

China Consumer EV Choice Preference Study Brief



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1. Background

In 2014 China's New Energy Vehicles (PHEVs and EVs) market became world's 2nd largest in terms of production and sales volumes (accounting for about 25% of global volumes), and is projected to become world's 1st largest in 2015. According to the China Association of Automobile Manufacturers (CAAM), national NEV sales volume reached 330k in 2015, marking an annual increase of 3.4 folds and reaching 1.5% of China's total new car market¹. Private vehicle sales surpassed commercial vehicle sales, among which 140k were EVs and 60k were PHEVs. China's EV industry is advancing quickly, supported by public funds and favorable regulatory framework (Table 1).

Table 1 NEV regulatory framework development

Year	NEV policy framework development
2009- 2012	China started its "10 cities, 1000 vehicles" program . The program quickly expanded to include 39 cities, and arguably laid the foundation for the initial development of the industry ²
6/2012	The State Council of China issued "Energy saving and new energy vehicles industry development planning (2012-2020)," targeting 500k PHEVs and PEVs by 2015 and 5 million by 2020 ³
2013- 2014	The years 2013 and 2014 saw a sharp increase in the number of national and local policies that encouraged the development of the NEV industry
5/2015	The "Made in China 2025 plan" (中国制造 2025) anchored energy saving and NEVs as one of China's 10 key sectors that should be at the forefront of development in the coming 10 years ⁴
10/2015	China issued the "Electric vehicle charging infrastructure development guide (2015-2020)" targeting > 12,000 new centralized charging and switch station and >4.8 million charging spots (accommodating for needs of 5M NEVs) ⁵
11/2015	Recent "NEV industry 10 year development roadmap" projects that sales volume of NEVs will Reach 5% of the total vehicle market demand by 2020, and 20% by 2025

¹中国汽车工业协会.2015 年汽车工业经济运行情况.

http://www.caam.org.cn/xiehuidongtai/20160112/1705183569.html

http://www.sdpc.gov.cn/zcfb/zcfbtz/201511/t20151117_758762.html

² http://www.evtimes.cn/html/201104/19543.html

³ http://www.gov.cn/zwgk/2012-07/09/content_2179032.htm

⁴ http://www.gov.cn/zhengce/content/2015-05/19/content_9784.htm

⁵ 关于印发《电动汽车充电基础设施发展指南(2015-2020 年)》的通知(2015-01-29 访问)

The increase in demand for NEVs during the last couple of years is arguably inspired by subsidies (**Table 2**) rather than the increase in vehicle models selection or quality of products about 85% of the newly introduced models (rising to over 60 EVs in 2015) are by no-name brands and considered low-quality models (**Figure 1**).

Table 2 Subsidy for NEV purchase by city, National and local combined

	Driving Mileage/R (km)	Allowance (\$/car)					
Туре		Beijing	Tianjin	Shanghai	Shenzhen & Guangzhou	Others	
EV	[80,150)	9,807	9,807	11,130	10,352	Shanxi Province,	
passenger car	[150,250]	14,010	14,010	13,232	14,789	Changzhou,	
	R≥250	16,812	16,812	14,633	17,747	Chongqing	
PHEV passenger car	R≥50	5,448	9,807	9,574	10,352	About 39 cities support EV	
Special purpo	se EV	560/kwh	560/kwh	592/kwh	592/kwh	progress via favorable	
FC passenger	car	56,042	28,021	112,083	112,083	policies.	
FC commercial vehicle		224,166	224,166	448,333	448,333		

Figure 1: NEV models national portion and list by manufacturer

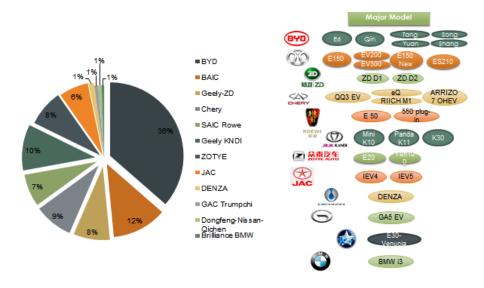


Figure 2: NEV EV models



Consumers show various interests in the electric cars, which is obvious through their stated or revealed preference choices. Not only do consumer characteristics such as travel attitude, personality, lifestyle, and mobility (Choo & Mokhtarian, 2004) matter, socio-demographic factors and environmental awareness are also important factors that affect vehicle type choices (Ziegler, 2012). In this context, understanding consumers preferences gives us a chance to identify tensions among consumers preferences, government incentives, and social benefits, towards the unlocking of car purchase decision making (Helveston, et al., 2015).

