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Study on Development Route for New Energy Vehicles Industry in China

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Abstract

In order to save energy and reduce emission, China is developing the new energy vehicles industry. China's new energy vehicles industry encounters the problem of path dependence, due to the difficulty of changing production and consumption of the traditional fuel vehicle. The new energy automobiles' production and sales are far from achieving the goal of development plan, despite the Government's strong avocation. Compared to the development route of other developed countries, we should strengthen the innovation in the fields of science and technology, finance, policy and marketing, to overcome path dependence in multiple ways, and strive to cultivate the new energy vehicles industry.

Keywords: new energy vehicle; industrial development; path dependence

1. Introduction

According to the newly carried out rule the Management Rule of New Energy Vehicle Enterprises and Products in July 1, 2009, the new energy vehicle refers to vehicles equipped with unconventional vehicle fuel as the power source (or common fuel but equipped with new types of vehicle engine) combined with advanced technology in power control and drive layout, which features in advanced theory, technology and structure (Ministry of Industry and Information, 2009). This genre of vehicles generally includes pure electric vehicles, hybrid power vehicles, plug-in hybrid vehicle, and fuel cell electric vehicle. Nowadays, since the concerns of environment and power source are constantly rising, the new energy vehicles have become the new trend of automobiles industry development worldwide. Zhang (2015) thought that the sales volume of China's new energy vehicles would increase two times.

As the reported vehicle sales data given by the China Association of Automobile Manufactures in July 10, 2015 has shown, at the first half of year, the vehicle production and sales volume reaches 120.95 million and 118.503 million, which is separately 2.6% and 1.4% growth in the same period last year. Noticeably, China's new energy vehicle sales volume is actually rising rapidly. First half of year, 76'223 new energy vehicles are produced and 72'711 of them are sold, which are 250% and 240% increase year-on-year. Among these sold vehicles, pure-electric vehicles reaches 49'042 and 46'219 in production and sales volume, which is 200% and 190% increase year-on-year, fuel cell electric vehicles reaches 27'181 and 26'492 in production and sales volume, which is 200% and 190% increase year-on-year (Zhang, 2015). However, these numbers still have a long way to catch up with the goal set by the *Energy Saving and the Development Scheme of New Energy Vehicle Industry (2012-2020),* which expect "by 2015, try to increase the production and sales volume of pure electric vehicles both up to 500'000. By 2020, try to increase the production and sales volume of pure electric vehicles separately up to 200'000 and 500'000". Even for the fact that the *Ten City and a Thousand Cars* project which the government strongly supported didn't work out in a great content, there still isn't any city that has accomplished the set goal. There's still a long way for the industry to go to meet those expectations. As for the study of new energy vehicles, Li (2011) had also done some designated studies on China's new energy vehicles development with the background of low-carbon economy. Zhang et al. (2014) also made some contribution to overcoming the path dependence of new energy vehicles' development.

Aiming to help new energy vehicles' development, experts and scholars at home and abroad are all studying extensively and deeply. Among them, Teece (1986) studied the connection between policies and innovations; Sierzchulaw (2014) studied innovation varieties out of the example of new energy vehicles; Sierzchula (2012) studied the problem of electric vehicles' competition environment; Pan (2015) studied the application and promoting strategies of urban new energy vehicles based on low-carbon traffic development; Wu (2015) studied the technological choke point and application of new energy vehicles. They mainly look to push the development in the field of scientific innovation and the political innovation. The main mindset of this essay is to apply the theory of path dependence and to analyze the obstacles exist in the path of China's new energy vehicles' development, by referring to the successful strategy of foreign countries' new energy vehicles' development, to discuss how could China overcome these obstacles and innovate in science, economy, policy and marketing, with the goal to fast-forward the process of new energy vehicle development.

2 Analyses of China's Current Developing Path of New Energy Vehicle

China attaches great importance to the new energy vehicle development. In order to realize zero-emissions, China's been focusing on electric cars from the beginning of new energy vehicle development. From 2001's "863" scheme of electric cars project, to 2010's *Energy Saving and the Development Scheme of New Energy Vehicle Industry (2012-2020) (a draft of discussing),* it shows that pure electric vehicles are the main direction our industry are developing, also the government has been supporting and subsidizing pure electric vehicles' development (Li, 2011). It's clear that China's new energy vehicles' development is government-oriented and aimed at electric cars from the start. However, even with all the manpower and material resource dedicated, the new energy vehicle industry only have a limited prospects of development. The reason is that China's new energy vehicle industries' development contains the problem of path dependence.

