Opportunities and Challenges of Electric Vehicles Development in Mitigating Climate Change in China

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Abstract. As a developing country, China has also undergone a noticeable climate change due to the increasing consumption of fossil fuels. The automotive market in China is estimated to be the world’s second largest new automotive growth market. China is now capable of manufacturing cars totally independently, which makes car prices more attractive to middle-income families. As one of the energy solutions, Electric Vehicles Technologies cannot be considered solely in environmental aspects. One energy system should not only contribute to sustainable development, but also to the environmental, social and economic aspects.

1. Introduction

The term motorized transport has never developed without the companion of the term energy. No matter the steam engine in the 18th century or the later invented internal combustion engine (ICE) or the electric motor or hybrid cars, transport development has undergone a process of matching proper energy supplies with updated technologies. Over the past centuries and up to now, ICE has been playing a dominant role in road transport. The use of fossil fuel has within the same period been relied by the modern society. However, being a limited and contested resource, oil has rapidly been explored and consumed, which revealed a day of oil depletion. Due to that the reservation of oil is mostly in the areas that are today politically unstable, and the oil prices are also fluctuating, which is the threat to a large part of the car users. But more importantly, the atmosphere has been severely damaged by CO2 and other greenhouse gas emissions from ICE driven vehicles. The impact of the greenhouse gases will increase gradually in the temperature level of the Earth. Wherever we looked, we saw evidence of destruction: melting permafrost, higher sea levels and unpredictable climate changes. “Climate change, which has identifiable potentially catastrophic effects on the environment and human security in the broadest sense, cannot be halted, much less reversed, without the control and reduction of carbon dioxide emissions into the atmosphere.”[1] According to IEA (International Energy Agency) predictions, global emission of CO2 will be 60% higher in 2030 than they are today if no counteracting political action is taken [2]. Climate change is a very important global challenge we are facing. The action that we fight pollution of emission especially come from vehicle is therefore needed nowadays and all sectors of society need to make prominent contributions.

The introduction of electric vehicles (EVs) has been a proposal to prevent climate change and attempts have been made in several countries during the 1980s and 1990s such as the USA and Denmark. However due to battery technology deficiency, the attempts were unsuccessful and given up. As the oil price increase and the atmosphere is severely damaged, the attempts of reintroducing EVs emerged in recent years in several countries such as USA, Japan, Denmark and China.

China has been undergoing a strong economic growth and at the mean time the demand of energy has also surged rapidly. As a developing country, China has also undergone a noticeable climate change due to the increasing consumption of fossil fuels. So, China is promoting electric vehicles (EVs) as another alternative CO2 reducing energy resource. The automotive market in China is

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estimated to be the world’s second largest new automotive growth market. China is now capable of manufacturing cars totally independently, which makes car prices more attractive to middle-income families[3].

At present, the key driver of EV is the improvement of battery technology. The major factors of battery technology are the range per charge, weight, battery life and cost. The development of advanced batteries such as lithium-ion is in progress.

2. Current situation of EV development in China

In order to solve energy supply issue, an electric vehicle technological innovation research was carried out. For many years, exploration and practice of the scientists has proved that the electric vehicle system can be improved significantly. This kind of electric vehicle system has been planned as project in some countries. In the future, the environment need suggestions that emissions of vehicle exhaust will decrease in big leaps during the next 50 years. In this point of view, emission goal will be near zero emissions.

In China, the private cars stock that relies heavily on fossil fuel is an indicator of cars use. This has important impacts on global environment. Private car use is increasing most rapidly in China. The private cars stock increased almost 4.6 times between 2005 and 2014[4]. As EVs begin to penetrate the automotive market, the shares are likely to increase, and global sales of electric vehicle is on the rise. (See figure 1)

![Figure 1. Global sales of EV](image1)

From 2014 to 2020, the EV stock will increase almost 50 times from seventy-eight thousand to more than 4 million EVs by estimation (See figure 2).

![Figure 2. EV stock target](image2)

The developmental trend in China involves a continuous growth of automobile industry. The government considers the automobile industry as one of the seven “pillar industry” of the economy. China has set EV sales targets to signal long-term commitment to vehicle electrification. According to
the report of EVI (Electric Vehicles Initiative)《2015 global electric vehicle and charging infrastructure outlook》, from 2012 to 2014, USA(39%)、Japan(16%) and China(12%) are countries with fastest growing EV sales in the world.

