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Review of electric vehicle policies in China: Content summary and effect analysis

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ABSTRACT

China has implemented numerous policies to develop electric vehicles (EVs). This paper focuses on evaluating the performance of these policies by systematically collecting and sorting them. These policies can be divided into three categories: finance policy, infrastructure promotion, and research and development (R & D) investment. In addition, the defects of EV policy mechanism are defined by being compared with the policy mechanisms in other countries. The results show that EV policy mechanism should be improved in China. For example, the subsidy and taxation policies are limited, and the goal formulation for EV infrastructure and the input for R & D investment are also unreasonable. Moreover, China need to establish uniform standards for the EV charging infrastructure and a charging pricing mechanism for EVs. Finally, we propose valuable suggestions to improve the performance of EV policies according to the empirical analysis.

1. Introduction

1.1. Vehicle exhaust increasingly aggravates the air pollution in China

With the rapid development of China's auto industry, China became the fourth-largest auto producer and third-largest auto consumer in the world by 2004 [1]. By 2009, China overtook the United States (US) as the nation with the largest production capability and market in the world [2]. Fig. 1 shows the growth trend of total oil consumption and automobile gasoline consumption. Automobile gasoline consumption as a proportion of total oil consumption is growing and will reach approximately 17% between 2015 and 2020. Automobiles have become one of the main drivers of growth in oil consumption. According to the National Bureau of Statistics (NBS), the number of civilian-owned automobiles in China reached 145.98 million by the end of 2014 [3], which is 53.44% more than the value in 2010. Moreover, the number of newly registered civilian automobiles reached 22.05 million [3] in 2014, indicating that more oil was consumed.

China has become the world's largest importer of oil. In September 2013, the average daily import of oil reached 6.3 million tons, exceeding the level of 6.24 million tons in the US [6]. According to the IEA, if there are no positive policies and measures to reduce oil demand by 2030, then Chinese oil demand will reach 808 million tons per year [7], and China's dependency ratio on import oil will increase to 80% [8]. The adoption of electric vehicles (EVs) can help mitigate petroleum consumption. Compared to internal combustion engine vehicles (ICEVs), well-to-wheels (WTW) petroleum consumption is reduced by 29% for hybrid electric vehicles (HEVs), 50% for plug-in hybrid electric vehicles (PHEVs), and 99% for battery electric vehicles (BEVs) [9].

According to a metric of environmental performance, China's air quality on a national scale is the worst globally [10]. The average number of annual haze days, which was approximately 5.3 between 1971 and 2000, have increased to10.2 days between 2001 and 2010 [11]. Twenty-five provinces were affected by haze in 2013, including more than 100 large and medium cities. The number of annual haze days has reached 29.9 days, which is the highest since 1961 [12]. Vehicle exhaust has increasingly become a major source of fine particulate matter (PM2.5), which promotes the formation of haze, especially in large cities such as Beijing. Fig. 2 shows that more car ownership is associated with higher PM2.5 levels. Therefore, controlling the number of traditional automobiles and reducing their exhaust pollution are crucial to reducing the number of haze days. Once China adopts a cleaner energy portfolio, the promotion of EVs could help mitigate air pollution. When the coal power is projected to account for only 41% of electricity generation in 2030, EVs can reduce WTW CO_2 emissions by 17% relative to the low private light-duty passenger

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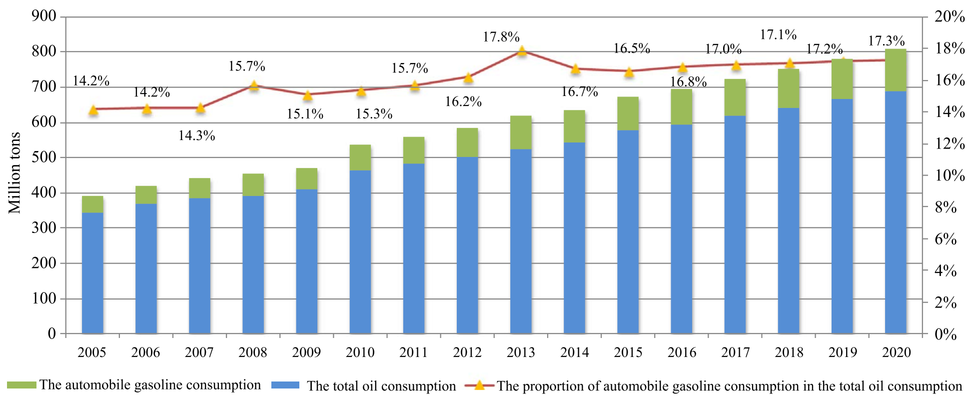