What Schumpeter was expressing shows the evolutionary economists' opinion that economy and technology is a positive feedback system. Once the system has been formed, it would development through a changeless path, which could barely transform to another even if there are alternative or better strategies (Schumpeter, 2009). When a new product with more advanced technology, more complete design and more convenience comes out, it would not necessarily take the place of the existing mainstream products; on the contrary it could have been laid aside due to the existing product's influence. Although the new energy vehicles stand for the directions of vehicle industries' development and upgrading and also have great influence at relieving the fossil fuel contradiction between supply and demand, reducing greenhouse gases demission and improving urban air quality, when it comes to applying and promoting the conventional vehicles' existence which lead to path dependence because of the self-reinforcement would still be a problem (Zhang et al., 2014).

2.1 The Irrationality of Consumers' Behaviors

In the macroscopic point of view, there are two types of consumers, which are innovational consumers and conservative consumers. The former have a thirst and nose for the cutting-edge technology products, and it would often be the first group of people to use the latest technological products. This type of consumers has a higher acceptance for the new energy vehicle and is the main force in new energy vehicle market promoting, their number, however, takes up quite a small part in all consumers. On the contrary, there are conservative consumers, who particularly have a strict and careful consuming attitude, are often skeptical about new technological products. Compared to that of the new energy vehicles' unstableness, the information of the conventional vehicles and its technology are surely much more easily to get hold of. In this case, people are most likely to make choices depending on their psychological set made from their past experiences, which are usually consuming the conventional vehicles. Thus, conservative consumers account a vast proportion of China's consumers. Lack of consumers and market, are the important reasons that slow China's new energy vehicles' development down.

2.2 High Cost of Enterprises Upgrading

Over the past century, the conventional vehicles take up a dominant position in the market. The motor industry is based on the fossil fuel energy source and then formed a system of technology, devices and quality standards, which differs greatly from the new energy vehicle industry. The latter's production equipment often have the feature of highly invested, highly sophisticated and time demanding. It means an enterprise has to give away a great deal of their earlier investment to upgrade their productions. If an enterprise decides to upgrade the production technology and equipment, firstly it has to throw in a huge amount of money for the new energy vehicles' development, production and usage, secondly their workers and technicians need time to learn and master the new skills, so it demands time for the scale effect to do its work and the cost to decrease. Also, the high risk of new energy vehicles' technological innovation and the blurry marketing future make the innovation

contains much higher risk for entrepreneurs. Lacking enough compensation and benefits, it is difficult for a conventional vehicle producer to fight against the high replacement and development cost to upgrade to a new energy vehicle producer.

2.3 Marketing Environment

China's marketing environment now is based on the fossil fuel energy, with the transportation's technology standards, basic facilities, rules of management developing for more than a centuries' time, which also fuse and evolve together with the policy, economy and society rules, and then it end up into the Techno-Institutional Complex (TIC) (Chen et al., 2010). Once the so called Techno-Institutional Complex's influence to both of the supply and requisitioning parties has come into being, internal market inertia would try to stabilize the market and prevent the innovation from developing. As a result, the vehicle manufacturers would stay in the production of fossil fuel vehicles, and the consumer's mindset and behaviors root in the conventional vehicles too (Pearson, 2007). Thus, to develop the new energy vehicle, it means a lot for China to search for a newer and more suitable developing path to overcome the current path dependence.

3. Inspirations on Developing Path out of Foreign Countries' Development

Developed countries have had many beneficial studies on products innovation in order to accelerate developing the new energy vehicles and overcome the problem of pat dependence. For example: Vernon first brought out the concept of products life-span in 1966, which is divided into four stages of introductory, maturity, modeled and declined (Li, 2001). Afterwards, Utterback and Abernathy (1978) added A-U products life-span theory to this basic concept, and by referring to the leading design of the products it divided the life-span into three stages of flowing, transiting and stabilizing (Schumpeter, 2009). While flowing, all the producers would come up with various innovation products which differ greatly from one another, when transiting, the products have generally been designed and these designs would determine the developing direction of future products, after that all the unqualified products would washed out of the market because it's a market for innovation products. At last there comes the stage of stabilizing, the leading designs would become main stream and the industries would enter a process of big-scale elimination, any products not suitable for the leading designs would be kicked out of the market (Zhang, 2007). In summary the technological transiting follows the circle of "fierce products innovation competition -> fierce revolution competition -> forming the leading designs -> increasing and improving -> radical innovation" (Abernathy & Utterback, 1978; Tushman & Anderson, 1986). The fierce revolution stage features in various technological revolutions, while the increasing and improving stage features in transiting one of the leading designs into mainstream (Klepper, 1996). During the fierce revolution stage it's difficult to form a leading design, however multiple innovation products might succeed in different markets in this stage (Teece,1986).