In 2014, New energy vehicles sold 74763, pure electric vehicles accounts for about 60%, an increase of 2.1 times [7]. (See figure 3)

![New energy vehicles sales in 2014](image)

**Figure 3.** New energy vehicles sales in 2014

There are 230 million e-bikes, 83,000 e-cars and 36,500 e-buses on the road in China by 2014[8].

3. China’s Policies and Measures to Spread of Electric Vehicles

Target-setting is by no means a prerequisite for, or determinant of, successful EV deployment, but it is useful for understanding the level of ambition and support from national policymakers[9].

In order to fulfil China’s Climate Change Program, the Chinese government intended to address climate change by means of sustainable development strategy. Key areas were targeted to reduce GHG emission by the strengthening of institutional, legal, economic, and technological instruments and hence to achieve energy conservation, energy structure optimization as well as ecological improvement.

The key targeted areas for potential spread of Electric Vehicles are listed below:

| Year | Policies and Measures                                                                 | Highlights                      |
|------|--------------------------------------------------------------------------------------|-------------------------------|
| 2007 | Chinese government launched ‘863 Initiative’                                         | Encourage R&D                  |
| 2009 | 《New energy automobile production enterprises and product access management rules》   | Refinement phase               |
| 2010 | 《Notice on carrying out the pilot of the private purchase of new energy vehicles subsidy》 | First subsidy policy           |
| 2012 | 《Energy saving and new energy automobile industry development planning(2012-2020)》  | Put forward industrial planning|
| 2012 | 《Electric vehicle technology development "Twelfth Five Year" special plan》             | Establish three goals          |
| 2013 | 《First new energy vehicles pilot cities announced》                                    | Government push to implement   |
| 2014 | 《Notice on further promoting the application of new energy vehicles》                   | Promoting the application of new energy vehicles |
| 2014 | 《Announcement on new energy vehicle purchase tax》                                     | Stimulating                   |
In order to follow up with the ambitions on the Electric Vehicles, laws and regulations are to be constituted by the Chinese government. Each entity’s responsibility will be clarified; policy incentives and efforts on discipline will be intensified; legal executants will be identified. Supervision and monitoring will be enhanced on spread of Electric Vehicles. Preferential policies for Electric Vehicles products will be formulated. Tax policies will be made favourable for the sale of Electric Vehicles. The government will also guide the public to purchase energy-saving and low carbon emission vehicles and disseminate the idea of conservation-orientation. Scientific research and technological development shall be promoted; constructions of talents and financial support are to be strengthened. Finally, public awareness will increase by using the promotion function of the government. Awareness will penetrate through all levels through a top-down procedure. Besides, publicity, public participation, education and training will be reinforced by the government. International cooperation and communication shall be reinforced in order to promote public awareness on climate change issues as well as exchange experience of other countries on climate change publicity and spread of Electric Vehicles. [9]

### 4. The development of EV key-technologies in China

Key activities for countries seeking to help technological innovation reach full market potential. As seen in Figure 4, Based on analysing the geographical distribution of electric vehicles patent, which can reflect the technical strength of individual countries. We can find that Japan is in a leading position, up 55.3%. China ranked second, accounted for 18.4%, but there is considerable distance compared with Japan.

![Figure 4](image.png)

**Figure 4.** The geographical distribution of electric vehicles patent over the world

From 1971, Japan has started to research EV technologies. The number of patents in nearly three years accounted for 17% of his total patents. However, China started to research EV technologies since 1988. The number of patents in nearly three years accounted for 51% of China’s total EV patents. Otherwise, China's enterprises still far compared with Japan, the number of Toyota's EV patents related to 3743, but China enterprise Chery only has 134 EV patents.
The earliest patent application for electric vehicles in China is in 1998. Before 2001, there is a relatively small number of patents in China. After 2001, the amount of patent applications and publications is beginning to show a steady upward trend, especially the rapid increase in 2009 and beyond. (Figure 5)

![Figure 5. The development trend of EV patent in China](image)

Along with rapidly development of EV in China, EVs have the potential to unlock innovation and create new advanced industries that spur job growth and enhance economic prosperity.

5. The Challenges of EV development in China

Despite the advances that vehicle electrification has made in the past two years, there are still significant barriers that stand in the way of widespread adoption. Technological, financial, market, and policy challenges could hinder market transformation if not addressed through further RD&D investments, public-private collaboration, and innovative policy and business solutions. The electric vehicles market in China will have the following specific characteristics:

1. Main driver for electric vehicles market in China
   Environmental protection is the main driving force for bringing electric vehicles into China’s market, in particular mitigating climate change. And another important driving force is energy shortage. Application of electric vehicles in China’s market can reduce the oil import dependency.

