infrastructure for the AFV industry (MOF, 2010a). The MOST has been promoting the R&D of AFVs primarily through the establishments of national science and technology projects, such as the "863 program" (China's advanced technology research, development and demonstration program launched in March 1986) (MOST, 2009). The MIIT is a relatively new ministry founded in 2008 as part of the "Department System Reform" of the State Council. After this reform, the MIIT took over from the NDRC and assumes the responsibility of vehicle emission monitoring, standard setting, and

project appraisal for the auto industry (General Office of the State Council, 2008). Meanwhile, the NDRC plays more of a coordinating role in the AFV industry (NDRC, 2009).

2.1 EV Policies during the Last Twenty Years (1991–2010)

The Chinese government updates its targets and directions for the nation's economic development based on a 5-year planning cycle. The last twenty years thus cover the eighth, ninth, tenth, and eleventh Five-Year Plan periods. The eighth Five-Year Plan period (1991-1995) was the first time EV R&D was promoted through MOST's "Research on the Key Technologies of EVs" as a National Key Scientific and Technological Project (Chen et al., 2003; Sun and Zhu, 2001). During the subsequent Ninth Five-Year Plan period (1996-2000), the MOST, together with 12 other ministries, led the "National Clean Vehicle Action" program, in which the development of Concentrated Natural Gas (CNG) and Liquefied Petroleum Gas (LPG) vehicles were promoted as short-term technological measures, while the EVs were considered as mid-term to long-term technological measures (MOST et al., 1999).

During the Tenth Five-Year Plan period (2001-2005), the MOST included for the first time the "EV Key Project" in its 863 Program and chose the new generation of EV technology as the major direction of auto technology innovation. Since then, the "Three Transverses and Three Longitudes" R&D strategy of EVs has been established (MOST, 2002; MOST, 2006a). The "Three Transverses" refer to the three types of AFV, namely fuel cell vehicles (FCV), hybrid electric vehicles (HEV), and pure electric vehicles (PEV); the "Three Longitudes" refer to the three

auto-related technologies, namely multi-energy powertrain system, drive motor and power battery. The MOST's "Alternative Fuel Vehicles Key Project" in the 863 program in the following Eleventh Five-Year Plan period (2006-2010) further reinforced the R&D activities of EVs and also started to explore the commercial market (MOST, 2006b; MOST, 2006c). During these two plan periods, the MOST 863 Program invested a total of 2 billion RMB[1] in the R&D of EV (Wan, 2008).

2.2 Most Recent EV Policies

In March 2009, General Office of the State Council issued the "Plan on Shaping and Revitalizing the Auto Industry", which is a major component of the national economy stimulus package during the period of global economic depression (General Office of the State Council, 2009). This plan sets out a production target of 500 thousand EVs (including PEV, HEV, and Plug-In Hybrid Electric Vehicle (PHEV)) and a 5% AFV share of all vehicle sales between 2009 and 2012. The plan stated a total of 10 billion RMB to be invested in the advancement of auto technologies, including the R&D of AFVs. It included a "National Energy-Conservation and Alternative Fuel Vehicle Demonstration Program". As outlined in the plan, the major activities of the demonstration program include: 1) demonstrating energy-conservation strategies and AFVs (mainly EVs) in medium- and large-size cities; 2) deploying AFVs in the public services area such as urban transit, taxi, public affairs, sanitary, post service and airport; 3) building charging grid to support fast charging of EVs; 4) expediting the construction of public charging facilities.

[1] In 2010, the exchange rate for RMB/$ is in the range of (6.65, 6.83).

Specifics of the demonstration program are announced in the "Notice about the Demonstration Program of Promoting Energy Efficient and Alternative Vehicles" (hereafter referred to as the "Notice") on Jan. 23rd 2009 by the MOF and the MOST (MOF and MOST, 2009).

3 Electric Vehicle Demonstration Program

The demonstration program is a cumulative product and realization of China's environmental- and technological-focused policies over the last twenty years. Following the direction identified in the "National Clean Vehicle Action" and the EV projects launched in the previous 863 Program, the demonstration program chose EVs as the major type of AFVs to deploy (MOF and MOST, 2009). As specified in the "Notice", the deployment vehicles include HEV, PEV and FCV (MOF and MOST, 2009). This announcement indicates EVs as the primary direction of AFV development in the future in China. The program distinguished itself from all previous efforts on EVs in that it is a critical step of going from promotion to actual implementation and from R&D activities to mass production.