Specifically, by referring to the content of innovation and eco-economy efficiency, the new energy vehicles could be divided into flex-fule, H_2ICE, LPG, CNG, HEV and EV. Figure 1 directly presents the extent of change done to the internal combustion engine system and the distribution of Ecological economy efficiency of all kinds of new energy vehicles.

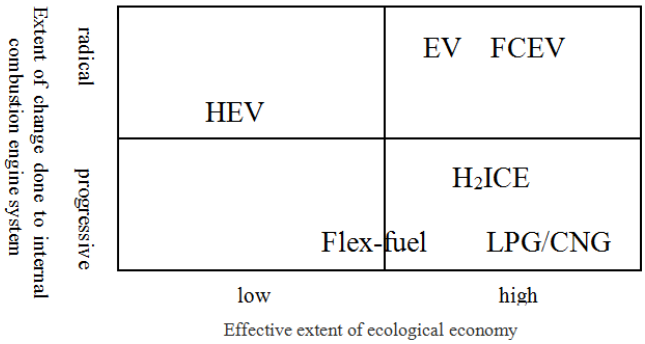

Figure 1. comparison of different technologies of new energy vehicles' innovational extent and ecological economy efficiency

Sources: Technological diversity of emerging eco-innovations: a case study of the automobile industry (Sierzchulaw et al., 2012).

The flex-fuel vehicles still have the original internal combustion engine and are categorized as a progressive innovation. The design uses ethanol gasoline and flex-fuel so it would still pollute the air. The hydrogen energy

vehicles, compressed natural-gas vehicle and the liquefied petroleum gas vehicles are all categorized as the progressive innovation, because these products do not completely differ from the original internal combustion engine system and simply improve the fuel efficiency by using hydrogen, compressed natural gas and liquefied ethanol gasoline and there for reduce the pollution to the air. The hybrid energy vehicle, however, is one of the radical innovations, it completely differs from the conventional internal combustion engine system, and use electric motor to provide most of the power, and however the remainder of internal combustion engine still burns the gas so it's not very eco-friendly. The pure electric vehicle and fuel-cell vehicle are two highly eco-economy efficient radical innovation, they not only change the power system completely, but also reach the goal of zero emission (Sierzchulaw et al., 2012).

Progressive innovation is a small-scale innovation, which preserve most of the essential element and then innovates in technology improvements. It is more acceptable for the market (such as the liquefied ethanol gasoline vehicles). The radical innovation, however, is a complete change compared to the original production mode and has a higher level of innovation, but it could be less acceptable for the market due to its revolutionary characteristics, such as electric vehicles (Tushman & Anderson, 1986).

Sierzchula and others have made an research on the new energy vehicle producers such as Toyota, GM, VW, Ford and other 15 which takes up to 80% of the market share. The research mainly focus on the technology variety, and it shows that, during the research period of 1991-2011, the new energy vehicle industry presents a trend of various technology developing (Sierzchulaw et al., 2012). The graph shows the average number of different new energy vehicles technologies of some leading vehicle producers, which increase from 1.3 in 1991 to 2.9 in 2011. It means that the technology variety is more notable. The next graph shows the number and categories of new energy vehicles produced by 15 producers, and it's obvious that most producers do not focus on one model only, but develop and study on multiple technologies. Meanwhile, producers would choose one technology as their main development goal. But generally, the whole new energy vehicle industry presents a balanced state in technology development. There is not one particularly in the leading tendency.

