All-Electric Vehicles Unlikely to Reduce Air Pollutant Emissions In China Through Mid-Century

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Abstract

For this analysis we used an econometric-engineering model of China's electric power system to assess whether replacing gasoline powered vehicles (GVs) with all-electric vehicles (AEVs) in China would reduce emissions of carbon dioxide and other air pollutants between 2015 and 2050.[2] We also assessed whether there is a cost advantage for AEVs. We found that AEVs increase emissions (and costs) compared to GVs, even in a scenario that assumes very high use of renewable electric power sources. We conclude that the efficiency of passenger cars, whether AEVs or GVs, is more important than the energy carrier—that is, electricity or fuels—for meeting emissions reduction goals.

Introduction

Growth in China's fleet of personally-owned, light-duty cars (see Box 1: Vehicles Considered in This Study) poses serious environmental challenges. China already faces dangerous levels of air pollution in all of its major cities. Growing fossil fuel use in the transportation sector could easily confound the nation's commitment to reduce its carbon footprint. These concerns (among others) have led to a substantial policy push for AEV utilization in China.

Box 1: Vehicles Considered in This Study

We used the following definitions:

- All-Electric Vehicle (EV): a car that runs solely on electricity and uses no gasoline.
- Gasoline Vehicle (GV): a car that uses gasoline for some or all of its fuel (may be a hybrid electric vehicle).

This analysis is limited to light-duty, personally-owned passenger cars (as defined by the U.S. Environmental Protection Agency). We did not assess the impacts of switching corporate fleets, buses, or trucks to electric power.

These policies benefit both the manufacturers and purchasers of AEVs. The Ministry of Industry and Information Technology (MIIT), for example, issued a 2013 document on calculating average fuel economy that allows carmakers to count AEVs as “zero emissions” and use them as offsets for gasoline powered vehicles at a 5/1 ratio.[3] Beijing’s municipal government allows AEVs on the road 7 days per week while GVs may be used only 6 days. Similarly, all property developers are requested to reserve 18 percent of parking space for AEVs in residential areas.[4] The central government and local governments subsidize purchase of electric vehicles in many regions of the country.[5]

Encouraging the use of AEVs shifts emissions from a car’s tailpipe to the electric power system, which is dominated by coal-fired power generation in China. This approach—addressing a problem by changing its locus—is seen elsewhere in China’s Action Plan on Preventing Air Pollution.[6] For example, production of synthetic natural gas from coal would shift some of the problems from the direct use of coal in China’s densely populated eastern cities and provinces to the less-developed western provinces, but it will increase rather than reduce carbon emissions. We conducted this analysis to find out whether replacing GVs with AEVs in China would do more than change the location of specific environmental problems – atmospheric emissions of carbon, sulfur, and nitrogen—by reducing these emissions in the short-term or long-term.

We used the China 8760 Grid Model[7] to test the effects of increasing demand for power by growing the AEV fleet. The model can be used to assess the costs and emissions of all the major fossil and non-fossil power generating sources on an hourly basis The model includes a module that directly compares costs and emissions of varying levels of future GV or AEV use. Tables 1-5 present many of the critical assumptions that underlie our modeling effort.

Methodology specific to this analysis follows.[8]

Assumptions and Methodology

Electric Power Outlook

Today over 70 percent of the electricity used in China comes from coal-fired generating plants.[9] Energy intensive industrial production dominates the economy. Despite China’s reputation for strong energy efficiency regulations, demand for electricity has grown at least as fast as the economy for the last 10 years.[10]

For this analysis, we projected a future in which China successfully implements very aggressive energy efficiency requirements and makes a substantial shift away from energy-intensive manufacturing as a basis for economic growth. The full-blown commitment to efficiency coupled with economic structural change keeps electricity demand at a level that can be largely supplied by low-carbon power sources. The results presented in this paper are based on a scenario that requires at least 80 percent of year 2050 power demand to be supplied from renewable power sources if they are available.

Vehicle Fleet Outlook

Today China has a little over 0.05 passenger cars per capita,[11] and we project growth to as much 0.5 passenger cars per capita by 2050. Although AEVs today constitute a small fraction of China's passenger car vehicle sales, we assume—for analytical purposes—substantial growth and a potential share of 85 percent of the market in 2050.