3.1 Program Scope

The demonstration program aims to subsidize the deployment of one thousand EVs in each of at least ten participating cities in four years. As such, it is also referred to as the "Ten Cities, Ten Thousand Vehicles" program. By the year 2012, the total number of EVs out on the road is expected to reach at least ten thousand.

The program focuses on financing vehicles used in the public service sectors such as buses, taxis, governmental fleet, sanitation and postal service vehicles; the

private vehicle market was excluded. The MOF and MOST provided two reasons for this. First, due to constraints such as technology, manufacturing capability, and supporting facility, the promotion of AFVs needs to proceed gradually, and public service fleets are easier to monitor and maintain than private vehicles. Second, public service fleets such as buses and taxis are the major transportation modes in the medium-large size cities in China, and are therefore expected to have significant demonstration results (Xin, 2009). The other restriction of the demonstration program is that the central government would only subsidize the purchase of demonstration vehicles while municipal government funds would be needed for building supporting facilities and maintaining vehicle fleets.

Although the demonstration program has received interests from many Chinese cities, only thirteen medium-large size cities were selected. These 13 participating cities include Beijing, Shanghai, Chongqing, Changchun, Dalian, Hangzhou, Jinan, Wuhan, Shenzhen, Hefei, Changsha, Kunming and Nanchang. Most of these cities are either metropolis or provincial capitals in China.

3.2 Vehicle Eligibility

The question of what vehicles are qualified for the demonstration program has been at the center and front of much discussion among all stakeholders. This question was answered by the "Admission Management Rules for the Auto Manufacturers and Products of Alternative Fuel Vehicles" (hereafter referred to as "Admission Rules") and the "Recommendation List of Vehicle Types for the Demonstration program of Promoting Energy Conservation and Alternative Fuel Vehicles (1st to 18th part)" progressively issued by the MIIT during 2009 and 2010 (MIIT, 2009a,

2009b, 2009c, 2009d, 2009e, 2009f, 2010a, 2010b, 2010c, 2010d, 2010e, 2010f, 2010g, 2010h, 2010i, 2010j, 2010k, 2010l, 2010m). These two official documents are important in that they directly determine whether the auto manufacturers are eligible to produce AFVs, whether the EVs they produce can receive financial subsidies from the demonstration program, and consequently whether the municipal governments can seize this opportunity to develop local auto industry.

In the "Admission Rules", MIIT defined AFVs as vehicles using unconventional fuels. The AFVs are further divided into three technical phases: Beginning Phase, Developing Phase and Mature Phase. This categorization is considered to have significant impacts on the manufacturers' future R&D directions.

The "Recommendation List" is one of the prerequisites that the demonstration vehicles must satisfy to enter the demonstration program. By Dec. 23, 2010, the first eighteen parts of the list have been announced and the complete list is still expected to expand in the future. In these published eighteen parts, there are totally 192 types of AFVs, including 113 types of buses, 41 types of passenger cars, and 38 types of service/engineering vehicles. Although most of the vehicle types in the "Recommendation List" are from Chinese own brand, four joint-venture companies also appeared on the list – Zhengzhou Nissan, Shanghai Sunwin (joint-venture with Sweden Volvo), Shanghai General Motors, and Guangzhou Toyota. Nissan, in particular, signed a cooperative memorandum on promoting the use of EVs with the MIIT on April 10 2009, making itself the first foreign automaker to arrive such an agreement with the Chinese government (Di, 2009). Based on this agreement, Nissan would help the MIIT make plans about the construction and

maintenance of electricity charging grid, and also help to promote the massive use of EVs in China.

4 Survey of Demonstration Program Status

The survey sponsored by the WB was conducted during the summer of 2009 with the 13 participating cities in the demonstration program. A questionnaire was first designed for interviewing the local chief managers or engineers of the demonstration program in the participating cities. It was prepared for either a face-to-face or telephone interview. The questionnaire included questions relating to the following six areas:

- Goals and Objectives: the motivation for the city to participate in the demonstration program and the objectives that they aim to accomplish;
- Deployment Plan: type and number of AFVs to be deployed, the deployment time frame, and the public service fields to be targeted at;
- Financial Plan: the sources and allocation of funds for vehicle procurement, charging station construction, vehicle operation and maintenance, and R&D activities;
- Monitoring and Evaluation: number of AFVs actually in use, amount of usage, and assessment of vehicle performance and impacts (e.g., on air quality);
- Challenges and Risks: the challenges encountered so far and risks perceived to impede success of the program; and
- Communication and Collaboration: the type and degree of interaction with other pilot cities.