Fig. 1. Total oil consumption and automobile gasoline consumption in China. Source: British Petroleum [4], International Energy Agency (IEA) [5], while the data after 2015 is predicted.

vehicle scenario [9].[1]

1.2. Status of research status on EV policies

According to the "Energy-saving and new-energy vehicle (ENEV) industry development plan (2012–2020)" [15], China will obtain a production capacity of 2 million and cumulative sales of over 5 million BEVs and PHEVs by 2020. The EV industry is not mature. Both the technology breakthrough of EVs and public awareness require government guidance [16]. Therefore, the government should also adopt mandatory measures, financial support policies, and administrative regulations. EVs have received a substantial amount of attention from policy makers and the public in many countries due to their ability to mitigate energy consumption and global warming. Policies, as an important instrument, could directly affect the spread of EVs. The literature on EV policies can be divided into two types with different analytical methodologies. We discuss the state of research on EV policies from two perspectives:

One perspective uses a mathematical formula and model. Massiani [17] proposed a thorough cost benefit analysis and reviewed the primary existing models for the evaluation of EV policies in Germany, finding that most of the investigated policies were inefficient. Jenn et al. [18] employed econometric methods and data between 2000 and 2010 to examine the effectiveness of the Energy Policy Act of 2005. The results showed that the act expanded the scale of HEVs with the sufficiently large amount provided. Diamond [19] and Sierzchula et al. [20] both determined the relationship of policy instruments to EV adoption. Diamond analyzed the relationship between HEV adoption and the variables of socio-economic and policy based on the registration data of HEVs and suggested that gasoline prices have a much stronger relationship with HEV adoption than incentive policies. Sierzchula used multiple linear regression analysis to test the relationship and found that the vehicle charging infrastructure had the closest connection with EV adoption. The other perspective focuses on the ideas and actions of policy makers without using a mathematical method. Bakker and Trip [21] recommended two feasible policy mixes based on an expert workshop. Cohen and Naor [22] discussed how policy entrepreneurs utilize the national security agenda to promote the energy policy they desired based on the policy entrepreneurship literature.

Some studies also discussed China's EV policy. Zhou et al. [23] adopted a life-cycle analysis of vehicle fuel/vehicle energy consumption and pollutant emissions to develop a number of policy recommendations. Zheng et al. [24] collected the relevant policies and interviewed the interrelated people of a demonstration program. The literature sources along with the mathematical method were mainly used to analyze the financial incentives and other socio-economic factors that significantly influenced EV adoption. The EV policies analyzed in the above literatures mainly considered a single participant or a certain type of policy instrument, such as policy makers or finance policy. This paper emphasizes the analysis of the overall EV policies in China. Firstly, the paper comprehensively collects and categorizes the EV policies. In this manner, we can base our analysis on the policy framework of China and find leaks in the EV policy mechanism related to other countries. Secondly, according to the different categories of EV policies, their implementation effects are analyzed with corresponding methods in the paper.

We attempt to determine whether the EV policies of China are effective, discuss the policy problems and propose definite recommendations for EV polices based on the policy effects in recent years. The remainder of this paper is organized as follows. In Section 2, we sort the EV policies into three aspects, including finance policy, infrastructure promotion and research and development (R & D) investment, according to their different functions in the development of EVs. Section 3 analyzes the implementation effects of EV policies. Section 4 concludes the paper with policy problems and proposes counter measures.

2. EV policies in China

The earliest policy on EVs in China is "The long-term special planning for energy efficiency" [25]. This policy highlighted the appeal of developing hybrid vehicles (HVs) and studying EV policies. Then China issued a series of policies on EVs. China attached great importance to the development of HVs at the beginning and emphasized the promotion of EVs in city buses, taxis and other fields in 2008 [26]. However, China presented only a rough roadmap with some energy-science-technology planning between 2004 and 2008 [26–28]. Since 2009, China has begun to refine the development guidance of EVs by clearly raising the relevant financial support [29] and digitizing the promotion objectives [30]. Moreover, in 2011, China proposed the full implementation of a pure electric drive technology transformation strategy [31], which indicates the importance this country has attached to BEVs.

2.1. EV finance policy

The EV finance policy primarily consists of fiscal subsidies and tax incentives. Finance policy can be analyzed from two perspectives—the nation and the region—because EVs can qualify for both national and regional subsidies.

2.1.1. National finance policy for EVs

"The notice on continuing the popularization and application work

[1] A saturation level of 300 private light-duty passenger vehicles per 1000 people.