We incorporated energy-efficiency in the automobile fleet in a manner we believed would be neutral to the case for either the electric or fossil-fuel vehicle. The Chinese government appears to be working toward a corporate fuel economy standard of 4.5 liters per 100 km by 2018. That means that all new GVs would have to be almost as efficient as the Toyota Prius is today, and we assumed gradual progress toward that standard to 2050. China has no efficiency standard for AEVs, and we identified no official efforts to develop one. Therefore we assumed that the consumption level of the most efficient AEV models on the market today—roughly 0.18kW/kilometer—would be the standard for all new AEVs by 2050. No assumption—including the degree of use of renewable power supply or the total number of automobiles—makes more difference for our comparisons than those for the comparative energy-efficiency of gasoline and all-electric vehicles.

The major assumptions driving our results are provided in Tables 1-6. Assumptions specific to vehicles are provided in Tables 1 and 5. Table 6 provides summary results, as do Figures 1-5.

Please refer to www.Entri.org/publications for detailed methodological information on the China 8760 Grid Model. The methodology for evaluating all-electric vehicles versus gasoline-powered vehicles was comparatively straightforward and can be summarized in five steps:

1. Key assumptions are made and input into the model for vehicles per person, distance traveled per year, efficiencies of the vehicles, incremental cost of all-electric vehicles and the rate of reduction in that cost, tailpipe emissions for oxides of nitrogen, carbon dioxide, particulates, total hydrocarbons, and for mix, efficiency, and emissions levels for power supply over time through 2050.
2. Key elements of policy components for scenario construction are chosen for the modeling runs, including the use of nuclear power, renewables, natural gas, degree of electric power utilization efficiency, and structural change in the economy.
3. The costs of a selected scenario are then compared with and without all-electric vehicles, with the incremental purchase cost of electric cars and the cost of power supply compared with the purchase and fuel costs of gasoline vehicles.
4. The emissions of carbon dioxide, sulfur oxides, nitrogen oxides, and particulates from vehicles and the power supply system are compared.

The net change in carbon emissions brought about by the use of all-electric vehicles is calculated by subtracting from the emissions from electricity generation used for vehicles the emissions that would have been emitted using gasoline instead for powering cars. That is,

$$C = C_{\mathrm{GV}} - C_{\mathrm{EV}}$$

where C means net carbon emission increase or decrease for the years 2015-2030, measured in tonnes of carbon dioxide (converted at 3.67 times the carbon equivalent).

The emissions of carbon from gasoline vehicles is calculated as follows:

$$C_{\mathrm{GV}} = V * D * \eta_{GV} * K_P$$

where V means passenger vehicles, D means distance traveled, η_{GV} stands for fuel efficiency (for example, liters per 100 km), and k_P is the carbon coefficient of petroleum or gasoline or substitute, which is assumed for this paper to be 19 kilograms of carbon per gigajoule.

The emissions of carbon from all-electric vehicles is calculated as follows:

$$C_{\mathrm{EV}} = V * D * \eta_{EV} * K_E$$

with η_{EV} standing for the efficiency of all-electric vehicles in watts per kilometer traveled, and K_E meaning the carbon intensity of electricity production, which is a value estimated by the China 8760 Grid Model. It is important to recall that in the case of all-electric vehicles—as for any incremental electricity demand—the carbon coefficient is a matter of the incremental electricity generated to satisfy the incremental demand. In this study, coal is the main fossil fuel used for power generation and the carbon coefficient for coal is assumed to be 25 kg per gigajoule. This calculation is performed in this study very simply—by subtracting the emissions of a given overall η_{EV} electric power scenario for China *caeteris paribus* from the emissions resulting from the same scenario in the absence of the use of all-electric vehicles. In the case without all-electric vehicles, coal-use by 2050 drops by over 90 percent in comparison to 2015. In the case with all-electric vehicles, coal use in 2050 drops to 65 percent of the 2015 level.

The resulting net emissions is reported on the basis of annual or total 2015-2050 emissions as metric tons of carbon dioxide.

The value of *V*, or total number of vehicles, is the same each year for electric or gasoline cars, depending on whether the scenario assumes the use, or not, of all-electric vehicles. The total vehicles of either type for a given year is derived from assumptions for the saturation of total vehicle use and the number of cars added per year as a function of time. The vehicle population assumed in this study was based on assumptions for the rate of cars per person in 2050, or 0.6 for China, and is based on the relatively low (by international developed country standards) current Japanese level. The share of total cars on road assumed to be plug-in electric versus gasoline is 0 or 85 percent, depending on scenario.

All carbon and efficiency assumptions are listed in Tables 1-5.

