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A CHINESE KANDI RECIPE: ONE PART SUSTAINABILITY AND ONE PART ENTREPRENEURIAL SPIRIT

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ABSTRACT

The call for environmentally sustainable business practices is growing in momentum. As supplies of fossil fuels decline, damages from environmental disasters mount and radical climatic effects appear, the logical result is that organizations operate in a more eco-friendly fashion. This paper examines the efforts of one Chinese automobile company, Kandi Technologies Group, Inc., to deal with the level of air pollution in China. Kandi and various end users may be in the process of transforming the way consumers think about and use automobiles. The "Kandi Model" is one where customers no longer own, but rather lease or share electric vehicles. Implications for the number of privately owned vehicles, air quality, and urban congestion are provided.

JEL: M41, M48, M49

KEYWORDS: Sustainability, Car Sharing, Electric Vehicle (EV), Kandi Technologies, Grid Stabilization

INTRODUCTION

China has made a remarkable transformation from an agrarian economy to a 21st century manufacturing powerhouse. However, this rapid economic growth has come with a terrible cost. China's air quality is some of the worst in the world. The current rate of growth is unsustainable without changes that reduce air pollution levels. This paper chronicles efforts by one Chinese company, Kandi Technologies Group, Inc., to introduce an innovative car sharing business model to consumers. Small, inexpensive electric vehicles are being made available for mass public transportation purposes under an innovative car sharing arrangement. If successful, this model should help to reduce air pollution levels caused by automobile exhaust. It would also further the Chinese government's desire to become the dominant player in the global automobile industry.

After a decade of nurturing China's auto industry to become the largest in the world, this country's leaders are having second thoughts. (Bradsher, 2011)

The day will come when the notion of car ownership becomes antiquated. If you live in a city, you don't need to own a car. (Ford, 2011)

Citizens emerge from their homes wearing surgical masks to help them breathe more easily. The sun is obscured behind a thick, smoky haze. The government orders certain factories to shut down operations for several days because the air quality is so poor. Is this a scene out of a science-fiction film? No. It is a day in the life of a Chinese citizen in Beijing, Shanghai or dozens of other mega-cities. After being considered a sleeping giant for many decades, China has recently experienced rapid urbanization and industrialization. In 1978, Deng Xiaoping began a series of economic reforms to initiate the process of

rapid industrialization and modernization. Previously, much of the Chinese economy was rooted in agriculture, a result of the "Cultural Revolution" started by Mao Tse Tung. At that time, approximately 84% of the population lived below the international poverty line of $1.25 U.S. per day. (Barclays, 2011, p.5) In what many might call a modern day economic miracle, by 2010, China had emerged as the second largest economy in the world. It was also the world's largest manufacturing producer, the largest luxury good market and the largest consumer of commodities. (Barclays, 2011, p.5) There was only one problem; the growth came at a horrific cost to the environment. China was and is acknowledged to have some of the worst air and water pollution in the world. In short, China's economic growth, while rapid, was and is, unsustainable in its present form. (Barclays, 2011, p.2) Table 1, which follows, illustrates the level of air pollution faced by the citizens in Chinese cities, such as Beijing and others.

Table 1: Air Quality Readings in Six Chinese and Two U.S. Cities on January 24, 2015

City	Air Quality Index (AQI)	Pollution Level
Beijing	153	Unhealthy
Chengdu	231	Very Unhealthy
Suzhou	173	Unhealthy
Guangzhou	160	Unhealthy
Nanjing	207	Very Unhealthy
Wuxi	175	Unhealthy
New York City	53	Moderate
Los Angeles	16	Good

This table shows air quality readings in six Chinese and two U.S. cities. The first column identifies the city. The second column indicates the numerical air quality index reading. The third column indicates the qualitative assessment of the city's air quality.