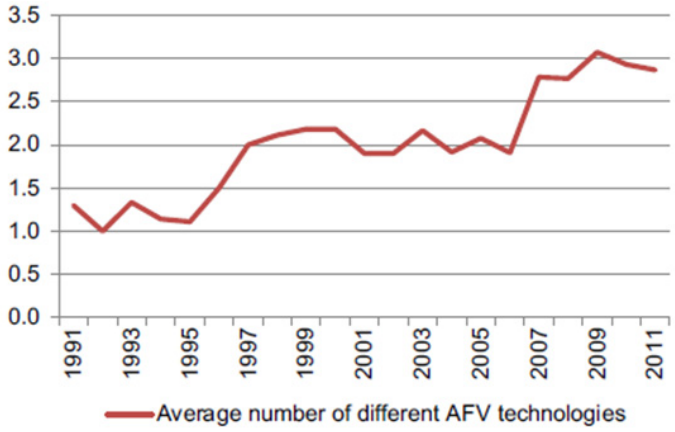

Figure 2. Average amount of new energy vehicles developed by American vehicle producer 1991-2011

Sources: Technological diversity of emerging eco-innovations: a case study of the automobile industry (Sierzchulaw et al., 2012).

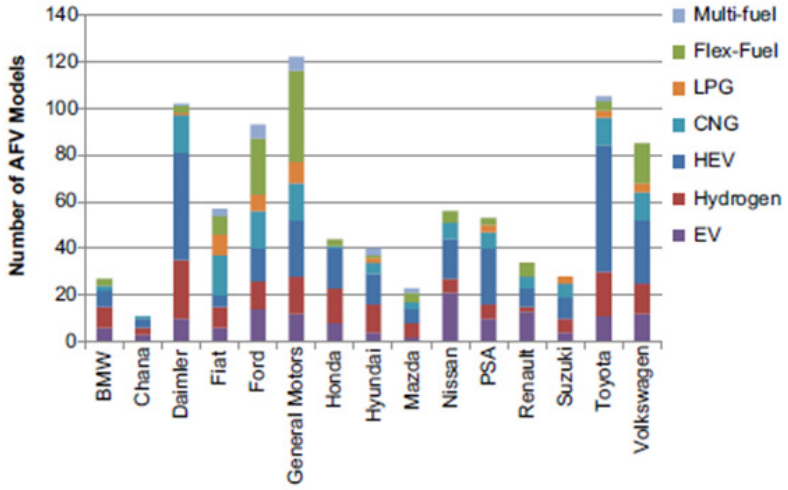

Figure 3. Numbers and categories of new energy vehicles produced by America's main vehicle producers 1991-2011

Sources: Technological diversity of emerging eco-innovations: a case study of the automobile industry (Sierzchulaw et al., 2012).

What's more, the study also shows that, for different types of innovation, producers would have different developing plans. The table 1 shows the data of theoretical and production volume of new energy vehicles. Apparently, producers make more theoretical vehicles while doing the radical innovation, and more production vehicles when doing the progressive innovation. Even if when electric vehicles are developed, more hybrid vehicles are promoted to the market, which shows that vehicles categorized as the progressive innovation products are more acceptable to the market, faster to manufacture and easily to form the scale effect. While the radical innovation products are not so acceptable and less knows to the consumers, they have to be presented as the theoretical vehicles in order to get the reaction of these consumers. After that, it will be considered whether to be manufactured, improved or shut down production.

Table 1. The amount of all technologies of theoretical and manufactured new energy vehicles

	Theoretical vehicles	Manufactured vehicles	total
Electric vehicles	97(19%)	33(9%)	130(15%)
Hydrogen energy vehicles	157(31%)	2(1%)	159(18%)
Hybrid energy vehicles	196(39%)	85(23%)	281(32%)
Compressed natural gas vehicles	20(4%)	108(29%)	128(14%)
Liquefied ethanol gas vehicles	5(1%)	36(10%)	41(5%)
Flex-fuel vehicles	11(2%)	109(29%)	120(14%)
Dual fuel vehicles	21(4%)	4(1%)	25(3%)
Total	507(100%)	377(100%)	884(100%)

Sources: Technological diversity of emerging eco-innovations: a case study of the automobile industry (Sierzchulaw et al., 2012).

The data above also points out that, compared to the new enterprises, operating ones are more capable and more willing to try the radical innovation (Chandy & Tellis, 2000; Hill & Rothaermel, 2003). This phenomena is much more particular in the motor vehicle industry, it shows that these enterprises are willing to make investment in the radical innovation and capable of achieving goals (Sierzchula & Bakker, 2012). However, during the process of innovation, enterprises should preserve some of their original technologies, just to assure their original costumers (Christensen, 1997). Thus, enterprises which are capable of radical innovation would often take two types of innovation simultaneously, doing both progressive innovational technology improvement and radical innovational technology development (Jiang et al., 2010).

