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# Energy issue of pure electric vehicle in China

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**Abstract**

PEV（pure electric vehicle）promotion can not only mitigate the recent traditional vehicle contradiction between supply and demand of energy, solve the vehicle energy problem after the exhaustion of fossil fuel, but also improve environment quality and energy utilization efficiency.But PEV promotion is restricted by infrastructures such as energy, power supply, charging station and so on. According to the composition characteristics of Chinese primary energy, situation of Chinese power industry and requirement of power infrastructures of pure electric vehicle, I analyzed the shortcomings in the power industry while PEV are promoted in China. There are four major problems in PEV promotion. First, in China more than 70% power supply is from coal, and the average coal consumption of power generation is high. Second, electricity generation per person-year of China is far less than that of developed countries, and power shortage exists in some areas. Third, the stability of power supply is poor because it can be easily affected by some uncertain factors, such as the supply of water, coal and natural gas. Furthermore, current power capacity can not meet the requirements of the PEV promotion. In order to promote PEV, power industry must acquire high power efficiency, sufficient power supply, and extensive use of clean fuel or renewable energy etc. EVS25 Copyright.

*Keywords: PEV, power supply, Energy issue*

## 1 Introduction

The date of main fossil fuel exhaustion approximates gradually, and traditional fuel vehicles face the increasingly serious problems of energy. But pure electric vehicle depend on power which have wide variety of sources, it can not only relieve the contradiction between energy supply and demand of current traditional vehicles, but also solve the vehicle energy problem after fossil fuel exhaustion. In addition, in the driving process, there is no harmful emission and the noise is low[1]. It can also achieve efficient use of energy by recovering vehicle braking and deceleration energy with the braking regeneration technique. Therefore, in the future vehicle industry PEV become the

focus of competition and the main direction of development. Grasping the key technology of the PEV is equivalent to master the future of automobile industry. Governments of all countries pay great attention to the development of PEV, not excepting Chinese government. The factors that influence the PEV promotion are: power and energy supply, dynamic performance, fuel economy and driving range of a PEV, infrastructures like charging station. This paper tries to analyze the advantage and disadvantage of present development of PEV in China from the characteristics of Chinese primary energy structure and the current situation of the power supply-demand.

## 2 The characteristics of Chinese primary energy structure

The characteristics of Chinese primary energy structure are more coal, less oil and natural gas. Coal is the main energy in China for a long time. In Chinese primary energy consumption, coal always constituted a high proportion. In 1952, coal made up 95 percent. In the 1950s~1960s, the proportion that coal accounted for was maintained at 90%; in the 1970s, the proportion dropped to 80%. Since the 1980s, the ratio remained at around 70%. Table 1 shows Chinese primary energy consumption from 2000 to 2008[2]. In 2008, the consumption of oil, natural gas, coal, nuclear energy, hydro electric and total primary energy consumption is respectively 1.680, 3.286, 2.107, 4.079, 2.632 and 2.07 times the data in 2000. This data shows that after 2000, nuclear energy is the fastest growing energy while oil is the slowest in Chinese primary energy consumption.

Table 2 shows the share of Chinese primary energy consumption from 2000 to 2008[2]. The composition proportion changed very little during the 9 years. The range of share of oil, natural gas, coal, nuclear energy and hydro electric consumption was respectively 18.76~23.37, 2.28~3.63, 67.44~70.53, 0.39~0.80 and 5.20~6.61. The natural gas continues to present an upward tendency. The average of share of coal consumption is 69.322% from 2000 to 2008.

Table 1: Chinese Primary energy structure from 2000 to 2008/ Million tones oil equivalent

| Year | Oil | Natural Gas | Coal | Nuclear Energy | Hydro electric | Total |
|---|---|---|---|---|---|---|
| 2000 | 223.6 | 22.1 | 667.4 | 3.8 | 50.3 | 967.2 |
| 2001 | 227.9 | 24.7 | 681.3 | 4 | 62.8 | 1000.7 |
| 2002 | 247.4 | 26.3 | 713.8 | 5.7 | 65.2 | 1058.4 |
| 2003 | 271.7 | 30.5 | 853.1 | 9.8 | 64.2 | 1229.3 |
| 2004 | 318.9 | 35.7 | 983 | 11.4 | 80 | 1429 |
| 2005 | 327.8 | 42.1 | 1100.5 | 12 | 89.8 | 1572.2 |
| 2006 | 346.1 | 50.5 | 1215 | 12.4 | 98.6 | 1722.6 |
| 2007 | 362.8 | 62.6 | 1313.6 | 14.1 | 109.8 | 1862.866 |
| 2008 | 375.7 | 72.6 | 1406.3 | 15.5 | 132.4 | 2002.545 |
| Average | 300.212 | 40.789 | 992.665 | 9.856 | 83.680 | 1427.201 |