The cost differential of all-electric vehicles is calculated as the purchase cost difference of the average electric vehicle times the number of vehicles purchased plus the cost of electric power consumed to run the cars, less the cost of gasoline that would be used otherwise. The cost methodology follows:

$$R = R_{GV} - R_{EV}$$

where R is the net amount of the purchase price difference for all-electric vehicles over gasoline vehicles plus the net amount of the difference in the cost of electricity and gasoline used by the vehicles over the period. That is:

$$R_{GV} = K_{EV\text{-}GV} + V * D * \eta_{GV} * P_G$$

and

$$R_{EV} = V * D * \eta_{EV} * P_E.$$

The variables P_E and P_G represent the prices of electricity and gasoline respectively. The "price" of electricity is actually an average cost value for electricity and is an output of the China 8760 Grid Model. The variable K is the premium paid for an electric vehicle over a gasoline vehicle and stems mainly from the battery cost. The purchase cost initially starts out as a premium of $6,000 per car purchased in 2015 and declines at 7 percent per year. The cost of electricity is an output of the China 8760 Grid Model. The assumed price of gasoline starts in 2015 at the current level of about 6 RMB per liter (about $1 per liter) and increases to about 8 RMB per liter by 2050. Usage for the average vehicle is assumed to be 30 kilometers per day for both electric and gasoline vehicles. Corporate vehicle fleets and trucks are excluded from this study.

Emissions of sulfur and nitrogen were calculated similarly to carbon dioxide, except that emission coefficients were estimated using current and expected coefficients of emissions per km traveled for vehicles or emissions per kWh of power generation. Emissions of these pollutants from gasoline vehicles were subtracted from the scenarios for AEVs to provide an estimate of the net change due to electrification of the car fleet. That is, emissions of sulfur, particulates, and nitrogen were estimated as follows:

$$E = E_{GV,i\text{-}k} - E_{EV,i\text{-}k}$$

where E = Emissions for pollutants i through k where i = sulfur dioxide, j = oxides of nitrogen, and k = particulates. The amounts were estimated on an annual basis and summed for the period 2015-2050.

These emissions for gasoline vehicles are calculated as follows:

$$E_{GV} = V * D * K_{i\text{-}k}$$

where V again means passenger vehicles, D again means distance traveled, and $K_{i\text{-}k}$ is the emission coefficient of gasoline. See Table 1 for a summary of the assumptions for these emissions.

The emissions of carbon from all-electric vehicles is calculated as follows:

$$C_{\mathrm{EV}} = V * D * \eta_{EV} * K_E$$

where K_E is estimated for all power generated in the China 8760 Grid Model. See Table 5 for the assumptions for coal-fired power for these pollutants.

Results

<u>We found that aggressive deployment of AEVs would increase the amount of electricity generated from fossil fuels and increase emissions of carbon, sulfur, and nitrogen.</u> See Figures 1, 2, 3, and 4.

We attribute the absence of benefits, i.e., reduced emissions, of using low-carbon electric power to run passenger cars to the nature of power supply in China. We modeled the future of the power supply growing in capacity from around 1,100 gigawatts of relatively firm supply today to more than 4,000 gigawatts of variable supply in 2050. We used: 1) actual data for wind and solar fluxes to model generation; 2) assumptions that increased the availability of variable sources by spreading generating facilities (wind turbines, solar collectors) across the Chinese countryside; and utilized most of the favorable sites. Still, the model constrained the supply of wind and solar to 1,800 gigawatts and 1,500 gigawatts, respectively, based on Chinese expert assessment of wind field and surface area exploitation limits. Hydropower was similarly limited to around 500 gigawatts and nuclear power to 400 gigawatts.

The nature of power demand in China favors AEVs in our model. We assumed AEVs would be charged only at the time of day most advantageous for wind-source generation (midnight to 4 AM) and for photovoltaic-source generation 11 AM-3 PM. These hours correspond to relatively low levels of power demand, meaning that marginal supply can be configured to be low-carbon energy.

<u>We found that using AEVs instead of GVs increases costs to the Chinese economy</u>. See Figure 5.

We attribute the cost increase largely to the cost of AEV batteries. We started with a relatively low cost premium for AEVs—$6,000 per vehicle—and made an aggressive assumption for the rate of cost reduction in all-electric vehicles—seven percent per year. Still, the capital costs of AEVs combined with the costs of adding capacity to satisfy new demand for electricity raise the costs to society of running an electric fleet compared to a gasoline fleet.