2. Main competitor for electric vehicles in China
   In the industry sector, electric vehicles will also face fierce competition from traditional cars as well as other newly developed technologies such as hybrid cars and hydrogen cars. Although electricity is cheaper than oil, electric vehicles system is so immature that higher price of electric vehicles is resulted from the higher initial investment. Cheap and abundant domestic traditional cars are the key competitors to EV.

3. Main hurdle for electric vehicles in China
   Most renewable energy in scattered areas is only a small fraction (9.3%) of Chinese energy supply, which is hampering the development of construction of nationwide grid for electric vehicles based on clean energies.

   Otherwise, the most significant technological challenges currently facing EVs are the cost and performance of battery. Most EVs will remain more expensive in the near term than their petrol vehicle equivalents even when combined with government purchase subsidies offered in many countries.

4. Huge need for investment in China
   Even electric vehicles system has enough investment to develop the electric cars, recharge stations and batteries, China would need much more investment to extensively expand the national market and construct nationwide grid for EV. It would be a huge investment and long term plan.

5. Policy framework for electric vehicles in China
   The policies are also very important and affect future growth of electric vehicles market in China. Although Chinese government already has the plan to improve environment and develop the electric vehicles project, the regulatory framework is not clearly defined yet and policy has low priority.
assignment. For example, Chinese government can make policy to reduce the import tariff and VAT (value added tax) on electric vehicles technologies and equipment for the use of the renewable energy.

6. CONCLUSION

To sum up, we think that there is a market and economic feasibility of developing EVs in China. With all the driving force on position, what is still missing is much more investment on constructing both renewable energy plants and EVs for the purpose that EV market can be eventually formed.

As we all know, it is the common topic to modernize the society and protect the environment. Here, electric vehicles system is the double-win method relating to this topic. In the last decade, people always thought a lot of economic development and financial benefits. However, they often ignore the energy storage and environment breakage. At the same time, more and more problems came into human’s concern, which violates the purpose of sustainable development. Let us think about the electric vehicles system. The development of electric vehicles can offset its dependence on imported oil. The other side, vehicle exhaust is the main greenhouse gas. If we can abase the vehicle exhaust, we can achieve environmental protection. Electric vehicles system is definitely one way of sustainable development. So far we do not have many large-scale electric vehicles demonstration projects because of the high costs. In the world, there are only a few pilot projects in some specific areas. It is not enough for electric vehicles development and progress. If we want to spread it out, we need to make more large-scale electric vehicles demonstration projects. For the government, they need to change policy to enhance the promotion of electric vehicles technology in industry in practice. For more and more demand of market, it will be indispensable in the future. Concerning the Better Place project, not only Demark but also the other countries started to test and practice electric vehicles system. For modernizing and protecting environment, it is profound in the future.

At the government part, Chinese government also plays a very important role in this whole project. Collaboration on research development and demonstration occurs among the countries. National policy and international policy collaboration also took place decades ago, which includes the efforts of technologies and equipments from the developed countries to developing countries. ‘These efforts include, in particular, bilateral cooperation, and more collective efforts through regional cooperative frameworks such as the Chinese battery maker BYD, State Grid Corporation of China (SGCC).’ [10] As one of the case study, there are some organizations, like Better Place who attempted to research and experiment to some local sample factories as well as the technology collaboration and international collaboration with China where it takes place. For the import of the key technologies and facility, exemption or reduction of import VAT (value added tax) should be granted. Furthermore, most renewable energy technologies are mature from abroad, and these energy technologies are open for commercial and industrial investment.

Moreover, energy system is also the main driver to promote the development of EV technologies. At present, gasoline and diesel provide the most of the transport energy. EV can use electricity to provide power for transportation. Electricity has already provided power for some rail network. In future, electricity will be used to charge batteries in fully electric vehicles. The demand for mitigating climate offered by future electricity based EV system would therefore be dependent on the clean energy, such as renewable energy, nuclear energy and coal energy with carbon capture and storage. The renewable energy is widely distributed in different parts of the China, which can form a mix grid. And EV might be recharged principally at night when electricity demand is lower. So EV system has less impact on the requirement for additional electrical capacity and EV can be used to absorb some surplus electricity form discontinuous forms of power generation. In the future, electricity based on the EV could have important impacts on Chinese electricity demand. Government shall also intervene energy system so that electricity power generations are moving to lower carbon electricity generations.

More and more countries have begun to attach importance to the reality of global climate change and attempted to modify their power framework towards a more environmentally friendly pattern. They will sooner or later compel the applications of electric vehicles in their market and society.
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