Table 2: Share of Chinese Primary energy consumption from 2000 to 2008 / %

| Year | Oil | Natural Gas | Coal | Nuclear Energy | Hydro electric |
|---|---|---|---|---|---|
| 2000 | 23.12 | 2.28 | 69.00 | 0.39 | 5.20 |
| 2001 | 22.77 | 2.47 | 68.08 | 0.40 | 6.28 |
| 2002 | 23.37 | 2.48 | 67.44 | 0.54 | 6.16 |
| 2003 | 22.10 | 2.48 | 69.40 | 0.80 | 5.22 |
| 2004 | 22.32 | 2.50 | 68.79 | 0.80 | 5.60 |
| 2005 | 20.85 | 2.68 | 70.00 | 0.76 | 5.71 |
| 2006 | 20.09 | 2.93 | 70.53 | 0.72 | 5.72 |
| 2007 | 19.48 | 3.36 | 70.51 | 0.76 | 5.89 |
| 2008 | 18.76 | 3.63 | 70.23 | 0.77 | 6.61 |
| Average | 21.429 | 2.757 | 69.332 | 0.660 | 5.822 |

Figure 1 shows the production share and consumption share of Chinese Coal in global from 1981-2008. After 2000, coal is still the main primary energy in China, and its production share and consumption share present an increasing trend. In 2008, both the share of Chinese Coal production and consumption in global reach respectively 41% and 42.6% from 28.02% and 28.5% in 2000.

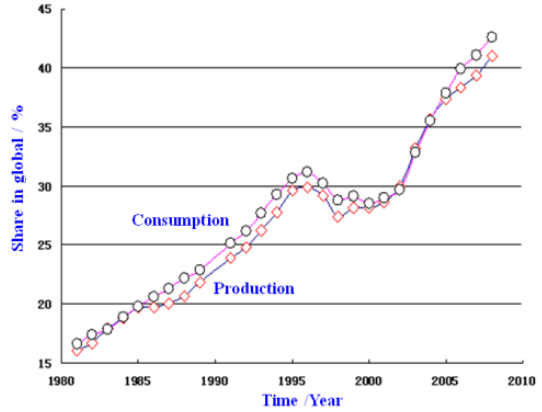


Figure 1: production share and consumption share of Chinese Coal in global

Figure 2 shows the comparison of primary energy consumption and its composition proportion with American, Russian, Japanese, German, French and Italian data in 2008[2]. From this figure, the composition proportion of coal in Chinese primary energy consumption is far higher than other countries. The ratio is 2.37 times 29.25% which is the average percentage of coal consumption of the whole world's primary energy consumption. This is mainly due to the sufficient coal deposits in China.

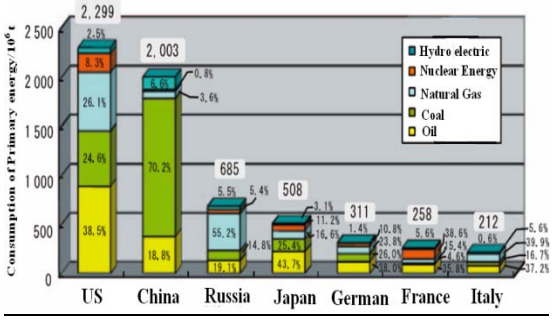


Figure 2: Comparison of Chinese Primary energy consumption and structure with some nations in 2008(Unit: oil equivalent)

## 3 The current situation of the power supply-demand in China

The composition characteristics of energy of Chinese power industry are similar to the characteristics of Chinese primary energy structure. They both consider the situation that in China coal storage is abundance. Table 3 shows in 2009 Chinese total generation capacity issued by China National Energy Board[3-4]. In China coal power is the main part of thermal power structure, accounting for about 95%. Then we can work out that coal power account for 70.869 percent of

Table 3: Chinese Total generation capacity and its share in 2009[4]

| | Total Generation Capacity / 108kilowatt | Share in Total Primary Energy/% |
|---|---|---|
| Thermal Power Generation | 6.5205 | 74.5993 |
| Hydroelectric Power Generation | 1.9679 | 22.5142 |
| Nuclear Electric Power Generation | 0.0908 | 1.0388 |
| Grid-Connected Wind Power | 0.1613 | 1.8454 |
| Other | 0.0002 | 0.0023 |
| Total Installed Generation Capacity | 8.7407 | 100 |

Chinese power composition because the proportion of thermal power is 74.599%. In 2009 Chinese coal consumption rate of power supply was 342g/kWh; the power transmission line loss (line loss quantity/supply) was 6.55%; the average of plant service power consumption rate from July 2009 to November 2009 was 6.68%[3] .