Commentary

It would be challenging for China to accomplish the aggressive development of non-carbon resources and economic and industrial structural change and energy efficiency we have assumed for our modeling effort. If it were to do so, China would probably exhaust non-carbon energy sources for power generation at the margin before 2050 even if a major shift to all-electric vehicles were not imposed.[12]

Assuming that fossil fuels would in that case remain in use—either as direct transportation fuel or to generate electricity for transportation—the most important policy push for China is energy efficiency. A mandate for automobile fuel economy equal to that provided by the Toyota Prius (4.5 liters/100 km) would save more carbon emissions than requiring all-electric vehicles.

Figure 1: Chinese Electric Sector and Automobile Carbon Dioxide Emissions With and Without Electric Vehicles
Million tons per year

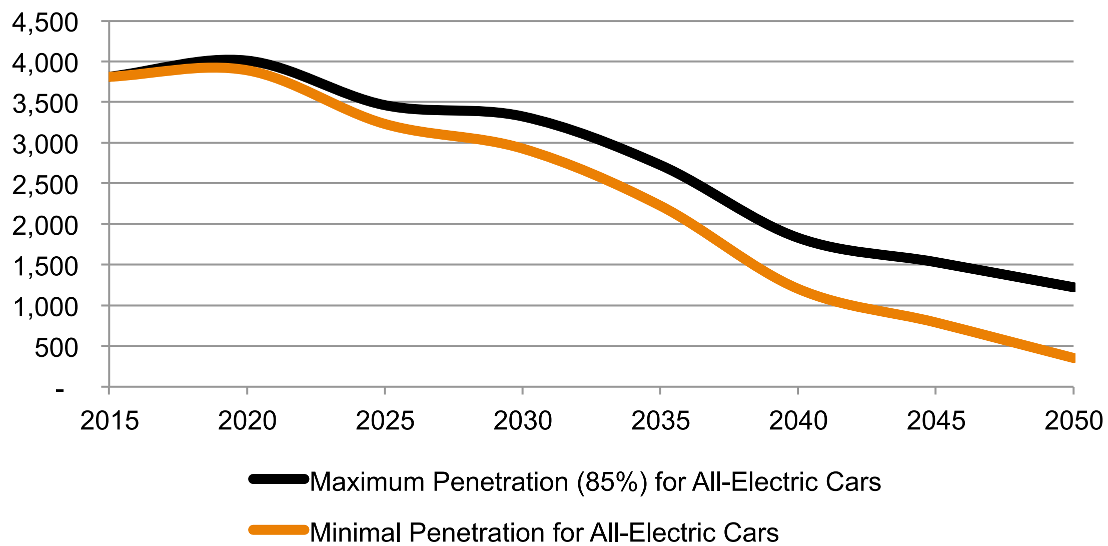


Figure 2: Chinese Sulfur Oxide Emissions With and Without All-Electric Vehicles
(Million Tons per Year)

