

Los Angeles, California, May 6-9, 2012

Scenario Analysis of Taiwan Commercial Fleet

Electrification-Case Study: Logistic Fleet

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Abstract

Electric vehicles are mostly used in the niche market. Compared to the common consumers, commercial uses are more suitable as target markets for electric vehicles at the initial rollout stage. The main obstacles for promoting electric vehicles are higher production cost (of which battery accounts for a major part) and paucity for public charging stations. It is relatively easy to make a breakthrough in commercial markets than in common consumer market, as far as the operational characteristics for commercial vehicles are concerned. At the present moment, testing operations for all kinds of electric commercial vehicle (BEV) throughout the world remain experimental, small-scaled, in a limited area, or still undergoing evaluation. Actual stable profit-producing examples have not yet materialized so far. This thesis probes into current operational condition of commercial vehicle fleet in Taiwan and evaluates the electrification, so as to propose potential business models in the future.

Keywords : Electric commercial vehicle, EV Fleet, Business models

1 Introduction

The main obstacles for promoting electric vehicles are higher production cost (of which battery accounts for a major part), and paucity for public charging stations. As far as the operational

characteristics for commercial vehicles are concerned, commercial markets, more than consumer markets, have more potential for electric vehicles to make a breakthrough, and may become important markets raising EV productions at the initial stage as a result.

As a matter of fact, in order to keep expenditure low commercial vehicle fleet owners have to seek continuously for advanced technologies that may extend mileage and comply with emission regulations. Benefited by tax credit, policy incentives, probable lowering operating cost, and several accumulative benefits, EV fleet owners may better afford initial investments in electric vehicles than consumers. In addition, by proper business models, including optimal battery size, optimal routes planning, and optimal charging time, payback period may be shortened. At present, most electrified commercial vehicles are: mail trucks, buses, logistic trucks, taxis, and service cars. Short-distance use, routine routes, collective parking, and high visibility characterize these fleets.

According to Ministry of Transportation and Communications, the market for commercial vehicle in Taiwan¹ is estimated around 280,000, and logistic trucks (including light trucks and trucks) accounts for 34%, and taxis 31%. The commercial vehicle hereafter is defined in a broad sense as any four-wheel vehicle for commercial use, and especially logistic trucks, which account for the highest amount in the commercial fleet market, are the main subject of study for this paper. And the commercial vehicle in discussion is electric driven and requires external electric supply for charging, mainly BEV. Fuel-cell EV is excluded in this study.

¹ According to the classification of MOTC, commercial vehicles in Taiwan comprise light trucks, trucks, taxis, rental cars, buses, among which trucks and light trucks are mainly for logistics.

2 Present Situation of Logistic Fleet Operation

2.1 Definitions

According to the classification of International Organization of Motor Vehicle, commercial vehicle comprises LCV, HCV, buses and coaches. The U.S., the largest commercial vehicle market, defines commercial vehicles as all vehicles registered as corporate-owned, including vehicle enlisted in fleets, as corporate vehicle, or vehicle for other commercial purposes. Although Europe and North America differ in defining commercial vehicle, both of them include LCV, MCV, HCV, and buses, as listed in Table 2.

In Taiwan, the highway freight transport industry, as defined in Highway Act, consists of general freight transport industry, fixed route freight transport industry, and container freight transport industry. Of the three industries, although general freight transport industry owns the highest number of vehicles, they belong to numerous corporations, and each owns less than 15 on average. In comparison, fleets in fixed route freight transport industry own the highest number of vehicles, or 355, per company. As a result, this industry is far larger in scale than the others, as shown in Table 1. As a matter of fact, in addition to general freight transport industry, fixed route freight transport industry, and container freight transport industry defined in Highway Act, Chunghua Post Co.(state-owned business administered by MOTC) also delivers freight as its main scope of business. In recent years, post offices have transformed in order to meet the market demand to include package delivery in addition to mail delivery. Chunghua Post has incorporated various transportation

systems into delivery planning and implementation, including highway, railroad (and HSR), waterway, airlift, along with its transportation tools and equipment, so as to form an intense delivery network. Chunghua Post owns more than 2,000

trucks under 3.5 ton as its major delivery trucks, so it plays an important role in domestic logistic market. Therefore, Chunghua Post is also included in this study.