Data for Table 1 were obtained on a weekend evening, when presumably most factories and industrial sites would be experiencing low levels of production. For the six Chinese cities, the Air Quality Index (AQI) ranges from a low of 153 (Unhealthy) in Beijing, to a reading of 231(Very Unhealthy) in Chengdu. For comparison purposes, AQI's were simultaneously obtained for two American cities, New York City and Los Angeles. The respective AQI readings were 53 (considered moderate) and 16 (considered good). Needless to say, the air quality of major Chinese cities is much worse than that of their American counterparts. In response to the widespread air pollution, Chinese government officials have introduced several initiatives to help improve the air quality. One such measure is the "Ten Cities Thousand Cars" program, which focuses on promoting public electric vehicles (EVs), such as buses and taxis. This program was implemented in 13 cities in 2009 and later expanded to include 25 cities in 2010 (Howell, Lee and Heal, 2014). Other measures have included a lottery system used to allocate permits to that can be used to purchase new license plates for automobiles.

Even after being selected by lottery, winning applicants must then pay in excess of the equivalent of approximately $10,000 U.S. to actually obtain the new license plate (EVs are exempt from these license fees). Officials have also implemented a "yellow tag" system. Older (and presumably more polluting) vehicles are ticketed with a yellow tag. Once this happens, they cannot legally be driven and must be replaced with a newer vehicle. Hao, et al (2014) have also identified 2009 as the year of the introduction of the "Electric Vehicle Subsidy Scheme" to help promote the penetration of EVs into the market. The remainder of this paper is organized as follows. The next section, reviews work in the area of environmental sustainability. Following the literature review, a discussion of China's efforts to promote the use of EVs and Kandi Technologies Group, Inc. (Kandi) and its potentially disruptive environmentally sustainable business model is presented. The paper ends with some concluding comments about possible future implications for China and its automobile industry.

LITERATURE REVIEW AND BACKGROUND

There is a change afoot in the way younger people look at the world. In the past, societies, especially western ones, tended to view freedom in exclusionary terms. That is to say, by being able to exclude or include others, we were empowered. Such was the case with privately owned automobiles. They were available to us to use any time, to go anywhere we desired, with whomever, we pleased. This thinking led to assets that sat idle most of their lives and congested urban areas with polluted air. In short, it is a very inefficient approach to urban transportation. Young people who came of age along with the Internet, to a large extent are beginning to view the world through a different lens. According to Rifken (2014) they are more about inclusion rather than exclusion. They are motivated by having continuous access to others and being able to network by mechanisms, such as via Facebook and Twitter, rather than by being able to have exclusive use of property. A survey of drivers between the ages of 18 and 24, found that 46% would choose access to the Internet over car ownership (Chozick, 2012).

In a similar vein, about 80% of the members of car-sharing clubs who owned a car prior to car sharing sold it after joining the club and each car-sharing vehicle eliminates 15 personally owned cars from the road (Rifken, 2014). It is against this generational shift in views of car ownership that the phenomenon of car-sharing has come into existence. Car sharing is a system that allows people to rent cars on a short-term basis. A customer may use a car as-needed (hourly or daily), and only pay for the time and mileage used. The car share operator will provide any vehicle maintenance, repair (normal wear and tear), and insurance. Shaeen and Cohen (2012). Salodini (2014) observes that, "Sharing services and the general concept of shifting from ownership to service use is spreading worldwide".

Car sharing has become popular among millennials. It reduces the sheer numbers of cars on the road as well as lowering carbon emissions. Sharing of vehicles has other advantages. Users no longer have the cost of purchasing vehicles, nor do they have maintenance, taxes, license fees, insurance, etc. In fact, a former vice president of research, development and planning at General Motors concluded that car sharing could save users more than 70% in operating costs and require them to invest less than one-fifth the amount needed to own a car (Burns, 2013). Car-sharing services are already engaged in the transition to EVs. Paris joined a car-sharing collaboration of 1,750 EVs and 750 charging stations spaced throughout the city and suburbs (Rifkin, 2014). The program operates very similar to bikeshare programs, like Verlib in Paris or Capital Bikeshare in Washington, D.C.