The general offices of the subordinate units of the MOST in the 13 pilot cities were first contacted in the end of July. Relevant institutions/persons in charge of the demonstration program were generally found through several iterations of referrals. The leading departments are listed in Table 1. Although there were several exceptions, the pilot cities generally had municipal science and technology commission/department leading the effort.

By the end of August, a total of 10 out of 13 pilot cities participated in and completed the survey with us: face-to-face interviews were accomplished for Beijing and Chongqing while phone interviews were accomplished for Changchun, Dalian, Jinan, Wuhan, Shenzhen, Hefei, Kunming and Nanchang.

5 Survey Findings

5.1 Goals and Objectives

Respondents from the pilot cities consistently provided one or both of the following as their reasons for participating in this program.

First, the cities considered this program as an opportunity to develop their local auto industry (especially the AFV industry), and in turn boost the local economy. Cities that already have well established local auto manufacturers aim to improve and strengthen their existing auto manufacturing chain. For example, Wuhan has just established the Dongfeng EV Industrial Park - the only National EV Patent Industrialization Pilot Base in China - in June 2009 (Xinhuanet, 2009). Shenzhen is also on the way of becoming one of the national AFV manufacturing centers according to the "Pearl River Delta Planning Guideline" (NDRC, 2008).

Cities of Kunming and Dalian that do not currently have local auto manufacturers also deemed this program as a good opportunity to attract auto manufacturers into their region.

Second, eight out of the ten cities being interviewed are faced with increasing pressure and challenges associated with the continuously growing population and vehicle fleet. The desire to energy-conservation, pollution-reduction and development of "Green Cities" has also become major motivation for the pilot cities to join the program. For example, Shenzhen has more than 1.4 million vehicles, whose emissions account for about 60-70% of the city's total air pollution. Kunming, a tourism city, also regards this demonstration program as an opportunity to improve its tourism by enhancing the city's image. Changchun is a city with previous success in AFV deployment - it has received significant energy-conservation and air quality improvement benefits since its implementation of a CNG&LPG demonstration program in 1998. This successful experience has given Changchun strong momentum and interest to participate in the current demonstration program. Furthermore, being an AFV deployment pilot city could help to promote the concept of new energy (or alternative fuels) to the citizens and raise the public environmental awareness, as mentioned by the interviewee from Nanchang. However, skepticism also exists as one interviewee expressed concern about the effectiveness of energy-conservation while agreeing with the objective of pollution reduction: "since the EV technology is still immature right now, there are many uncertainties and the effects of energy-conservation might be weakened."

5.2 Deployment Plan

The respondents were asked about the size, vehicle types and service fields planned over the 4-year demonstration period (2009-2012) in their respective cities. The results are summarized in Table 2 and discussed below.

Judged solely by the number of EVs to be deployed, Shenzhen is the most "ambitious" city. It aims to deploy as many as 24,000 EVs by the end of the demonstration period. This target clearly exceeds the national requirement of 1,000 vehicles for each pilot city. Beijing has the second highest amount of EVs to deploy – 1,000 EVs by 2009 and 5,000 EVs by 2012. Subsequently, Changsha and Shanghai plan to deploy 4,570 and 4,157 EVs respectively by 2012. Hangzhou, Chongqing, Wuhan and Dalian set their deployment target to be in the magnitude of 2,000 to 3,000 vehicles. The remaining five pilot cities plan to deploy only around one thousand EVs, which just meets the minimum requirement of the "Ten Cities, Ten Thousand Vehicles" plan.