Table 2 and Table 3 separately present the data of various new energy vehicles produced in America and Japan between 2000 and 2009.

Table 2. Sales volume of all technologies of new energy vehicles in American market 2000-2009

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
All motor vehicles	15869103	14646211	15066949	14753910	15011888	14966290	14263685	13819125	11136230	10429553
CNG	9501	11121	8988	6122	7752	3304	3128	2487	4440	3770
EV	6215	6682	15484	12395	2200	2281	2715	3152	2802	2255
Flex-fuel	600832	581774	834976	859261	674678	743948	1011399	1115069	1175345	805777
HEV	9350	20282	36035	47600	84199	209711	252636	352274	312386	290271
Hydrogen	0	0	2	6	31	74	40	63	63	26
LPG	4435	3201	1667	2111	2150	700	473	356	695	126

Data sources: US DoE, 2011c.

Table 3. Sales volume of all technologies of new energy vehicles in Japanese market 2000-2009

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
All motor	108863	105596	111107	111123	113669	116622	123828	125733	121521	868779
vehicles	30	12	02	57	99	67	13	02	15	1
CNG	2447	4028	3972	3852	3265	3066	3091	2175	2379	1197
EV	150	183	83	49	17	0	0	0	0	1706
HEV	12950	25089	15514	42423	66540	61263	90410	90523	121101	466631
Hydrogen	0	0	0	0	0	2	5	1	0	5
LPG	2183	3157	2194	3244	3121	1799	2438	874	609	450

Data sources: JAMA, 2011.

Apparently from the table above, other than electric cars, the main force in America's new energy vehicles' market are the flexible fuel vehicles, compressed natural gas vehicle and the hybrid vehicles, in which the CNG vehicles shows a trend of decreasing while the hybrid vehicles' sales volume is increasing rapidly. Flex-fuel vehicles have the most sales in the market all along. However, it is the hybrid vehicle that is the main leader of sales in Japan's market.

In summary, most of the developed countries' multi-country vehicle companies have taken to route of new energy vehicle development, and transformed from incremental innovation to radical innovation gradually, which efficiently avoid the problem of path dependence and therefore push the industry to develop.

4. Strategy of China's New Energy Vehicles Development

To overcome the new energy vehicles development path, China must put effort into the field of innovation of technology, economy, policy and marketing in order to accelerate developing the new energy vehicle industry.

4.1 Scientific Innovation

To carry out the scientific breakthrough plan and improve new energy vehicles' performance and quality. For an enterprise, it must acquire strategic foresight to seize the opportunities to develop the new energy vehicles. By increasing investment in developing and establishing developing alliance with universities and research institutions, enterprises could study the new energy vehicles' essential technology and parts. For example, improving existing internal combustion engine's efficiency and reduce polluting emissions, using substituted clean energy to reduce the dependence on fuel, developing high power rate and power saving electric motors and charge stations. Of these researches, the most important one should be the development of fast charging, long usage-span and high endurance (over 300KM) electric vehicles' battery, because the electric drive system, which often takes up to 50% in the cost of the whole vehicle, is the most essential part of some most common new energy vehicles, such as hybrid power vehicles, pure electric vehicles and plug-in hybrid vehicles. Also the battery takes up to 50% to 70% in the cost the electric drive system, so the batteries' performance and cost directly decides the developing route of new energy vehicles.

4.2 Finance Innovation

In the development the new energy vehicle, funding is a key element. So it's important to innovate in the way of fund raising and multiply financing channels in order to gather more capital for developing, purchasing production equipment, installing charge stations and accelerating the market promoting. Shenzhen has been discovering in this aspect of developing. Aiming at solving the problem of higher prices, unmatched usage-span between vehicles and batteries and incomplete charging station networks, Shenzhen sticks to the developing

mode of "government supporting and supervising, enterprises fund raising and operating, technology innovating and modifying", in which financial institutions provide financing lease services for electric taxis, which solves the problem of higher prices and operating risks and promotes the sale of electric vehicles and increase the market share of electric vehicles(Pan, 2015).