Discussion

China is facing a major environmental crisis. China has only 44 passenger cars for every 1,000 people, while Germany has 517, Japan has 453 and the U.S. has 423. (World Bank, 2012) Yet, while it lags behind other nations, China's rapid industrialization and urbanization has caused it to be home to seven of the ten most air polluted cities (Howell, Lee and Heal, 2014). A report by Barclays (2011) stated, "The current economic development pattern, however, is no longer sustainable". (Page 2). One possible solution to the problem of air pollution is presently being explored by the Chinese. It is the use of EVs. EV adoption would aid in overall energy conservation and help to protect the environment (Tseng et al., 2013; Zhou et al., 2013). Since an EV does not burn gasoline or other fossil fuels, they would reduce tailpipe emissions (Hawkins, et al. (2013). However, one must consider that electrical power plants may burn fossil fuels to generate the electricity used to charge an EV's battery. (This point will be discussed a bit later in the paper, during a discussion of the concept of "base load".) However, before EVs can become part of the solution to the problem of dirty air, consumers must be willing and able to adopt them. Historically, there have been three issues that have prevented mass adoption of EVs.

These are the cost of batteries, inadequate driving range and the length of time to fully charge a battery. (Howell, Lee and Heal (2014, p 6). The high cost of EVs has been a real deterrent to their adoption.

Howell, et al. (2014) reported that, "For example, in 2010, BYD's plug-in hybrid F3DM sedan, the only PHEV in China, sold for 149,800 yuan, compared with 59,800 yuan for the equivalent F3 conventionally-powered model". (p19). One of the ways the Chinese government has been addressing the cost issue is through the use of subsidies. The federal subsidy in China varies with a vehicle's battery capacity, up to a maximum of about $9,400 (State Council, 2012). In addition, several provincial and/or local subsidies are in place to match the federal subsidy. Wan Gang, who is the Minister of Science and technology and an EV proponent, stated in 2013 that subsidies are "short-term solutions" and to create a sustainable industry would require improving technology and lowering costs (Howell, et al., 2014).

The second issue of range anxiety may be partially addressed by the availability of charging stations. Scarcity of available charging infrastructure is one of the major barriers to the mass adoption of EVs (Sweda and Klabjan, 2011). Zhang, et al. (2014) report that half of the automobiles have no parking places in Beijing at present, so they have to park on the street. If charging stations were readily available, drivers could be more confident that they would not run out of charge. Two approaches have been advocated to address the charging issue. The first, advocated by the State Grid of China Corporation, involves the swapping of a spent battery for a freshly charged one. This battery exchange system has been demonstrated in cities, such as Hangzhou China, and can be accomplished in about the same amount of time it takes a driver to fill up their tank at a gas station. Furthermore, the depleted batteries can be recharged slowly, a practice that extends battery life and puts little additional strain of the existing electrical grid. The disadvantage of the swapping method is that it would require a standard battery configuration, if it were to be efficiently implemented.. It would also require automobile manufacturers to give up a bit of control over their products, since they would no longer control the battery. It would also require a redesign to allow for the batteries to be exchanged. At present, most manufacturers are against battery swapping and favor a plug-in method of recharging. This allows them to maintain control over the battery and allows them to convert existing internal combustion models into EVs by simply modifying them to accept a battery that accepts a plug connection, rather than re-engineer them for replaceable batteries. Large oil companies, such as Sinopec favor plug-in recharging.

However, availability of charging stations, in and of itself, does not eliminate the problem. This is because once a station is located, the third issue with EV adoption becomes apparent. It may take several hours to recharge a depleted battery. This point is not lost on Becker et al. (2009) and Zhang et al. (2014) who believe that simply putting charging sites on city streets will not meet the demand for refueling. Furthermore, even if the third issue of time is dealt with by very rapidly charging a battery, it presently comes at the cost of a much shorter overall battery life. (Bashash et al. (2011); Botsford and Szcepanek (2009); CAERC (2013). Shortening the life of an already expensive battery brings us full circle back to the first issue of battery cost. Efforts by the Chinese government to battle air pollution by replacing internal combustion engine powered vehicles with EVs appear doomed to fail. Even allowing for decreased battery costs through the use of improving technologies and economies of scale in manufacturing techniques, we have the problem of physically parking and charging the vehicles.