Even though the "Notice" includes HEV, PEV and FCV as three major categories of EVs to be deployed, almost all the pilot cities only deploy HEV and/or PEV. For example, among the 1,000 EVs to be deployed in Beijing in the year 2009, 870 will be HEVs and 130 will be PEVs. Wuhan also plans to deploy 1000 HEVs and 500 PEVs in two years. The only exception is Dalian. In addition to the 150 HEVs and about 100 PEVs that it has already deployed, Dalian currently is also testing four FCV buses. The lack of interest in FCV in the current demonstration program can be partly attributed to the fact that the Chinese governmental investment would focus on HEV in the short term and FCV in the long term (Wan,

2008). Even for the pilot cities that plan to deploy both HEV and PEV, HEV usually has a more dominating amount. The reason is obvious – HEV is the type of EVs that require least supporting facilities, while the other two types of vehicle require either electricity or hydrogen charging facilities. Thus, the deployment of HEVs is much less challenging. However, Hefei is exceptional in that it only planed to deploy PEVs. The interviewee from Hefei said that they preferred PEVs because their local auto manufacturers had mastered pioneering PEV technology.

The public service fields for the EV deployment also differ among the pilot cities. The central government requires enough diversity in the deployment fields, but the cities are constrained by the available infrastructure and technology. For example, taxis cover a much broader geographic scope than buses and are not on fixed route; thus, it also has a higher requirement on the distribution of facilities (e.g., charging stations). Cities of Beijing, Wuhan and Chongqing have not started to deploy EV taxis yet because their local manufacturers do not have such vehicles available at the time of the survey. As EV technology matures and more EV models become available in the future, the deployment of EVs could be expected to span across more service fields.

5.3 Financial Plan

Based on the interviews with 10 pilot cities, the expected total cost of the demonstration program for most pilot cities would be in the magnitude of hundreds of millions of RMB. For example, Wuhan plans to invest about 460 million RMB, Hefei plans to invest 590 million RMB, and Changchun plans to invest 490 million RMB.

The costs of the demonstration program mainly consist of four components: procurement of vehicles, construction of charging facilities, operation & maintenance, and R&D activities. As mentioned in section 3, the central government subsidizes only the procurement of vehicles while the local governments are responsible for other activities such as building the supporting facilities. As the pilot cities start to implement the demonstration program, several financial problems and concerns have emerged.

5.3.1 Procurement of Vehicles

Although the MOST and the MOF have specified subsidy standards for the procurement of vehicles based on technical parameters, at least three pilot cities indicated that subsidies from the central government are far from enough for the complete implementation of the program. Two other cities also expressed concerns about the uncertainty of the availability of subsidies from the central government. In such cases, the municipal governments have to bridge the gap of vehicle procurement expense.

The financial difficulty for the procurement of EVs is more severe in the private field, since the subsidy for the demonstration program only covers the public service fields. Unless the central government extends the subsidization to the private purchases of EVs in the next few years of the demonstration period, cities that plan to deploy EVs into the private fields will have to face the added financial burden by themselves or leave it to the EV buyers. For example, Shenzhen plans to deploy 15,000 AFVs into the private market, adding pressure on the local finance. Shenzhen plans to meet this target by raising public awareness and providing

economic incentives to encourage people to buy EVs. In contrast, Chongqing only plans to test a small number of 100 EVs into the private market, with a one-time subsidy of 36 thousand RMB per vehicle and 6,900 RMB's waiver of toll charges provided by the local government.

5.3.2 Construction of Charging Facilities

Electricity charging facilities are needed for PEVs and PHEVs and they are costly. The pilot cities generally planed to use two types of electricity charging facilities – charging station and charging pile.

The public charging stations are very similar to gas stations. They are typically constructed by the urban roads or highways. One charging station usually accommodates multiple charging equipments and provides different charging functions such as slow charging, fast charging, and battery change. The major problems with charging stations are that they require significant land space and their capital cost is high. Respondents from the pilot cities revealed that, although the cost of a charging station varies, most of the cities expect it to be in the magnitude of ten millions of RMB per station (Lu et al., 2010).

Charging piles are then typically built at parking lots or by the roadsides. They have the advantages such as small land consumption and high flexibility. However, they can only provide the slow (normal) charging function which usually takes 5 to 10 hours. A single charging pile may cost between 20,000 RMB and 30,000 RMB (Lu et al., 2010).