According to existing data, in the load for supply of 600MW sub-critical units can reached 315.5g/kWh; The average coal consumption rate of power supply can reached 317.4g/kWh in one day[5]. The average coal consumption rate of power supply of 600MW sub-critical units and 600MW supercritical units was respectively 329g/kWh and 317g/kWh during 2007 and 2008 in China[6]. In addition, the plant service power consumption rate increased as the power load increased and its value varied with power generation equipment. As the average of plant service power consumption rate of 350MW units was 4.33~6.5% [7] while the average of plant service power consumption rate of 300MW units is 4.64~5.62% [8]. It can be seen that the coal consumption rate of power supply and the plant service power consumption rate both have great potential to reduce. Considering the point of view of increasing energy efficiency, so far vigorously promoting PEV is not good for the efficient use of energy.

Figure 3 shows the changes of China electricity supply and demand index (ratio of per year electricity supply and demand) from 1978 to 2006. In the 28 years, over-supply of electricity is only 12 years and the surplus electricity only up to 9.6%. The Statistics of the Statistics Department of China Electricity Enterprise Federation show that, in 2010, the electricity supply and demand of the whole country is an overall balance with surpluses. But in some areas, such as Shanghai, Jiangsu, Zhejiang, Hubei, Hunan, Jiangxi, Sichuan and Chongqing, electricity supply is lack in some periods of time and shortage of power supply exists. Besides electricity supply is easily influenced by some uncertain factors such as water, coal and natural gas. If we promote PEV in China, we need to solve the problem of the electricity supply shortage and the electricity stable supply.

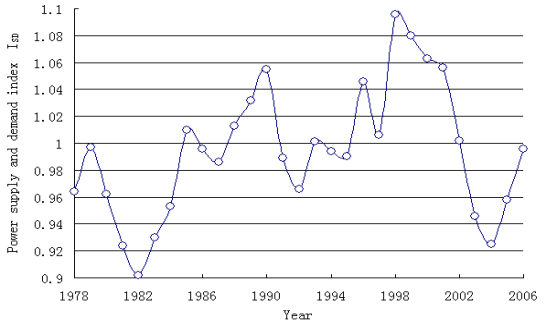


Figure 3: Power supply and demand index (ISD)in China from 1978 to 2006[10]

Figure 4 shows the comparison of per person-year electricity generation in China with American, Russia and the global average. The data of Electricity generation and population is respectively from reference 2 and 11, the data of population shown in table 4 from 2000 to 2008.

The table shows that the differences of per person-year electricity generation between China and American, Russia and the global average are gradually reduced. But even in 2008, Chinese per

Table 4: Global, Chinese, American and Russian populations during the 2000-2008[11]

| Year | China (million) | American (million) | Russia (million) | Global (million) |
|---|---|---|---|---|
| 2000 | 1262.25 | 282.22 | 145.56 | 6052.25 |
| 2001 | 1276.54 | 285.32 | 145.08 | 6106.65 |
| 2002 | 1284.53 | 288.37 | 144.07 | 6199.73 |
| 2003 | 1292.27 | 290.81 | 143.43 | 6272.52 |
| 2004 | 1296.16 | 293.66 | 143.85 | 6369.69 |
| 2005 | 1303.72 | 295.56 | 143.15 | 6462.05 |
| 2006 | 1311.80 | 298.99 | 142.37 | 6517.76 |
| 2007 | 1318.31 | 301.29 | 142.10 | 6614.40 |
| 2008 | 1325.64 | 304.06 | 141.08 | 6692.03 |

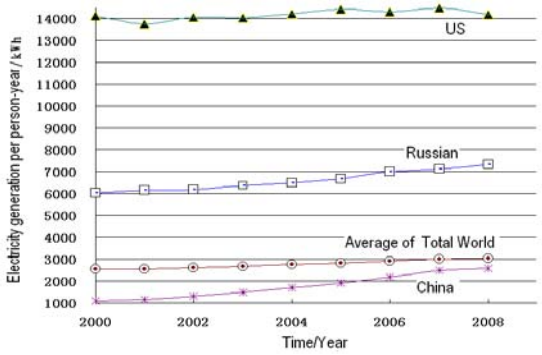


Figure 4: Comparison of Chinese Electricity generation per person-year with US, Russian and Average of Total World

person-year electricity generation is only 84.98% of the global average, 13.96% of American's and 27.52% of Russia's. This shows that Chinese power supply conditions are not superiority. So PEV promotion means to competition electricity with other industries.