If a slow charge approach is adopted, which improves battery life, drivers will be lined up at charging stations waiting for their turn to recharge. This leads to congestion, at best, and an overall unwillingness of consumers to adopt EVs. If a fast charge approach is adopted that would allow drivers to quickly recharge, it comes at the cost of a very short battery life, which makes an already expensive EV even more so. Zhang, Rao and Liang (2014), recommend a possible approach that China's leaders could pursue to better promote EV usage. They suggest that promotion of EVs should start with low-end vehicles. As manufacturers begin to experience economies of scale with parts production, etc., these could eventually be upgraded to mid-tier and finally high-end vehicles. Inexpensive, short-range vehicles would be able to take care of most urban consumers' needs and allow them to get comfortable with the idea of a new technology. In this way, consumers used to riding bicycles or possibly e-bikes could become comfortable with the idea of an EV usage. For example, in Beijing, 95% of drivers log less than 62 miles per day

(ICCT, 2013). The case for small, inexpensive, low-speed vehicles is probably best summed up by Howell, et al (2014), who state, "The hundreds of millions of Chinese who cannot afford conventional cars may present a powerful market for cheap, low-speed EVs". (P21) Even Li Shufu, the founder and Chairman of Geely is a proponent. He stated at a 2013 press conference, "Low-speed electric vehicles have many advantages. They are suitable for short driving ranges." (Perkowski, 2013) At that point, quality and driving range could be upgraded slowly due to economies of scale and forecasted improvements in battery technologies. These improvements could pave the way to incorporation into mid-level vehicles and eventually make their way to more upscale vehicles with longer driving ranges. In addition, starting with inexpensive, short-range vehicles in urban settings would allow time to build out the required charging station infrastructure necessary for longer range travel. This could help to solve the chicken and egg problem for EV adoption. That is, drivers don't want to adopt EVs until there are adequate charging facilities to alleviate range anxiety while policymakers are reluctant to spend resources on charging facilities only being used to recharge a handful of cars.

Zhang, Rao and Liang (2014) state that the Chinese government needs to allow for private capital to be used to create charging stations. Since one of the biggest bottlenecks to the adoption of EVs by consumers is "range anxiety", or the fear of running out of charge, the more charging facilities, the better for mass adoption. This point is echoed by Wang, Liu and Fu (2015) who believe the development of charging infrastructure not only affects the operating results of EVs, but also affects the purchase and use behavior of consumers. However, there is an alternative method to the use of plug-in charging of batteries. It's possible to simply swap a depleted battery and replace it with a fully charged one. This swap process can be completed in roughly the same amount of time it takes to fill a conventional car's gas tank. Battery swapping has multiple advantages. First, the range of the vehicle can be enhanced in a manner similar to what filling up at a gas station does to an internal combustion powered vehicle. Second, the depleted battery can now be recharged via the slow charge method, which greatly extends its usable life. Third, the charging could be done during non-peak demand times which would put less stress on the electrical grid and allow for the use of base load power generation. In fact, Wang, et. al (2015) believe the construction of a battery swapping network is the key to promoting the EV industry.

That is exactly the model being pursued by one innovative company based in Jinhua China. Imagine a vending machine that dispenses cars instead of food or drink. Not just any car, but a zero emissions electric vehicle, which individuals may rent for only a few hours at a time, if they desire. The car is then returned, recharged and reloaded back into the vending machine. Such is the vision of Kandi Technologies Group, Inc. In fact, it is not a dream, it is currently a reality. A large parking garage has been automated and set up to dispense small EVs to patrons. Documentary film maker, Aaron Rockett has dubbed this method of vehicle rental, "The Kandi Machine" (Rockett, 2013). According to Howell, et al (2014), "In April 2013, Kandi completed an EV assembly line with initial annual production of 100,000 vehicles. Kandi has increasingly gotten official sanction of its low-speed EV strategy, and is working with a number of cities…" (p.21)

The Kandi Machine is just one variation of the vision of Kandi's CEO, Hu Xiaoming. Hu, prior to becoming CEO of Kandi, was the Chief government scientist in charge of the project to develop electric vehicle batteries. Mr. Hu is presently engaged in a plan to help ease urban congestion and clean up the air in China's cities. Hu and his company are currently carrying out a program to rent inexpensive EVs for very short-term urban use. The model is patterned after Hangzhou China's bike sharing program, the largest such program in the world (Shaheen and Guzman, 2011). The EV car share program allows users to rent a vehicle for only a few hours at a time. The user does not have to worry about paying license fees (sometimes amounting to thousands of U.S. dollars), having a parking space at home for a car (most Chinese urban dwellers live in high rise buildings with limited parking), insurance, and maintenance costs. In addition, by sharing one vehicle among many users, less resources and energy will ultimately be consumed in manufacturing vehicles and less congestion will result, due to fewer vehicles in use. The

user simply returns the EV to one of several locations interspersed throughout the city and the rental company will take care of recharging the vehicles' batteries.