Helveston et al. used choice-based conjoint analysis to measure consumer preferences in the U.S and China and found some interesting results (Helveston, et al., 2015). The study shows how much the average survey respondent was willing to pay for a trade off in an attribute. U.S. respondents were found less sensitive to price and operating cost if they are older, have higher income, have higher education, own more vehicles, and/or have more children, while Chinese respondents who have higher income and education levels are more sensitive to operation costs. However the study also found that attitude towards being environmentally friendly is among the strongest factors correlated with preference towards any electrified vehicle type in both countries. In the U.S., electrified vehicles may be viewed as a symbol of high-status, however this is not the case for Chinese car buyers, implying the effects of the differing cultural and socio-economic perceptions (as well as the electric car brand options available on the different markets).

As electric cars are new to most consumers worldwide, researchers found that owning and using electric cars produces a structural change in consumer preferences (Driscoll, Lyons, Mariuzzo, & Tol, 2013). Similar findings suggest that consumers that had experience with and/or an exposure to EVs are more assertive in their purchase decisions and show greater willingness-to-pay a premium for EVs (Larson, Viáfara, Parsons, & Elias, 2014). Surveys of households vehicle preferences yielded some interesting insights into car type preferences correlated with household size; for example, a household is more likely to own one compact or small car if there are less than three members in the family, whereas households with over three members prefer to own SUVs (Liu, Tremblay, & Cirillo, 2014).

This study brief is meant to reaffirm some of the observations obtained through previous studies, and do so through an innovative approach that combines a relatively accountable survey design (structured choice preferences) tailored for the average Chinese consumer (through multiple tests of design and language), with social media distribution channels (iCET's official WeChat and its various employees and stakeholders' own personal WeChat). The brief is limited in scope and length, however may trigger new consumer choice preferences studies towards a better informed and more effective NEV regulatory and policy framework.

2. Study goal

While the Chinese NEV market seems to be getting on track to meet the national goal of 5 million cars by 2020 and a production capacity of 2 million cars, understanding Chinese consumer preferences would serve the auto industry and policy makers in their efforts⁶. While the auto industry is known for its diligent market intelligence work, market competitiveness is unable to turn market insights into common knowledge.

This study is primarily aimed at publically exposing insights into major consumer preferences, attempting to align stakeholders' understandings of Chinese demand for NEVs and spurring discussion as for how best this demand could be served. Therefore, all stakeholders (policy designers, corporate decision-makers, third parties) will be able to learn from the survey results for improving their strategic planning going forward, and be encouraged to increase their awareness of actual demand characteristics versus perceived preferences.

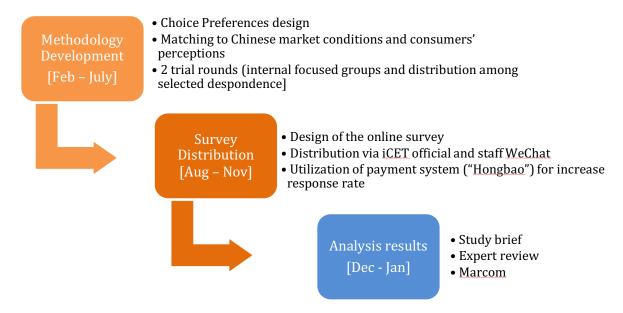
*i*CET hopes to also engage the general public in sustainable private vehicle decision-making. In the process of survey distribution yet another benefit may occur – the engagement of other third-parties in the effort to increase public awareness and the expansion of *i*CET's social media channels.

6 http://www.chinaev100.org/index.php?option=com_content&view=article&id=688:2020-500&Itemid=126&lang=cn

3. Methodology

The methodology employed in this study is a consumer choice preferences survey. The survey was initially designed by *i*CET's intern and current PhD student from Carnegie Mellon University (CMU), John Helveston. The survey's final design and content were shaped by *i*CET, building on its familiarity with the Chinese auto and EV market as well as its experience with consumer outreach and surveying. *i*CET then distributed the online consumer EV choice preferences survey through its social media channels, namely its official and staff's WeChat.