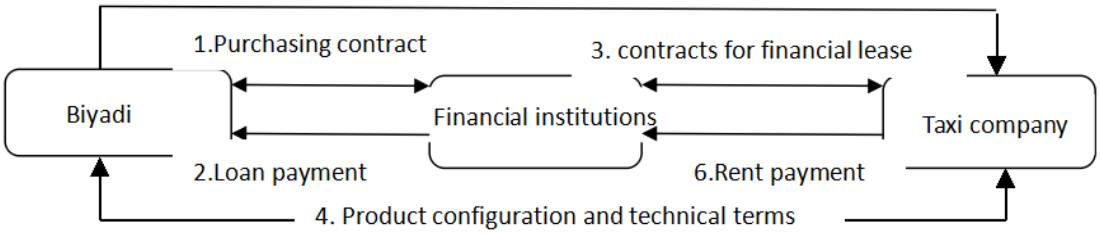

Figure 4. The business mode of electric taxis in Shenzhen

4.3 Policy Innovation

The environmental benefit new energy vehicles bring is non-excludable and positively external, which makes it difficult to self-develop in the fierce market competitions. So the government needs to draft some policies to support the development and promoting of new energy vehicles products (Rennings, 2000). These kinds of policies often come in two genres: Mandatory technological revolutions policies or market-based adaptive policies (Jaffe et al., 2002).The former's main form is the enterprises' compulsive technological revolution with the goal set by government (Lee et al., 2010).The market-based adaptive policies are more common, such as the preferential tax policies, Innovative research and development subsidies and so on. The latter indirectly encourages and stimulates enterprises to develop and revolutionize its technology (CBO, 2010). The government could carry out **some of the policies below**, in order to push new energy vehicles industries' development.

- Enlarge the supportive strength of enterprise innovation policies. The policies are the compass of industry developing, which means great guidance and coordination to the developing of new energy vehicle industry, the main focus of government would often shows the direction of their future for the producers. Government mainly uses mandatory policies to push technology revolution or other adaptive policies based on markets for guidance and support. Mandatory technology revolution means strict production standards, no production and sales are allowed if the products could not reach the technological standards. In order to stimulate the innovation of new energy vehicles, supportive policies are often needed (Kemp, 1997). However, it's probably not so necessary after the new energy vehicle industry has formed a well operating market itself. The supportive policies commonly mean government giving capital support and policies benefit to active new energy vehicle producers, and shows recognition and reward to the extraordinary ones, so it could effectively increase the willingness of innovation actions. Governmental support and guidance should not be focused on electric vehicles only, though (Sierzchulaw et al., 2012). Whatever that could contribute to energy saving and emission reduction should be rewarded. Approving progressive innovation and radical innovation at the same time, then we could achieve the expected goal.

- Improving consumers' purchase subsidy and usage benefit. For example, American and Japanese government provide purchase subsidy for hybrid energy vehicles. This policy has formed a stable hybrid vehicle market with the help of rising gasoline price and the development of electric vehicles. As far as China's market is concerned, in order to promote the new energy vehicles, the government should pay attentions to the market terminals other than just the enterprises, so the consumers' purchase subsidy for new energy vehicles could be improved. April 29th, 2015, the finance department, science department, industry department and information department together with National Development and Reform Commission released the *Notice*, which shows that by 2016, pure electric vehicles have the subsidy of 25'000-55'000 yuan per car according to the miles, while the electric buses have the subsidy of 120'000-500'000 per car. The subsidy standard of 2017-2018 would decrease 20%, and 40% in 2019-2020 (Wu, 2015). This kind of subsidy policy doesn't work well in the market, neither does it for the financial policies. The main reason is that the subsidy is far too less to make up for the extra fee consumers have to pay when they purchase the new energy vehicle instead of conventional vehicles. Thus, China ought to increase the scale of subsidies, making it enough to make up for the prices numerically (at least for a period of time). The government could also exempt the freeway fees, Bridge fees and parking lot fees for the electric vehicles, and benefit could be provided on vehicle license, which would make consumers directly feel the benefit of purchasing new energy vehicles and therefore have less refuse when purchasing. Also the market

share of new energy vehicles would be increase due to this.

- Improve the assistant facilities' construction and popularization. Because of the specialty of the new energy vehicles, many other equipment and facilities are required for its using (such as the charging stations, charging stop and clean fuel). Lack of relative assistant facilities is an important reason that China's new energy vehicle struggles to develop. In order to push new energy vehicles' development, the relative facilities must be complete, so they could provide the necessary conditions for the new energy vehicles. The government should also accelerate in formulate the industry standards such as clean energy standards, chargeable batteries standards. So it could solve the problem purchasers might encounter. Especially for the charging stops, the government, electricity networks and enterprises should work together closely to construct charging stops in main gas stations, living region, shops and parking lots, in order to provide electric vehicles users more convenience.