Table 1. Commercial Vehicle Segmentations- Comparisons between EU and North America

Vehicle Classification	Definition	EU (ACEA)	NA (DOT)
LCV (Light Commercial Vehicle)	Vans and light trucks. Applications: pick-up and delivery, utilities, airport operations, facilities management and several over vocational applications.	GVWR \leq 3.5t	Class 2-3 GVWR \leq 14,000LBs
MCV (Medium Commercial Vehicle)	All types of mid size, vans and buses. Applications: Home delivery, logistics, parcel delivery, utilities and others.	GVWR >3.5 & \leq 16t	Class 4-5 GVWR>14,000LBs & \leq 19,500LBs
HCV (Heavy commercial Vehicle)	All types of large trucks. Applications: Line haul freight trucks, refuse trucks, mining and construction trucks, and others.	GVWR >16t	Class 6, 7&8 GVWR>19,500LBs

Table 2. Classification and Market Size of Commercial Fleets in Taiwan

	Fixed route freight transport industry	General freight transport industry	Container freight transport industry
Nature of operation	Delivering freight on trucks in approved routes for business	Delivering freight on trucks for business	Delivering container freight on trailers in approved areas for business
Number of vehicles per fleet	335.3	11.8	13.4
Average mileage of each vehicle per day (km)	94	174	582
Average loading of each vehicle per day (ton)	4	16	93

2.2 Operation analysis of each fleet

Generally speaking, logistic fleets in Taiwan comprise mail delivery fleets, fixed route freight transport fleets, general freight transport fleets, and container freight transport fleets. Since fixed route freight transport industry provides home delivery and logistic services, and they also vary in freight

to deliver, vehicle for delivery, and delivery methods, this study divides fixed route freight transport fleets into home delivery fleets and logistic fleets in hope that the analysis will be closer to reality.

Deeper analysis of the five types of commercial fleet mentioned above in load demand, delivery distance, and vehicle mode shows that mail delivery industry, home delivery industry, and logistic industry have high demand in downtown

area delivery; general freight transport industry and container freight transport industry mainly provide delivery service across different areas. Operational structure of different commercial fleet industries is shown below in Table 3:

Table 3 The operational structure of logistic/freight transportation fleets in Taiwan

	Mail service industry	Home delivery industry	Logistics industry	General freight transport industry	Container freight transport industry
Loading requirement	<500kg	1~2t (urban area)	2t (urban area)	$\geq 4t$	$\geq 10t$
Distribution distance (per day)	$\leq 80km$ (urban area)	$\leq 80km$ (urban area)	80~100km (urban area)	$\geq 150km$ (inter-area)	$\geq 200km$ (inter-area)
Vehicle model	Mainly 1.75t	mainly 3.49t 、partly 3-layer truck	mainly 3.49t, and will adopt 6.5t as the major model in the future	mainly 6.9t, and supported by 3.49t	>10t (mainly trailer trucks)
Vehicle parking	centralized (post offices)	centralized (in each area)	centralized (in each area)	centralized (in each area)	centralized (in each area)
The degree of fixed route	high fixed routes and area	high fixed routes and area	high fixed routes and area	medium	not fixed
Ownership of vehicles	centralized (post offices)	centralized (owner)	centralized (owner)	medium (fleet/individual)	high
Key examples	Chunghua Post Co., Ltd.	Taiwan Pelican Express Co., Ltd.	HCT Logistics 、Kerry TJ Logistics	Chung Lien Transportation Co., Ltd.	Famous Express Co., Ltd.

(1) Mail delivery fleets

These fleets take advantage of highway in urban area, and use other means of transportation, such as air delivery, high speed rail, and railroad for inter-area delivery. Since the mails are not heavy and are packed in fixed sizes, it is easy to categorize them and keep the total weight of mails under 500 kg. In addition, distribution centers are densely located in cities, and the fleets take fixed routes, so that delivery distance per day can be kept under 80 km. Mail delivery fleets in urban areas mainly consist of light truck less than 1,200 cc and weighing under 2 tons. After delivery, the vehicles return to the post offices and park there. All the vehicles are owned by the post offices as stipulated by law.