Figure 3: EV consumer Choice Preferences Study Methodology



3.1 Consumer Choice Preferences

Choice modeling attempts to model the decision process of an individual through Revealed Preferences (RP) or Stated Preferences (SP) made in a particular context. RP studies use the choices made already by individuals to estimate the value they ascribe to items, while SP studies use the choices made by individuals made under experimental conditions to estimate these values - they state their preferences via their choices rather than reveal choices made. The theory behind choice modeling was developed independently by economists and mathematical psychologists. Typically, it attempts to use discrete choices (A over B, B over C, C over A, etc.) in order to infer positions of the items (A, B and C) on some relevant latent scale. Choice modeling is regarded as the most suitable method for estimating consumers' willingness to pay for quality improvements in multiple dimensions. Many alternative models exist in econometrics, marketing, sociometrics and other fields, including utility maximization, optimization applied to consumer theory, and a plethora of other identification strategies which may be more or less accurate depending on the data, sample, hypothesis and the particular decision being modeled.

Table 3 Pros and Cons of Choice modeling

Pros	Cons
Forces respondents to consider trade-offs between attributes;	Discrete choices provide only ordinal data, which provides less information than ratio or interval data;
Makes the frame of reference explicit to respondents via the inclusion of an array of attributes and product alternatives;	Inferences from ordinal data, to produce estimates on an interval/ratio scale, require assumptions about error distributions and the respondent's decision rule (functional form of the utility function);
Enables implicit prices to be estimated for attributes;	Fractional factorial designs used in practice deliberately confound two-way and higher order interactions with lower order (typically main effects) estimates in order to make the design small: if the higher order interactions are non-zero then main effects are biased, with no way for the analyst to know or correct this ex post;
Enables welfare impacts to be estimated for multiple scenarios;	Non-probabilistic (deterministic) decision-making by the individual violates random utility theory: under a random utility model, utility estimates become infinite;
Can be used to estimate the level of customer demand for alternative 'service product' in non-monetary terms;	The means (true positions) and variances on the latent scale cannot be separated.
Potentially reduces the incentive for respondents to behave strategically.	

3.2 Survey design

The survey design was based on a previous design in (Helveston, et al., 2015) and implemented using Sawtooth Software, one of the most prominently used conjoint survey programs in industry and academics. Through the two pilot rounds of the survey (internally and through selected groups of despondence), the design was modified in order to better fit Chinese surveying expectations (shorter, less wording, intimidating questions part of the demographic section moved to the end of the survey). Finally, two rounds of translation took place with a focused group study in between for matching the language to the general' public informal common use of language in the context of mobility, cars, and EVs.

3.3 Survey distribution

The survey was widely distributed through *i*CET's official WeChat account by *i*CET's employees utilizing their personal connections. Both distribution channels may create a bias in the results: *i*CET and its employees represent a groups of educated professionals, living in Beijing and Changzhou (yet originated from five different cities in China), which are characterized with relatively high environmental awareness. *i*CET also shared the survey with various partners from Shenzhen, Shanghai and Beijing – all of which are working in the field of EVs and related regulatory design (e.g. Tsinghua Shenzhen graduate school – EV perceptions research team, D1EV, the Energy Foundation). The responses may therefore better represent similar group of potential EV buyers rather than the general public.

Figure 4: Snapshot of the survey design in its online distribution platform

Suppose these 3 vehicles below were the <u>only vehicles available for purchase,</u> which would you choose?						
Attribute*	Option 1	Option 2	Option 3			
Vehicle Type	Conventional 🔐 300 mile range on 1 tank	Plug-In Hybrid 🔓 & 🚁 300 mile range on 1 tank (first 40 miles electric)	Electric 🎉 75 mile range on full charge			
Brand	German	American	Japanese			
Purchase Price	\$18,000	\$32,000	\$24,000			
Fast Charging Capability		Not Available	Available			
Operating Cost (Equivalent Gasoline Fuel Efficiency)	19 cents per mile (20 MPG equivalent)	12 cents per mile (30 MPG equivalent)	6 cents per mile (60 MPG equivalent)			
0 to 60 mph Acceleration	8.5 seconds (Medium-Slow)	8.5 seconds (Medium-Slow)	7 seconds (Medium-Fast)			
Time	0	0	0			