The national electricity networks have been operation the charging service networks' constructions. By 2012, 12 charging stations and 274 charging stops have been constructed in the area of Beijing. Also the biggest, most powerful and eco-friendly charging stations in the world, the Gaoantun station have been constructed. Across the country, there are stations being built too. For example, *Guangzhou's electric power vehicle charging station construction plan 2010-2015* expects 61 bus charging stations (including 38 normal speed stations and 23 fast speed stations), 54 bus fast charging stations and 80110 normal speed charging stops would be built by 2015(Anonymity, 2014). However, with the vast surface and big population of China, these charging stations could hardly satisfy the need of new energy vehicles. The government should make the plan earlier and more reasonable, accelerate the construction process and make a good base for the development of new energy vehicles.

4.4 Marketing Innovations

The government could carry out **some of the policies below**, in order to push new energy vehicles industries' development.

- The government should promote new energy vehicles in public transportations and government transportations. With the government purchasing the new energy vehicles and supporting enterprises' innovation development, public and government transportations with new energy vehicles could be a model to introduce new energy vehicles the consumers. So the consumers could easily understand and accept the new products.

- Strengthen the new energy vehicles' propaganda. Using televisions, newspapers and car sales shows to propagate the new energy vehicles' benefit in saving energy and reducing emissions, also pushing out more theoretical vehicles for consumers to test drive and comment, consumers could get the knowledge of the new energy vehicles and accept it. Meanwhile the vehicles are being improved constantly, and provide new products for the market.

- Enterprises should acquire the basic need of the consumers by referring to the market research, so it could find out its position in the vehicle market and release products with better cost performance. In reality, the urban pure electric vehicles' import should start with low-end small cars priced within 50'000 yuan, with the medium speed and endurance ability and fashionable looks. Their main potential customers would be white collar class who pursue fashion and new-born products, with their help, the sales of the new energy vehicles could be constantly increasing, and the industry could be developed faster.

5. Conclusion

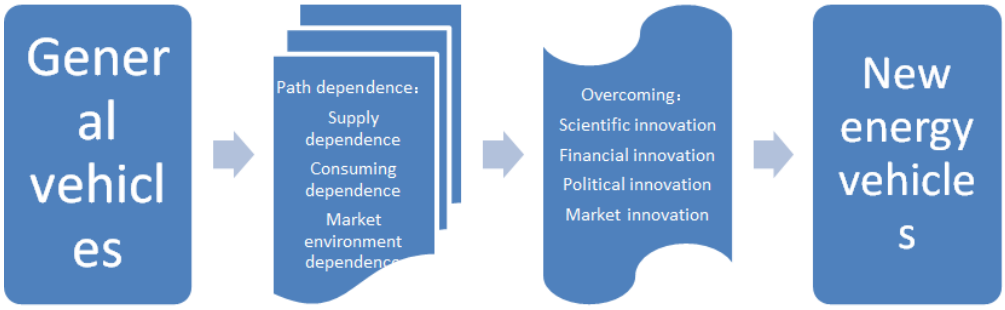

Figure 5. The development path of new energy vehicles

In summary, it's obvious that China's new energy vehicles developing route differs greatly from that of other foreign countries. In the foreign countries, the development goal of new energy vehicle is clear, adding that developed countries' innovation and marketing developing patterns are perfect conditions for the new energy vehicles to breed. After the test of time and market, the best models of new energy vehicles would come out eventually. Compared to that, China's new energy vehicles industry is single handedly led by the government. Most of the enterprises focus on development of electric vehicles and hybrid vehicles. However, with the limitation of technology level, equipment and consumers' psychology, China's new energy vehicle industry has a tough time developing well.

Thus, I suppose enterprises and the government should follow the rules of marketing and innovation patterns, reach the goal of producing variable innovation products with suitable policies, facilities and market by going in the direction of new energy vehicles developing route. After that China's new energy vehicles industry could finally overcome the problem of path dependence and accelerates in developing itself.

As for the future studies of China's new energy vehicles development, the developing path should also be focused on innovation variety and corresponding policies, facilities and markets.

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