(2) Home delivery fleets

They conduct light freight delivery mainly in urban areas, with each loaded vehicle under 2 tons and delivery distance within 80 km. For inter-area delivery, middle to heavy trucks (mainly 3.49t trucks) are used, or they cooperate with general freight transport companies to conduct delivery. In addition, the vehicles are parked together and have fixed routes. Instead of renting, business owners own all the vehicles, as stipulated by law.

(3) Logistic fleets

These fleets mainly conduct delivery of packages in urban areas, with the loading of 2 tons and delivery distance between 80 and 100 km. For inter-area delivery, middle to heavy-sized trucks (mainly 3.49t trucks) are used, or they cooperate

with general freight transport companies to conduct delivery. In order to satisfy the demand, the fleets are moving to adopt 6.9t trucks for larger loading space for urban area delivery. The trucks have their own centralized parking lot in major cities. Their service routes must be approved in advance and are highly fixed. Instead of renting, business owners own all the vehicles, as stipulated by law.

(4) Container freight transport fleet

These fleets mainly conduct inter-area delivery with various kinds of frights, including commercial goods delivery and relocation service. Due to the variety of freight, the fleets have higher demand in loading, mainly 3 to 4 tons or higher. Daily delivery distance is relatively longer as well, with an average between 120~140 km. The vehicles are parked centrally, though the routes are adjusted to suit customer demand, so they are seldom fixed.

Operational condition analysis of logistic fleets in Taiwan

Judging from the operation of five major commercial fleets, loading demand and daily

delivery distance are the key factors in deciding the vehicle models to adopt. Mail delivery fleets, home delivery fleets, and logistic fleets have a demand for loading capacity lower than 2 tons and delivery distance shorter than 100 km per day. Thus they choose to operate on light trucks.

Commercial fleets by law must set up their own freight stations and parking space in order to conduct freight distribution and vehicle parking. Thus, vehicle parking is highly centralized. Service routes and areas are subject to approval by authorities, so the mail delivery fleets, home delivery fleets, and logistic fleets with their service area mainly in urban areas have fixed route, so that each vehicle may conduct delivery in fixed routes. Destinations, for general freight transport fleets and container freight transport fleets, are selected by customers and they are mostly factories, harbors and/or airports, so the routes are relatively irregular.

The following is the analysis of domestic logistic fleets categorized according to the mileage, service routes, and loading demand, shown as Figure 1.

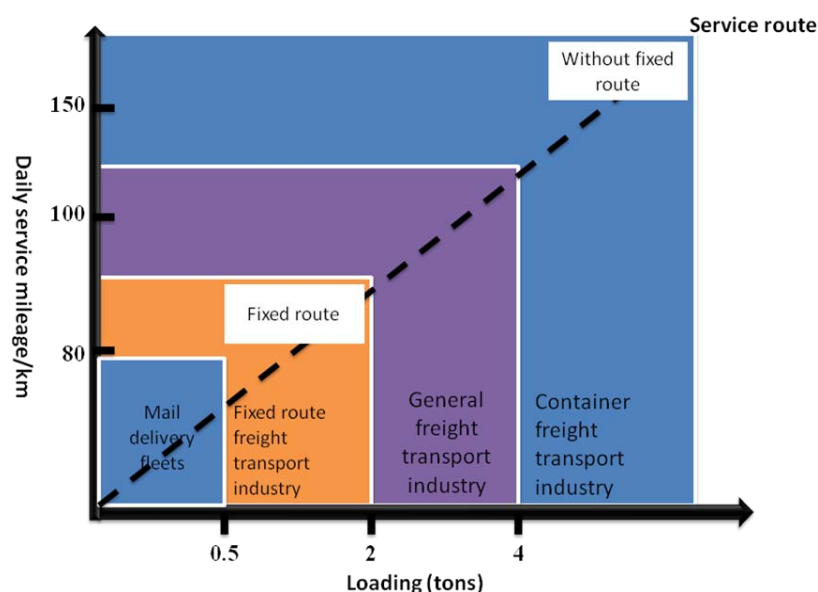


Figure 1. Analysis of operational conditions of logistic fleets in Taiwan

3 Construction of commercial fleet system

In order to make electric vehicles, infrastructure, intelligent traffic systems, and payment system supporting the new business model are also key issues in addition to the supply of batteries, motors, and adaptors, critical components.