4. Results

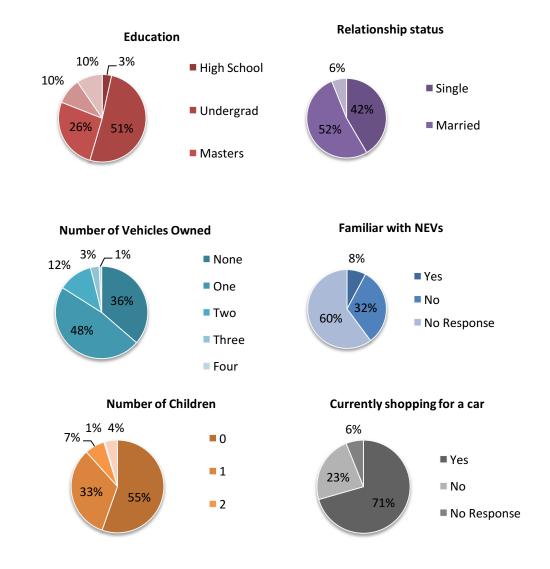
The survey yielded 623 interested respondents of which only 341 completed the relatively long survey (a 55% response rate is normal for these types of surveys). However being a stated preferences survey, responses that had internal conflict were excluded, leaving us with a valid sample of 231 (meaning 110 respondents were not paying attention to the survey questions and

filled it randomly). This section outlines the survey's major stated demographics and perceptions and major revealed EV preferences.

Respondents' demographics

The surveyed group was comprised of a majority of men (59%) with ages ranging from 20 to 56 years, and a stated mean income of RMB137,000 (although 15% of respondents did not provide an answer). As illustrated in Figure 5, 52% of respondents were married, 87% had a university degree (university degree accounts for 10% of the population), 55% had no kids, 48% already own one vehicle while 48% own none, and 70% are looking to buy a car.

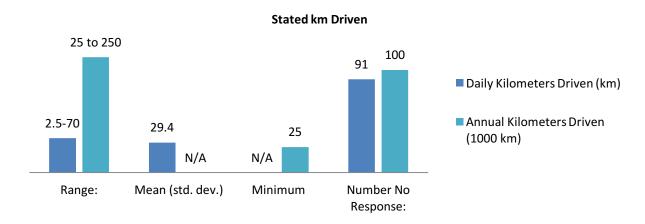
Figure 5: Respondents demographics and car related statements

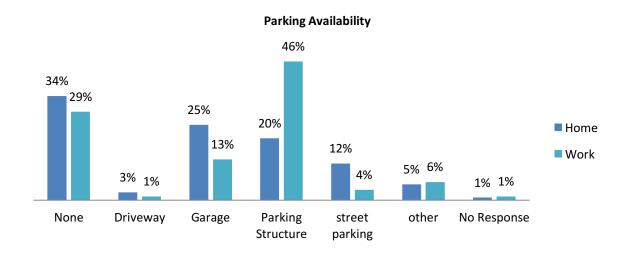


EV purchase potential

32% of respondents stated not understanding the concept of New Energy Vehicles (NEVs), yet assuming their vehicle search on their upcoming purchase would yield gradual understandings, we wish to focus on the potential of actual purchase should they will be willing to – based on two crucial EV purchase considerations: perceived km traveled (ensuring EV can serve their travel needs) and parking availability (enabling stable charging). Among respondents, half answered their daily km range was no more than 250km per day, a distance that could easily be served by an electric car if mid-day charging time and access can be achieved. As for parking access, the picture looks grim: 34% of respondents stated not having access to home parking, and 29% stated not having access to work parking. Combined, an overall of 21.6% have neither parking at home nor at work. However, if the stated 20% of home structured parking and 46% of work structured parking could be made a permanent parking (say through subsidized EV parking fees or regulated free EV parking) the issues of charging could potentially be resolved.

Figure 6: Respondents km driven and parking availability statements





Vehicle type preferences

Vehicle type of the survey findings shows how much people are willing to pay for a different vehicle type (if everything else was equal). For example, on average people are willing to pay about RMB60,000 for a hybrid (HEV) vehicle over a conventional vehicle, even if everything else was the same (brand, price, etc.). On the other hand, people tend to be slightly opposed to full electric vehicles (BEVs), with a negative willingness to pay. This outcome is in correlation with studies todate, showing the relative ease of acceptance of PHEVs and oppose to EVs (陈然, 2014; Helveston, et al., 2015).