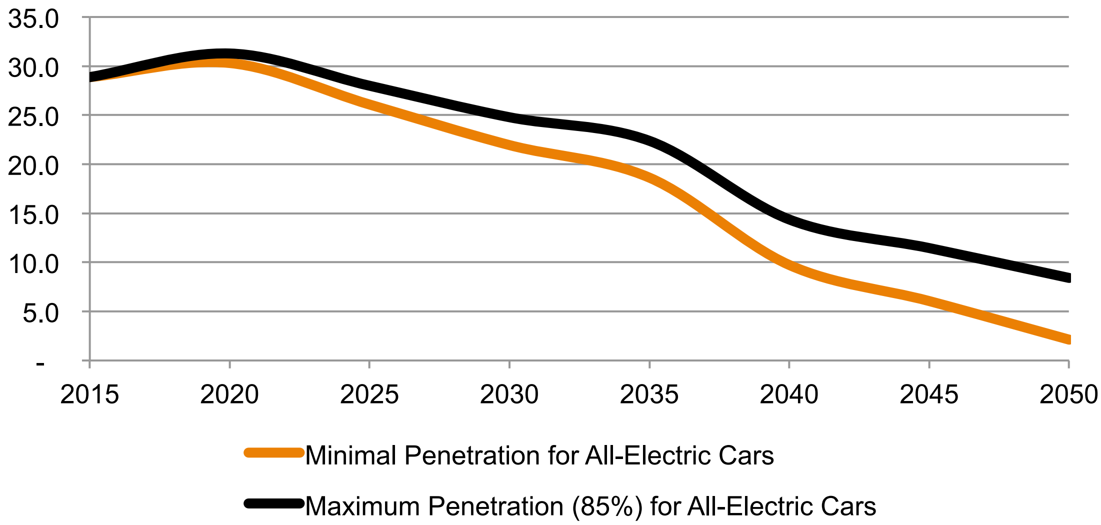
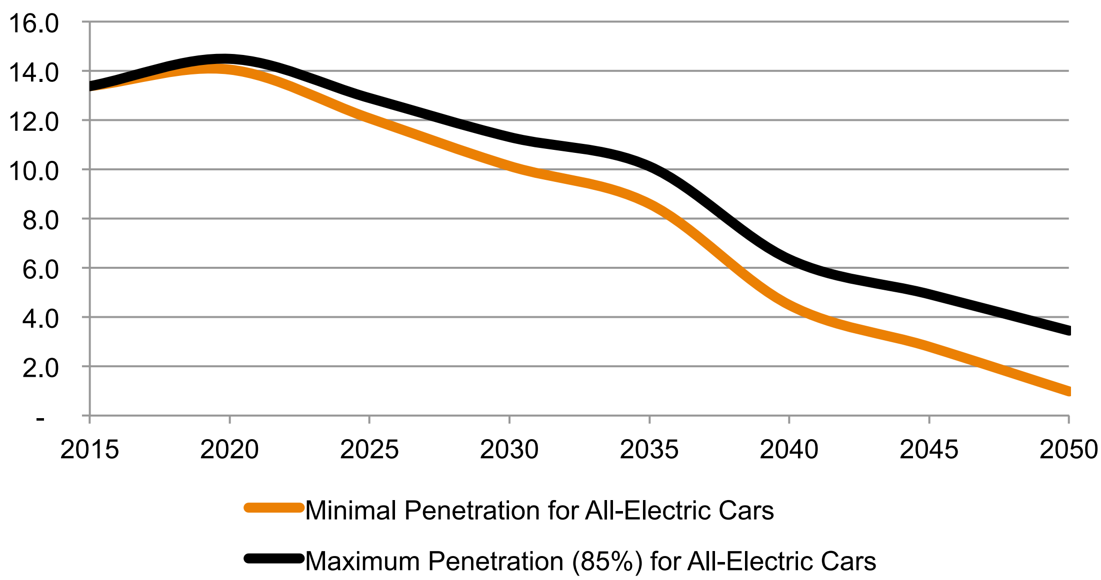


Figure 3: Chinese NOx Emissions With and Without All-Electric Vehicles
(Million Tons per Year)



