Renewable and Sustainable Energy Reviews 70 (2017) 24–43

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Incentive policies from 2006 to 2016 and new energy vehicle adoption in 2010–2020 in China

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ARTICLE INFO

Keywords:
New energy vehicle
Policy system
Path dependence
Subsidy
Market adoption

ABSTRACT

New energy vehicle (NEV) development is key to reducing vehicle pollutant emissions, conserving fuel oil energy, and sustaining both the automotive industry and the transportation industry of a country. China is now ranked first in terms of NEV adoption. Policies are the main driving force. This paper aims to uncover how policies systematically link together to provide support, direct rapid development, regulate various players to cope with the challenges, and achieve an impressive progress in NEV adoption in China. We propose a policy dependency mapping method which enables us to analyze 175 NEV policies from national, Jing-Jin-Ji regional, Beijing, Tianjin, and Hebei from January 2006 to April 2016, with adoption targets projected from 2016 to 2020.

Our research reveals that the NEV policies constitute complex policy systems involving governments at various levels with multiple purposes. The national policies direct local policies and depend upon local policies to implement and meet the decomposed targets, whereas regional policies horizontally coordinate the provincial governments and solve issues across provincial boundaries. Local policies play a key role in implementing the national and regional policies and address different local challenges (such as traffic congestion and local economy development). The NEV policy systems are dynamic, and NEV adoption in local areas is uneven. The public sector is the first breakthrough to promote NEV adoption, followed by a demonstration in the private sector. Beijing takes the lead in terms of both EV adoption and policymaking. Challenges in local protectionism, technology advancement with subsidies phasing out, and subsidies fraud are discussed. These findings help both policy makers and NEV players to understand the NEV development roadmap and create better strategies to promote NEVs in the future.

1. Introduction

The emerging new energy vehicle (NEV) industry is of strategic importance in China. It facilitates the country's meeting climate change targets, coping with energy challenges, and sustaining both the automotive industry and the transportation industry by providing more-diversified energy resources [1]. To this end, a series of interrelated policies have been promulgated from national to local levels to incentivize NEV adoption in the last ten years. As a result, NEV annual sales witnessed an average increase of 103% from 2006 to 2015, as shown in Fig. 1. NEV sales volume totaled 331,092 in 2015 and reached 0.5832 million by the end of 2015, both ranking first in the world. However, mass adoption of NEVs is not as easy as it appears. In fact, there are numerous significant challenges in meeting the targets. The purpose of this paper is to uncover how policies at different levels link together to provide support, direct rapid development, regulate various players to cope with the challenges, and achieve such impressive progress.

In China, NEV refers to vehicles using alternative energy instead of fossil fuel as the power source, largely including all-electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), and fuel-cell vehicles (FCVs) [1]. China has been the world's largest automotive market since 2009. In 2015, the number of motor vehicles totaled 279 million, including 172 million automobiles [2]. It is estimated that 150 million internal combustion engine vehicles (ICEVs) can consume 230 million tons of fuel oil [3]. However, 60.6% of the oil supply in China depends upon imports as of 2015 [4]. In addition, vehicle pollutant emissions from the burning of fuel oil are a significant source of air pollution. In

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http://dx.doi.org/10.1016/j.rser.2016.11.211
Received 9 May 2016; Received in revised form 17 October 2016; Accepted 15 November 2016
1364-0321/

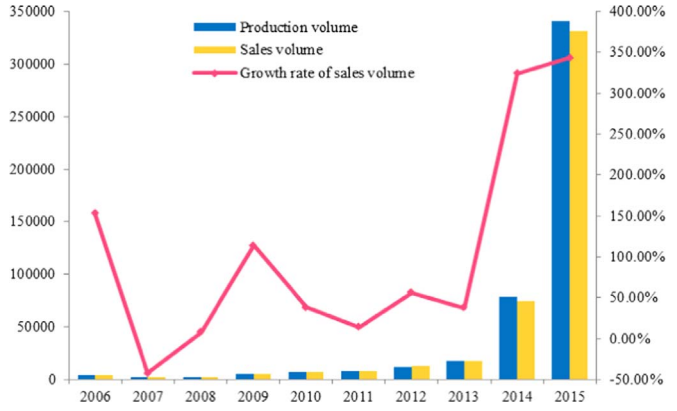

Fig. 1. NEV production and sales volume in China from 2006 to 2015.

2014, exhaust pollutants totaled 45.473 million tons, including 6.278 million tons of nitrogen oxides (NOx), 4.284 million tons of hydrocarbons (HC), 3.434 million tons of carbon oxide (CO), and 0.574 million tons of particulate matter [5].

As an integral part of world efforts to mitigate climate change effects, China has announced that she will lower carbon dioxide emissions per unit of gross domestic product (GDP) by 40–45% by the end of 2020 and devote efforts to further cut them by 60–65% in 2030 compared with the 2005 level [6,7]. Reduction of vehicle emissions is a key part of this national effort. For that purpose, the corporate average fuel consumption (CAFC) of newly sold vehicles shall be 5.0 L/100 km in 2020 [1,8] and 4.0 L/100 km in 2025 [8]. Clearly, relying on ICEVs alone can hardly meet the vehicle emissions control targets. Development of NEVs is promising to control vehicle pollutant emissions and mitigate dependence upon fuel oil and has the potential to apply renewable energy [9–14]. It is estimated that the NEVs adopted in 2015 could lower the CAFC values in the country from 7.02 L/100 km to 6.67 L/100 km in the same year [15].