Baseline: Conventional vehicle HEV ■ PHEV-15km PHEV-30km PHEV-60km BEV-120km BEV-160km -15 -10 -5 0 5 10 15 Willingness to Pay (10k RMB)

Figure 7: Revealed vehicle type preferences (willingness to pay)

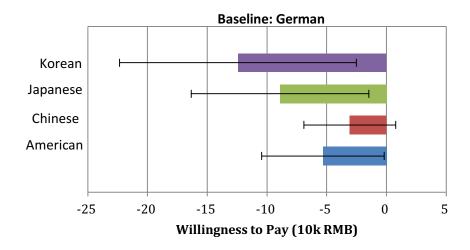
Note: PHEV refer to plug-in hybrids with a minimum e-range of 15km; BEV-120km refer to full-electric models that have a minimum e-range of 120km

Brand preferences

From the repeated questions on vehicle choice, including brand revealed preferences, the survey shows that people are willing to pay for a brand based on its country of origin. The baseline shown in

Figure 8 is German, demonstrating other brands are negative compared to German brands - meaning people like German brands the most. Korean and Japanese brands come second and third in respondents' revealed preferences, while American and Chinese are least attractive (刘佳, 2007).

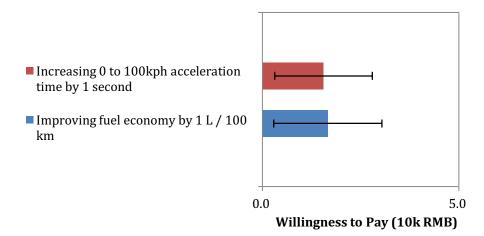
Figure 8: Stated brand preferences (willingness to pay)



Vehicle performance preferences

Findings from the repeated vehicle choice questions related to vehicle performance reveal how much people are willing to pay to improve their fuel economy and their acceleration time. It seems that acceleration captures almost as much attention and intention to pay as fuel economy performance. Respondents are willing to pay nearly RMB15,000 on average (a maximum of over RMB27,000) for 1 second improvement in acceleration or 1L/100km improvement in their fuel consumption performance, despite the fact the former have increased economic implications (and is useless in most Chinese urban areas that tend to be too congested for high acceleration) while the latter results in potential fuel savings.

Figure 9: Stated vehicle performance preferences (willingness to pay)



5. Conclusions

China's NEV market is set to grow rapidly to internalize ambitious government goals, yet real market growth requires more than supply-side benefits. In order to ensure that demand expectations and preferences are being met, a better understanding of the average consumer is due. In particular, understanding consumer sensitivity to mileage, parking, and brand are assumed to be the key for unlocking EV commercialization bottlenecks: at the policy design level, transport infrastructure development, auto-manufacturing strategy, and third parties are involved in the complex NEV ecosystem.

In an effort to include the general public in sustainable private vehicle decision-making, *i*CET has partnered with its former intern and current PhD student from Carnegie Mellon University (CMU), John Helveston, to design a user-friendly yet scientifically robust survey. The survey was distributed utilizing *i*CET official and its stakeholders' social media channels (primarily WeChat). Out of over 600 respondents, only 231 were completed in a coherent and scientifically satisfying manner (others have either not been completed or seem to be self-contradicting). The study reaffirmed previous studies and yielded some new results:

- Chinese consumers are willing to pay about RMB60,000 for a hybrid (HEV) vehicle over a conventional vehicle, even if everything else was the same (brand, price, etc.).
- People tend to be slightly opposed to full electric vehicles (BEVs), demonstrated by a negative willingness to pay.
- Chinese consumers are willing to pay for a brand based on its country of origin, in the following declining order: German, Korean, Japanese, American and Chinese.
- Chinese consumers place almost the same importance and intention to pay for acceleration improvement as they do on fuel economy performance: respondents are willing to pay nearly RMB15,000 on average (a maximum of over RMB27,000) for 1 second improvement in acceleration or 1L/100km improvement in their fuel consumption performance.

A further investigation into whether parking availability at home/work and structured parking at home/work influences willingness to pay for NEV is due. This study yielded limited number of results that could not indicate what the impact of home/work parking on the willingness to pay for EVs. *i*CET hopes to have an opportunity to further contribute to the area of consumer NEV preferences, welcoming collaboration opportunities and encouraging social research institutions and transport research institutions to join hands towards better informed decisions making that will gear China's sustainable vehicle market development.

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