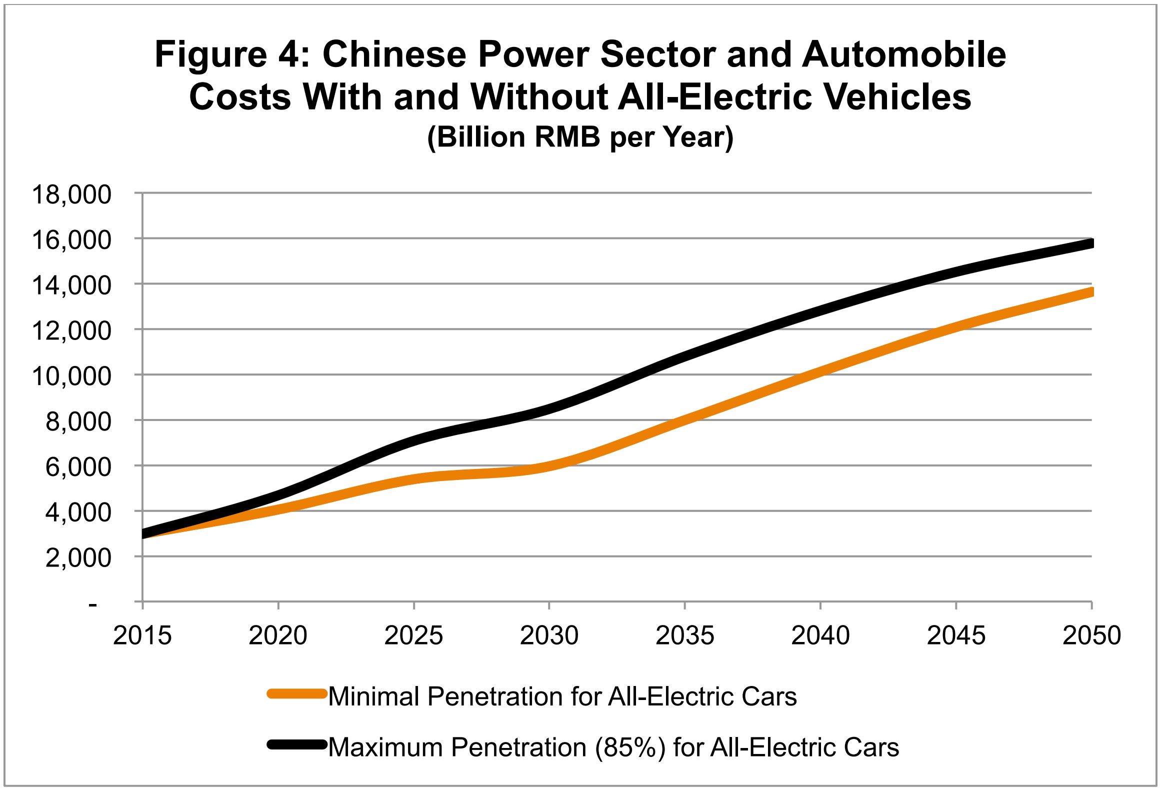


Table 1: Assumptions for Electric Vehicle Analysis

Item	Assumption
AEV share of personal cars in 2050	85 percent
Cars per capita in 2050	5.7
Maximum number of AEVs in 2020	20 million[13]
Maximum number AEVs in 2050	635 million[14]
Incremental cost of an AEV in 2015	$6,000[15]
Rate of reduction in AEV cost	7 percent per year from 2015[16]
AEV efficiency	
• 2015 (U.S. sales-weighted ave.)	19 kWh/100 km[17]
• 2050	18 kWh/100 km
New gasoline vehicle efficiency standard[18]	
• 2015	7.5 liters/100 km
• 2050	4.5 liters/100 km
Battery capacity	25 kWh
Battery maximum charge rate	8 kW
Battery recharge period	00:00-04:00 and 10:00-14:00
Vehicle usage rate	50 km/day
Gasoline vehicle emissions[19]	
• Nitrogen dioxide	75 mg/km
• Carbon monoxide	1,810 mg/km
• Total hydrocarbons	130 mg/km

- Particulate matter 5 mg/km

Table 2: GDP and Structural Change Assumptions

	2015	**2020**	**2030**	**2040**	**2050**
Service Share	47%	51%	59%	67%	75%
Economic Growth	7.0%	5%	4%	4%	2.8%

Source: Entri 2015

Table 3: Assumptions Used in All Scenarios

	2015	**2020**	**2050**
Population (billion)	1,375	1,394	1,340
Urban Households (share)	0.50	0.63	0.79
Exchange Rate (US$/RMB)	6.25	6.25	6.25
Discount Rate	0.10	0.10	0.10
GDP Elasticity	1.23	1.23	1.23
Price Elasticity of Electricity Demand	-0.21	-0.21	-0.21
Peak/Average Load	1.20	1.20	1.20
Fossil Fuel Price (percent per year change)	2	2	2

Source: Entri 2015

Table 4: Assumed Energy Efficiency of Average New Electric or Gasoline-Powered Vehicles in China, 2015-2050

Year	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
New Electric Vehicle Energy Efficiency (Watts/100 km)	19	19	19	19	19	18	18	18
New gasoline car fuel economy (liters/100 km)	7.5	6.0	5.5	5.0	4.5	4.5	4.5	4.5

Sources: Electric vehicle efficiency is based on authors' assumptions for improvements from average efficiencies of new electric vehicles in 2015 as reported by the U.S. Environmental Protection Agency and the U.S. Department of Energy at www.fueleconomy.gov, retrieved May 2015. Gasoline vehicle efficiency is based on standards to be implemented according to Chinese law

Table 5: Emissions Coefficients for Fossil Fuels

	SOx (g/kWh)	**N0x** (g/kWh)
Sub-Critical Coal	5.8970	2.7220
Super-Critical Coal (>600 MW)	5.8970	2.7220
Natural Gas	0.05	0.77

Table 6: Comparison of Selected Scenario Results	Without AEVs	With AEVs
Total Cost (T RMB), 2015-50	311	369
Total TWh per Year, 2050	11,877	12,879
GW, 2050	4,224	4,224
Total Carbon Dioxide (B Tonnes), 2015-50	92	109
Total Sulfur Dioxide (M Tonnes), 2015-50	719	848
Total Nitrogen Dioxide (M Tonnes), 2015-50	332	385
Fossil share of kWh generated in 2050	3%	10%

Note:
The scenario used for this comparison was, for both vehicle types, the "High Renewables" scenario in a "second generation" study, forthcoming fall 2015, with modifications to include the electric and gasoline vehicle fleet, modified to increase non-fossil power generation to increase the assumption for nuclear power in that scenario from 78 GW to 400 GW in the scenario presented here.