Since the rental company has complete control over how and when it charges the batteries of returned EVs, it can use a slow charging technique, which extends the life of batteries relative to that which would result from a quickly charged battery. In addition, batteries can be charged at night, putting less strain on the power grid itself. Finally, by charging during evening hours, the rental company is making use of the power grid's base load. The base load is the amount of power that utilities need to generate to meet the lowest level of potential customer demand. For example, the power company has to provide a certain level of power just in case a customer decides to turn on their lights at 3:00 AM. When the consumer flips the light switch, they expect their lights to turn on. In most cases, however, the base load of power is simply generated, run through the system and returned to ground, i.e. wasted. However, by charging EV batteries during off peak hours, this previously wasted electricity is now used. The result is a fully charged set of EV batteries without consuming any additional resources or causing any additional pollution. For those consumers who have access to parking, and therefore, the ability to use plug-in charging, Kandi offers what it calls the "Long Lease".

This runs for between one and three years and for about $150 U.S./month, includes the use of the car, maintenance, and power (Rogowsky, 2013). In this version of Kandi's model, a consumer has access to a car anytime they want. It's as if they own the vehicle, the only difference is, the car in question is a zero emission EV and the consumer benefits by locking in a low cost lease. This model works because a normal internal combustion powered vehicle requires the owner to secure a license plate, recently costing in excess of $10,000. That's assuming a plate can be obtained through the lottery system that's in place for the distribution of car licenses throughout most of China. In addition, one must add to the cost of the license, thousands of dollars of taxes that are levied on internal combustion cars but waived for EVs. Finally, conventionally powered cars are subject to driving restrictions (odd vs. even days, etc.) that do not apply to EVs. Kandi's micro-bus car sharing model originated in the city of Hangzhou. At present, it has expanded to eight additional cities of, Shanghai, Chengdu, Nanjing, Guangzhou, Wuhan, Chansha, Changzhou and Rugao. It is also expected to be adopted in several more cities during 2015. On December 19, 2014, the China Innovative Electric Vehicle Symposium was held in Hangzhou, China. Among those in attendance were representatives from the National Science and Technology Development and Reform Commission, the Ministry of Finance, the Minsitry of Industry and other Chinese officials (d1ev.com/36422.htm., 2014, Translated from Chinese). One such official, Wan Gang, the Minister of Science and Technology and also the Vice Chairman of the Chinese People's Political Consultive Conference (CPPCC), addressed the conference attendees. In his speech, Gang indicated that the "Hangzhou micro bus mode affirmed". Furthermore, Minister Gang stated,

The convening of this meeting, affirmed Condi "micro bus" mode, but also in the country to promote the follow-up and operations indicate the direction for "micro-bus." Important model Condi Micro bus" mode as Chinese electric vehicle for urban public transport model innovation, will play an important role in the development and improvement of China's electric vehicle industry of urban public transport. (d1ev.com, 2014, Translated from Chinese) [Note: Condi is the word that appears when Kandi is translated from Chinese].

Shortly after the symposium concluded, Kandi, or more precisely, Kandi's CEO and founder, Hu Xiaoming was singled out for his contributions through Kandi's car sharing "micro bus" business model. The China Association of Automobile Manufacturers awarded Mr. Hu its 2014 China's Annual Green Car-Innovator Award. (d1ev.com, 2015-Translated from Chinese). The public recognition and accolades aside, how are Kandi's EVs being received by the Chinese public? According to a Morningstar news release,

As of the end of 2014, there have been a total of 9,852 Kandi Brand electric vehicles ("EVs") delivered to Hangzhou, 686 EVs to Shanghai, 1,020 EVs to Chengdu, 340 EVs to Nanjing, 700 EVs to Guangzhou, 612 EVs to Wuhan, 388 EVs to Changsha, 500 EVs to Changzhou, and 300 EVs to Rugao. With a total of 14,398 Kandi EVs delivered throughout the country as of the end of 2014, the Company believes it becomes the leading volume seller in the Chinese pure EV market. (Morningstar, 2015).