Among the pilot cities, Jinan may have the biggest construction plan of charging stations. It aims to build 9 advanced charging stations (with an estimated cost of 30 million RMB each) and 300 regular charging stations (with an estimated cost of 0.4 – 0.8 million RMB each) in 4 years' time. The total estimated cost is 510 million RMB. At the time of the survey, Wuhan was negotiating with Nissan about the construction of 20-35 charging stations while Nissan was also negotiating with the State Grid Corporation of China (the country's biggest power supplier) about the construction of charging stations. Hefei plans to build centralized charging parking lots for the bus companies and distributed charging stations for cars. Its charging facilities will be built accordingly depending on the number of EVs being deployed each year, with an estimation of cost in the magnitude of tens of millions RMB. Dalian also planned to invest about 50-60 million RMB for building charging stations. Nanchang has a very preliminary plan to build four charging stations, each of which would cost 16 million RMB. Changchun plans to spend 3 to 4 million RMB to build one charging station in its High and New Technology Industrial Development Zone.

Compared to the charging stations most of which are still under planning or construction, charging piles have already started to be used. For example, Nanchang currently uses charging piles as a temporary solution to charge EVs in the absence of charging stations. Shenzhen then deems charging piles as a long-term solution – it has an ambitious plan to install a charging pile for every PEV or PHEV being deployed.

It is apparent that cities such as Jinan, Wuhan and Shenzhen are preparing electricity charging facilities for the mass deployment of EVs while other cities such as Hefei, Dalian, Nanchang, and Changchun plan to build only a few facilities for testing and demonstration purpose. Generally, most pilot cities are still in the planning stage of their charging station construction.

5.3.3 Operation & Maintenance

Another category of supporting facilities to be built is the vehicle maintenance service stations. In addition to the traditional maintenance service for regular vehicles, the EV maintenance stations would focus more on the maintenance of power batteries, electric engine and electric controlling parts. Unlike the charging stations which are funded by the municipal governments, the EV maintenance stations will be mainly funded by bus companies and auto manufacturers, both of which are also supposed to provide technicians for maintenance service.

The pilot cities also expect the operating and maintenance costs for EVs to be much higher than that for the traditional vehicles. However, the financial resources to fill this gap appear to be a problem. At the time of the survey, only cities of Wuhan and Nanchang indicated that they would use provincial or municipal funding support to bridge the gap, while all the other cities did not have a clear solution yet.

5.3.4 Research & Development Activities

The demonstration program itself does not sponsor any vehicle R&D activities. The pilot cities are supposed to procure superior EVs using competitive bidding.

Nonetheless, as mentioned in section 5.1, all the cities want to develop their local AFV industry by taking advantage of this demonstration program. Since the funding from the central government for R&D is largely allocated to major state-owned auto manufacturers, pilot cities without these state-owned auto manufacturers need to invest in the R&D activities themselves.

Wuhan plans to share the financial burden equally between auto companies and governments, each donating 10 million RMB a year. Nanchang also plans to co-fund 20 million RMB into the R&D activities each year by the local government and auto producer. Cities such as Dalian, Changchun and Chongqing, on the other hand, would rely mainly on the auto companies themselves for the R&D investments. Other pilot cities do not yet have a very clear financial plan for supporting their local R&D activities.

5.4 Monitoring and Evaluation

At the time of the survey, the pilot cities generally did not have a very detailed plan about the monitoring and evaluation of the demonstration program. The main reason is that even the MOST is still working on the standards for program monitoring and evaluation. Four pilot cities (i.e., Kunming, Wuhan, Nanchang and Dalian) did plan to establish or hire institutions/companies to perform monitoring and evaluation, but their current focus tends to be more on the operating performance (e.g., vehicle reliability) rather than the efficiency (e.g., how much energy could be saved and how much emission could be reduced) of the EVs. Guidance is needed as to what data to collect, how to collect, and how to evaluate the program.

5.5 Challenges and Risks

When asked about the major challenges experienced so far and any risks perceived during the implementation of the Demonstration Program, the survey respondents expressed the following.

First, almost all interviewees expressed concerns about the reliability of the relatively new EV technology, since the Chinese auto manufacturers are apparently still in the process of improving the EV technology and developing more EV types. As one of the interviewees stated, "most of the vehicle data is from test experiments, and we are not so sure about how these vehicles would perform when they are actually running on the urban roads."

Second, the high cost of EV is perceived as a major barrier for its deployment. Whether the governments (i.e., state, provincial and municipal government) could provide sustained and sufficient financial support would directly impact the success of the demonstration program. Although vehicle procurement is subsidized by the program, the participating cities are reimbursed only after the purchase is made and the vehicles are determined to qualify for subsidies. This reimbursement process raises financial uncertainties for the cities. Land resources were also reported as a concern. How to acquire enough land to house EV facilities such as charging stations, especially in the high density cities, is considered as a major challenge.