Source: Entri, 2015

Notes and References

1. William CHANDLER is a former Laboratory Fellow and Director of Advanced International Studies at Pacific Northwest National Laboratory and currently research director for the Energy Transition Research Institute (Entri). WANG Yanjia is a Professor of Energy Systems Sciences at Tsinghua University in Beijing, China and a consultant to Entri. Holly GWIN is formerly chief of staff for the White House Office of Science and Technology Policy and currently is general counsel for Entri. LIN Ruosida is formerly an engineering associate with Entri and currently a research associate for the Rocky Mountain Institute.
2. The abbreviations “EVs” refers to all-electric vehicles and “GVs” to gasoline-powered cars. The latter may include hybrid-electric vehicles, but not plug-in hybrid vehicles.
3. 乘用车企业平均燃料消耗量核算办法（http://www.gov.cn/gzdt/2013-03/20/content_2358627.htm) (Average fuel consumption of passenger accounting method).
4. 电动汽车不限行 新建建筑须配充电停车位-新华网 **http://news.xinhuanet.com/info/2015-06/01/c_134286507.htm**).
5. United Nations Department Of Economic And Social Affairs, “Electric Vehicles In The Context Of Sustainable Development In China,” Commission On Sustainable Development Nineteenth Session, New York, 2-13 May 2011.
6. See《国务院关于印发大气污染防治行动计划的通知》(State Council Issued Notice of Action Plan for Air Pollution and Control), 9 September 2013, Beijing. Retrieved from http://news.xinhuanet.com/english/china/2013-09/12/c_132715799.htm. See also《环保部细化京津冀鲁控煤目标 火电厂西迁趋势明显》(Ministry of Environmental Protection policy to control electric power plants in Beijing, Tianjin, Hebei, and Shandong shows clear intention to shift coal to the west), retrieved from http://news.cnfol.com/130923/101,1277,16018241,00.shtml, October 2013 (Fujian Gold Online, 23 September 2013).
7. For a detailed presentation of the China 8760 Model methodology, see William Chandler, Chen Shiping, Lin Ruosida, *China 8760 Grid Model Methodology, 2015 Revisions,* forthcoming, Entri, summer 2015 (www.etransition.org/publications).
8. These results are therefore not directly comparable to other results we have published using the aforementioned model because previous studies did not include automobiles.
9. This share of coal in Chinese power generation was 75.2% in 2014 according to China Electricity Council. Data retrieved from http://www.cec.org.cn/guihuayutongji/gongxufenxi/dianliyunxingjiankuang/2015-02-02/133565.html in July 2015.

10. From 2000 to 2014, GDP increased 3.96 times while electricity demand increased 4.39 times.
11. Statistical Communiqué of the People's Republic of China on the 2014, *National Economic and Social Development* via Xinhua News Agency, 26 February 2015.
12. We did not model the import of solar or wind generated electricity from nearby countries such as Mongolia or from a future global power grid.
13. We acknowledge that assuming this number or electric vehicles could be in use in China in 2020 is probably unrealistic. But a smaller assumption would have almost no short-term impact on municipal air pollution unless the vehicles were somehow concentration in a small number of cities.
14. This value is based on an assumption that 85 percent of automobiles in use in 2050 would be all-electric. The overall level of automobile use may be challenged on the basis that it is too large for China given the already prevalent conditions of traffic congestion in China's major cities. But please note our results are compared against auto use with and without electrification, meaning that the level of automobile use itself would not change the overall result for anything other than extreme changes in assumptions. Moreover, this assumed level of automobile use is a straightforward result from our understanding the likely pattern of automobile use in China that would result from China following in the path of most developed countries, as indicated in research results published by Stefan Pauliuk, Ni Made A. Dhaniati, and Daniel B. Muller in "Reconciling Sectoral Abatement Strategies with Global Climate Targets: The Case of the Chinese Passenger Vehicle Fleet," *Environmental Science and Technology, Nov.* 2011. Please note that we used the "low scenario" provided by these authors indicated that China would reach only the lower levels of per capita automobile use of other countries with similar levels of per capita income (in comparison to the projection for Chinese in 2050), including Japan.
15. We note that this arbitrary assumption is at the lowest end of the range we have seen of current incremental cost estimates of all-electric vehicles.
16. This rate of cost reduction is based on an arbitrary assumption. It is intended to be on the upper end of a range of plausible rates of reduction in the incremental cost of the purchase of an electric vehicle versus a gasoline-powered car.
17. Our assumed present level of efficiency for all-electric vehicles is the sales-weighted average of all-electric cars in the United States in the first six months of 2015. Sales data were obtained from on on-line source, **http://insideevs.com/monthly-plug-in-sales-scorecard/**, retrieved on 8 July 2015. The data as reported on that site are included in the following table of data, along with the official U.S. Environmental Protection Agency (USEPA) EV efficiency ratings, which we obtained directly from **www.fueleconomy.gov**, also on 8 July 2015. Please note that our model converts usage rates to per kilometer levels and that we assume the USEPA incorporates battery charge losses in the reported EV efficiency ratings. Please note further that our model separately incorporates line losses in the power grid and so to avoid double-counting we do not include a separate loss for that factor. As to whether our use of U.S.-based sales and efficiencies is justified, we would respond simply that Chinese production, sales,