# 4 The requirement of electricity infrastructure for PEV

In general, there are three reasons for the PEV promotion. Firstly, it can mitigate the recent traditional vehicle contradiction between supply and demand of energy, improve energy utilization efficiency. Secondly, it can improve environment quality of the impacted area. Thirdly, it can improve the competitiveness of counties or companies in the auto industry. To achieve these aims, we must have an efficient, adequate power supply, a clean production power industry, and infrastructures such as charging stations. From Chinese energy structure characteristics and the current situation of the power industry, we can see that only when the average coal consumption rate of power supply decreased to the level of developed countries, electricity supply was abundant, and less influenced by uncertainty factors such as the supply of water, coal and natural gas, in other words, when the power supply is relatively stable, then it can adapt to the requirements of PEV for the power industry in the future.

According to Table 3, by the end of 2009, Chinese total power generation capacity is 8.7407 billion kilowatts, per person electric power capacity (0.87407 billion kilowatt / 1.33 billion people) is 0.657 kW.

Table 5 shows Chinese Total generate electricity and their Share in 2009, it indicates that hydroelectric power, nuclear power and wind power for electricity generation is less than 20% of the total. Chinese Total generate electricity was 3.6639 billion kWh in 2009, per person electricity generation (3663.9 billion kWh / 1.33 billion people) is only 2754.8kWh. Compared with Figure 4, by the end of 2009 Chinese per person-year power generation is still lower than the global average level in 2008.

Table 5: Chinese total generate electricity and their share at 2009[4]

| | total electricity generation/$10^8$kilowatt-hours | share of total electricity generation /% |
|---|---|---|
| thermal power generation | 29922 | 81.6671 |
| hydroelectric power generation | 5747 | 15.6855 |
| nuclear electric power generation | 700 | 1.9105 |
| grid-connected wind power | 269 | 0.7342 |
| other | 1 | 0.0027 |
| total power generation | 36639 | 100.0000 |

The charging supply is one of the prerequisite for the promotion and widely using of PEV. Constructing charging station has little impact on the electric users in those counties which have high level of electricity energy production and per person electricity power capacity. However, for the lower level countries, it means that the PEV will compete with other electricity users, and it will have a stronger influence on them. The following example is to illustrate the influence.

Suppose we have a PEV, its driving resistance is identical with a GV(Gasoline Vehicle) whose 100km fuel consumption is 6L.And if its battery fully charged, its driving range is 200km. Then Energy consumption of PEV can be estimated by the GV's energy consumption (Egv).The calculating formula is as follows.

$$Egv=200km\times(6L/100km)\times0.74kg/L \times43.2MJ/kg\times20\%=77.76MJ \quad (1)$$

In this formula: 0.74kg/L、43.2MJ/kg and 20% represent gasoline density, low heat value and the average effective energy conversion efficiency.

Converted Egv to electricity, we can get the consumed Epev(Energy consumption of PEV) when PEV travel 200 km.

$$Epev=77.76MJ\div3.6MJ/kWh\div90\%=24kWh \quad (2)$$

In this formula: 3.6MJ/kWh and 90% represent the coefficient of energy conversion and the comprehensive efficiency of PEV

Formula (2) shows that, the PEV whose driving range is 200km, need to charge nearly 24kWh at one time. This is basically consistent with developed PEV whose power consumption per kilometers is 0.12～0.15 kWh[12]. The relationship between charger charge time tc and power Pc of the PEV, which is equal to a normal GV whose fuel consumption is 6 liters per 100 km, is shown in Table 6.

The ratio of charge power PC and per person electric power capacity PPECP is also shown in Table 6. At the end of 2009, PPECP equals to 0.657 kW. Table 6 indicates that as for the China power industry, in order to ensure a PEV which is equal to a normal GV of 6L gasoline consumption per hundred kilometers to drive 200km, the power consumption is equivalent to 142.9 PPECP in China using the fast charging way of 15 minutes, and even if use a slower way of 10h, it also equivalent to 3.6 PPECP. Thus PEV promotion means to enlarge power capacity substantially.

Table 6: Relationship between charger charge time tc and power Pc

| tc/h | Pc/kW | Pc/PPECP |
|---|---|---|
| 0.25 | 96 | 142.9 |
| 0.5 | 48 | 71.4 |
| 0.75 | 32 | 47.6 |
| 1 | 24 | 35.7 |
| 5 | 4.8 | 7.1 |
| 10 | 2.4 | 3.6 |

## 5 Conclusions

PEV promotion can not only mitigate the recent traditional vehicle contradiction between supply and demand of energy, solve the vehicle energy

problem after the exhaustion of forward fossil fuel, but also improve environment quality and energy utilization efficiency. Carbon emissions can be reduced when we use renewable energy sources to generate electricity. But PEV promotion is restricted by power supply, infrastructures like Charging Station and energy structure and so on. Only when the power industry has a high energy conversion efficiency and adequate supply, and extensive using of clean fuel or renewable energy, the promotion of PEV can really reach people's good wishes.

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