As do other strategic emerging industries, NEV market adoption in China faces numerous hurdles and barriers. Some are commonly encountered worldwide, such as the high initial production cost [10], high battery cost [16], insufficient charging infrastructures [17,18], short cruise range [10], unsafe and unreliable batteries [19], technologies shortcomings [20,21], waste management of used NEVs and used batteries [22], consumer preferences [10], and external costs such as traffic congestion [23]. Others are specific to China such as local protectionism, limited parking spaces for NEVs, and the difficulties of installing charging facilities in residential communities.

To overcome the inhibitors and to accomplish the adoption goals, governments from national to regional and local levels have enacted a series of policies. The national policies target the strategic direction, and the key milestones reflect contemporary government approaches to address significant issues and concerns. National policies are promulgated for countrywide implementation. The regional policies implement the national policies with special focus on issues beyond province borders. Local policies play a key role in implementing the national and regional policies and also address local concerns. Local policies are made by local agencies to promote NEVs.

The NEV market adoption program started in 2009 when China initiated the pilot demonstration program [24]. During 2013–2014, 88 cities launched the NEV market adoption program [25,26]. These cities are located in different regions, for example, the Beijing-Tianjin-Hebei region, Yangtze River Delta region, and Pearl River Delta region. Among these, the Beijing-Tianjin-Hebei region, which is known as the Jing-Jin-Ji region, a shortened form of (Bei)jing, (Tian)jin and Hebei, contributed 17.05% of NEV adoption in the country in 2015. The Jing-Jin-Ji region occupies more than 218,000 square kilometers in northern China and consists of 13 cities, including two megacities, i.e., Beijing and Tianjin. By the end of 2015, the region had a total population of 111.42 million with a GDP of RMB 6935.79 billion (approximately USD 1068.80 billion[1]), approximately 10.25% of the nation's GDP. Currently, the development of the Jing-Jin-Ji region is a formal national strategy [27] that calls for regional coordination to achieve breakthroughs with more efficient, integrated, and sustainable development. Because national policies rely on local policies for implementation, and the adoption targets are further decomposed through local assurance measures, the Jing-Jin-Ji region provides an idea background to analyze the NEV policy system at national, regional, provincial, and municipal levels.

These policies are a specific representation of the intents, roadmaps, and inputs of governments at various levels, and regulate all players in the NEV market, including manufacturers, suppliers, consumers, institutions and agencies. In analyzing industry innovation, policies are traditionally classified into three categories [28–30]: (a) Supply oriented: to provide essential support for industry development, such as provisions for R & D infrastructure, financial support, human resources and technical assistance; (b) Demand oriented: to stimulate market demand for the products, such as provisions for government procurement, outsourcing, and trade regulations; and (c) Environment oriented: to create preferential circumstances facilitating industry development such as provisions for tax reduction or exemption, and preferential financial and legal regulations. However, in many cases, a single NEV policy analyzed in this paper contains not only provisions to regulate the supply, but also measures to incentivize demand and/or to create supportive circumstances. In addition, the traditional method cannot disclose the dependency path or implementation roadmap between different levels of policies. Hence, the logic for how government intentions and priorities at different levels is implemented can hardly be identified using traditional methods. We do not follow this approach.

Instead, we propose a policy dependency mapping (PDM) method to uncover the important paths in which government intentions and priorities are implemented from national to regional and local governments, which helps understand the key role that these policies play in the promotion of NEVs in China. We then decode the policy systems along the dependency paths using the PDM method and reveal how incentive policies in the last ten years drove NEV adoption and built the world's largest electric vehicle market from scratch. The findings of this paper help both policy makers and NEV players to understand the NEV development roadmap and create better strategies to promote NEVs in the future.

The remainder of the paper is structured as follows: the PDM method is proposed in Section 2. We analyze the national policies in Section 3. We then analyze the NEV policy systems of Beijing, Tianjin, Hebei, and Jing-Jin-Ji region and their dependency upon national policies using the PDM method in Section 4, Section 5, Section 6, and Section 7, respectively. Finally, we summarize the main findings and discuss challenges in Section 8.

2. Methodologies

We collected and analyzed 175 Chinese NEV policies from national, regional, provincial, and local municipal levels promulgated in January 2006–April 2016. Among these, 163 were promulgated in 2006–2015, and 12 were newly released from January 2016 to April 2016. These policies project NEV adoption targets and subsidies through the end of 2020. Among these, national policies are 29.71%, regional 6.29%, and local 64.00%.

We select the policies using the following principles: the policy shall (1) be promulgated by government agencies; (2) relate to the NEV industry; (3) be effective as of April 2016; (4) have connection to other policies in the map; (5) be publicly reported or publicly accessible.

[1] Assume an exchange rate of 1 USD =6.4893 RMB at the end of 2015.