and use of EVs is too small to provide any guidance in this regard and that Chinese auto in many ways follows those in the United States.

Electricity Consumption Rates of EVs Sold in the United States in the First Half of 2015

Model	Sales	Share	kWh/Mile
Tesla S	11600	21%	0.36
Nissan Leaf	9816	18%	0.3
Chevrolet Volt	5622	10%	0.37
BMW i3	4456	8%	0.27
Ford Fusion Energi	4292	8%	0.38
Ford C-Max Energi	3543	7%	0.38
Fiat 500e	3384	6%	0.29
Toyota Prius PHV	2890	5%	0.29
Chevrolet Spark EV	1785	3%	0.28
VW e-Golf	1518	3%	0.29
Mercedes B Class ED	1172	2%	0.4
Ford Focus Electric	811	1%	0.32
BMW i8	733	1%	0.43

18. See in particular “Limits and Measurement Methods for Emissions From Light Duty Vehicles,” China 5, GB 18352.5-2013; 国务院关于印发节能与新能源汽车产业， 发展规划（2012—2020 年）的通知， 国发〔2012〕22 号 (State Council on printing and distributing energy-saving and new energy automobile industry Development plan (2012-2020) notification (2012), 22), 中央政府门户网站，www.gov.cn 2012 年 07 月 09 日 09 时 11 分，来源：国务院办公厅 (Central Government portal www.gov.CN on July 09, 2012 09:11 Source: State Council). See also “Energy-saving and new energy vehicles industrial development planning,”(2012-2020), http://www.gov.cn/zwgk/2012/07/09/content_2179032.htm. Fuel consumption limits for passenger cars is guided by regulation GB19578-2014. Limits and measurement methods for emissions from light-duty vehicles is governed by regulation GB18352.5-2013.国务院关于印发节能与新能源汽车产，发展规划（2012—2020 年）的通知， 国发〔2012〕22 号 (State Council on printing and distributing energy-saving and new energy automobile industry Development plan (2012-2020) notification (2012), 22), 中央政府门户网站，www.gov.cn 2012 年 07 月 09 日 09 时 11 分，来源：国务院办公厅 (Central Government portal www.gov.CN on July 09, 2012 09:11 Source: State Council). See also “Energy-saving and new energy vehicles industrial development planning,”(2012-2020), http://www.gov.cn/zwgk/2012-07/09/content_2179032.htm; <乘用车企业平均燃料消耗量核算办法>第十五条 为鼓励发展节能与新能源汽车产品，在统计企业达到国家乘用车平均燃料消耗量目标的情况时，对企业生产或进口的纯电动乘用车、燃料电池乘用车、纯电动驱动模式综合工况续驶里程达到 50 公里及以上的插电式混合动力乘用

车，综合工况燃料消耗量实际值按零计算，并按 5 倍数量计入核算基数之和；综合工况燃料消耗量实际值低于 2.8 升/100 公里（含）的车型（不含纯电动、燃料电池乘用车），按 3 倍数量计入核算基数之和；其他插电式混合动力乘用车，按实际数量核算。http://www.gov.cn/gzdt/2013-03/20/content_2358627.htm (Accounting method of average fuel consumption for passenger car manufactures).

19. For a discussion of these and other assumptions used in the "China 8760 Grid Model," see www.etransition.org/publications.