Third, for the pilot cities that wished to explore the private market, there is a strong need to raise the public's awareness and acceptance of EVs. Considering the fact that only about 1,000 Toyota hybrids were sold in China market in 2008,

gaining market penetration would require effective marketing and subsidization strategies. Our interviews revealed that the pilot cities of Shenzhen, Wuhan, Kunming and Nanchang had already started to raise public awareness about AFVs through media such as TV, radio broadcast, and newspapers. The other pilot cities either had not started to do so or would rely on the auto manufacturers to promote their AFV products.

5.6 Communication with Collaboration

The interviewees were also asked whether their cities have communication and collaboration with the other pilot cities. It was found that communication between the pilot city governments and the auto manufacturers in other cities was prevalent. For example, Hefei indicated that they have exchanged information with auto producers from other cities about the development of EV technology. Wuhan is also considering the procurement of some EVs from the other pilot cities. Government agencies of the pilot cities have also communicated about and shared lessons learnt through their respective programs. For example, being the pilot city with the most ambitious scope of deployment, Shenzhen has been visited multiple times by the other pilot cities. Nonetheless, more tangible collaboration among the pilot cities had not been reported, suggesting that participating cities implemented their respective programs rather independently even though the demonstration program is a national project.

6 Discussions and Recommendations

Recent Chinese economic and energy policies recognize the transportation sector as a key element in the nation's effort to meet its energy and air quality goals. In particular, the Chinese government considers EV as a promising strategy and launched a four-year demonstration program in 2009. The survey conducted with the 13 participating cities toward the end of the first year of the program revealed that many of the EV deployment details were yet to be finalized. The extent of impacts of the demonstration program therefore remains highly uncertain. However, the challenges encountered and the lessons learnt so far by the participating cities are valuable experiences that would help improve China's current and future demonstration program and perhaps similar efforts in other countries.

Drawing from the survey findings, this study offers the following four recommendations for the Chinese EV demonstration efforts (see WB (2010) for a more expanded discussion of these recommendations).

Recommendation I: Consider a range of monetary incentive options to help overcome the EV adoption barriers relating to cost, technology readiness, and consumer acceptance. The incentive options include:

a) Increase government support in vehicle manufacturing and R&D in the form of grants, loans, and tax credits. The current demonstration program focuses on stimulating EV purchase behavior and is not set up to sponsor manufacturing and R&D activities. Yet the lack of manufacturing and R&D capability is found to be a major barrier for the success of the program. Although the Chinese government's investment in these areas during the last

twenty years has been more significant than ever before, continued and increased investments on manufacturing and R&D are necessary to support a large-scale EV demonstration, as evident in the experiences of other countries in similar deployment efforts. For example, the Advanced Technology Vehicle Manufacturing Incentive program of the United States (US) provides grants and loans to support developing advanced technology vehicles and the parts needed for them (DOE, 2008). As part of this program, the US congress appropriated $25 billion in manufacturing loans in the fall of 2008 to support manufacturers that increase fuel economy by 25% or more relative to 2005 levels. In March 2009, The Obama administration further allocated $2.4 billion in grants for 48 new advanced battery and electric drive projects (DOE, 2009). In the United Kingdom (UK), approximately £400 million[2] of support has been committed to encourage development and uptake of ultra-low carbon vehicles (BERR, 2009).

b) Consolidate resources from national, provincial/state, and municipal levels to provide grants and loans for the deployment of charging facilities. One challenge experienced by the EV pilot cities is that the construction of the supporting infrastructure is left to the cities themselves. This financial burden is especially a concern for cities with a weak local economy and insufficient provincial support. Clear commitments and consolidation from government at all three levels will help address these infrastructure investment needs. For example, in the US, under the American Recovery

[2] In 2010, the exchange rate for £/$ is in the range of (0.62, 0.68).

and Reinvestment Act, the US Obama administration allocated $400 million in 2009 for the largest-ever coordinated demonstration of EVs, including nearly 13,000 vehicles and more than 22,000 electric charging points in more than 20 cities across the country (DOE, 2011a). In states including Oregon and Arizona, the federal investment is supplemented by state subsidies on recharging infrastructure for EVs, both at home and on the go (DOE, 2011b; DOE, 2011c, DOE, 2011d).