One week after the Morningstar release, a follow-up press release appeared in Barrons. It stated, in part, "…(Kandi) today announced that the first 60 Kandi Brand electric vehicles ("EVs") were delivered to launch another innovative EV business model, a "mini Police Car" Program. The EVs are designated for the first time use by the Hangzhou Uptown Public Security Bureau to facilitate performance of community safety patrols, population permit patrols, fire safety inspections, as well as other police duties." (Barrons, 2015) It would be premature to draw any firm conclusions about the long-term adoption of EVs by the Chinese public. However, the early results appear promising for one particular EV business model, that of the "Kandi micro bus". The car sharing model appears to have the backing and financial support (through subsidies) of the Chinese government. It addresses the underlying concerns of consumers about range anxiety and high purchase prices due to expensive batteries, by allowing users to rent by the hour, rather than buy their vehicles. The biggest constraint at the moment appears to be a lack of rental facilities, due to the high cost of acquiring real estate to build the rental garages. Even this is being addressed by targeting large housing complexes, which could include an EV charging area during construction, and allowing residents to sign up for long-term leases.

The early success of the Kandi micro bus mode is all the more encouraging when viewed along with the findings of Helveston, et al. (2015) who found that Chinese respondents were more receptive to battery electric vehicles than American respondents. They postulated this was because most Chinese car buyers were first time buyers with little experience with internal combustion cars. Many Chinese lived in densely populated areas and had no expectations of taking long cross country trips via car. In addition, many Chinese also have experience with owning or sharing bicycles, both electric and manual. To them, they are already accustomed to plugging in their bike after a short trip. In short, it appears that many Chinese consumers have already been conditioned to accept a program similar to that of micro bus car sharing.

CONCLUDING COMMENTS

China is at a crossroads in its efforts to promote the widespread use of EVs. Its leaders have made zero emission vehicle adoption a priority out of necessity. In addition to providing economic subsidies to manufacturers, they have encouraged creative methods to get consumers to adopt EVs. One particularly promising approach has been undertaken by Kandi Technologies with its philosophy that it is providing transportation, rather than simply manufacturing vehicles. Kandi's effort to create a variation of a bike sharing program for EVs is particularly promising. Early results appear to indicate that Chinese consumers are becoming more comfortable with the idea of sharing, rather than owning a car. As a result, many problems such as, parking, license fees, insurance, etc. are solved for the consumer. From a societal perspective, expansion of the Kandi Model appears to be sustainable in terms for reducing air pollution and urban congestion. Recent statements by high ranking Chinese government officials appear to indicate that the State is supportive of the micro bus car sharing mode of transportation and will provide financial assistance in the form of subsidies to help ensure its adoption and ultimate success.

There are several limitations to this study. First, only one company's effort to get Chinese citizens to adopt EVs was examined in detail. Many other companies are also engaged in the manufacture and distribution of EVs. However, most are attempting to sell their vehicles to consumers, which is the traditional business model for car manufacturers. Second, the ultimate success of Kandi's micro bus model, or any other manufacturer's business model, may acutely depend on the continued backing of

Chinese government officials. Virtually any business in China operates at the pleasure of the Chinese government, should they suddenly decide to withdraw their support, the micro bus model will probably not succeed. Third, is the issue of EVs resulting in cleaner air for China. Several recent studies have found that the implications for air quality depend on the mix of fuels used by the power plants which generate the electricity used to charge EV batteries. If the dominant fuel is coal, there may not be any appreciable improvement in air quality and could even result in an increase in air pollution (Michalek, et al. 2011). Finally, due to the fact that Chinese policies and a Chinese company are being examined, much of the information has been translated from Chinese, a cumbersome process involving the use of machine translation.

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