c) Expand provincial and municipal level financial incentives – such as tax credits, free or discounted parking spaces, free or discounted connection to other transportation modes, and exemption from road charging – to help stimulate the EV buying market. For example, in the US, in addition to a federal tax credit of up to $7,500 for each newly purchased EV (DOE, 2011e), a few states also establish extra tax credits of up to $5,000 at the state level (DOE, 2011f; DOE, 2011g). In the UK, there is significant tax differential between electricity and liquid hydrocarbon automotive fuels. EV users in London have free parking up to £6,000 and several types of congestion pricing exemption (BERR and DfT, 2008).

Recommendation II: Consider a range of non-monetary incentive options in addition to the monetary incentives. There could be allowance for compliance to standards (super credit) in EV manufacturing and R&D activities. There could also be designated inner-city parking spaces and allowance to use superior lanes for EVs as to promote the vehicle purchase. For example, several states in the US provide HOV lane access and designated parking space programs to EV users (DOE, 2011h;

DOE, 2011i). The UK also planned dedicated parking bays for EVs in London (Mayor of London, 2009).

Recommendation III: Strengthen the monitoring and evaluation component of the demonstration program. The lack of a well-designed monitoring and evaluation framework is one obvious shortcoming of the current demonstration program. Particularly lacking is a mechanism for evaluating environmental outcomes such as changes in the amount of energy consumed, amount of greenhouse gas (GHG) emitted, and air quality condition. Among all these, GHG impacts of EVs usually attract the most attention in the international community. However, there are three critical factors determining the well-to-wheel GHG intensity of an EV: the carbon intensity of the electricity generation mix, the efficiency of the vehicle and associated charging mechanism, and the impact of EVs on the generation mix. Currently the biggest challenge faced by China is that the Chinese electricity grid has relatively high GHG emissions and is projected to remain GHG-intensive for quite some time, due to the long remaining lifetime of the coal-fired generation capacity. As a result, if the pilot cities want to accurately and consistently measure their GHG impacts of the demonstration program and promote the benefits, the municipal governments need to build a more direct linkage between electricity generation and consumption, and allow for dedicated use of renewable energies. This could be done with the assistance of WB to develop a monitoring and evaluation system as part of a lending project with a client city. Alternatively, the Chinese central government agencies could consider taking the lead on with

developing monitoring and evaluation requirements by drawing from international experiences in this area (see, e.g. Frey et al., 2009).

Recommendation IV: Reduce self-interest and enhance cooperation among the pilot cities. Our survey revealed that several cities did share their experience with other participating cities; however, this appears to be where the collaboration ends. More tangible discussion and cooperation on technological perspectives should be encouraged. For example, the municipal governments could pool funds together to invest on the R&D activities of specific technology. Such collaborations and sharing of experiences – both positive and negative – can be best enhanced through central government-led workshops and facilitated by academic institutions and organizations such as WB. With years of operational experiences in supporting sustainable urban transport development in a number of Chinese cities, the WB could also serve as a policy and technical contributor to such workshops.

To sum up, the Chinese EV demonstration program was launched in 2009 as a direct result of about twenty years of R&D on EVs. The purpose of this study is to examine the initial status of the pilot program, help the pilot cities to learn from each other's experiences, and document the lessons learnt. At the time of our survey, the demonstration program was limited to 13 pilot cities and only vehicles used for public service. Since the completion of the survey, the demonstration program has been expanded to include a total of 20 pilot cities in May 2010 (adding Tianjin, Haikou, Zhengzhou, Xiamen, Suzhou, Tangshan, and Guangzhou) (MOF et al., 2010) and 25 pilot cities in August 2010 (adding Shenyang, Chengdu, Hohhot, Nantong and Xiangfan) (HPSTD, 2010). Furthermore, a "Notice about the

Demonstration Work of Promoting Alternative Fuel Vehicles in the Private Market" was announced in June 2010, indicating the beginning of EV deployment in the private market among 5 pilot cities (i.e., Shanghai, Changchun, Shenzhen, Hangzhou, Hefei) (MOF, 2010b). Further investigation and documentation of the subsequent phases of the demonstration program would provide valuable information for both the Chinese pilot cities and other countries pursuing this line of work.

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