Requirements for vehicles in commercial fleets are different from those of private vehicles. Management and operation must be taken into consideration for setting up a service system for the fleet. In addition, demands in environment, such as durability, traveling distance, loading capacity, vibration, and controllability, are higher for commercial use as well.

In order to alleviate the burden of commercial vehicle drivers, commercial fleets depend more on electronic and automatic on-board equipment than private vehicle drivers do. For Future commercial fleets to be electrified, four key points in establishing the operational system are: (1) Fleet owners and the sales of vehicle dealers (2) battery vendors and the sales of battery to vehicle dealers (3) Sales between battery vendors and power company (4) fleet owners and vehicle managing and power monitor system provider. There are new issues and business models in respond to each key point, as showed in Table 4.

Table 4 Key points for current commercial fleets to adopt electronic operational system

Role	Issue	New Business Models
fleet owners \longleftrightarrow vehicle dealers	vehicle sales model	vehicle sales vehicle rental vehicle body sales vehicle body rental
battery vendors \longleftrightarrow vehicle dealers	battery sales model	battery sales battery rental
battery vendors \longleftrightarrow Power company	battery sales model charge fees from fleet owners	charge fee model from fleet owners cost recovery of battery and charge station
fleet owner \longleftrightarrow vehicle managing and power monitor system provider	Establishing vehicle management system	Establishing vehicle power monitor system in addition to original management system

(1) fleet owners \longleftrightarrow vehicle dealers

Electrified vehicles are business equipment to fleet owners. To them, the main purpose is to make profit by having the fleet delivering cargos. However, the whole electrified vehicles are high cost items. Thus, the owners have to lower the cost by renting the vehicles or retailing batteries. In addition, maintenance services for electrified

vehicles are not widely provided, and used electrified vehicle market is still unformed. Thus, how to ensure the convenience of electrified vehicle service and evaluation of used vehicles are important issues ought to be taken into consideration in establishing service system.

(2) battery vendors \longleftrightarrow vehicle dealers

The battery accounts for the most cost of a whole electrified vehicle, and is arguably the most critical system. The battery is consumed with mileage and each charging. When recharge capacity of the battery reduces to 70% of its original, the battery must be replaced, increasing the hidden cost. Thus, demand of reusing the battery decommissioned from electrified vehicles for other purposes (e.g. electricity storage equipment in power plants) brings about new business opportunities in the market. These opportunities also indirectly lower the cost of batteries in the long run.

(3) battery vendors \longleftrightarrow Power company

Power companies provide one-stop service for battery and charging equipment for fleet owners to deal with charge station establishment and battery acquisition. With designed payment mechanism, fleet owners may share the cost of batteries and establishing charging stations.

(4) fleet owner \longleftrightarrow vehicle managing and power monitor system provider

When fleets expand to a certain size, it is necessary to establish a vehicle management system to dispatch vehicles and arrange delivery routes. As electrified vehicles incorporated into operation, demand for monitoring vehicles increases as well. The monitoring system may ensure vehicles to complete whole delivery without power supply cutoff.

3.1 Future trend of commercial fleet system service

(1) Small scale operation at present may decrease the resources invested in establishing service system

Electrified vehicle operation is still in its initial stage. Thus, many operational projects are small in

scale, so as to facilitate data gathering and decrease required parts in establishing the service, and the initial cost would not be too high to recover.

To adopt electrified vehicles, a fleet needs to establish more services and invest more. Short-term immediate establishment includes a business model of selling vehicles, batteries, and charging stations. In the long run, the fleet also needs to establish electrified vehicle management system in cooperation with financial institutions so as to complete a payment system, and optimized electricity grid, including charging service and electricity sellback. In order to introduce a vehicle management system, vehicle power monitoring also needs to be added to the original vehicle dispatching and route arranging functions, so as to eliminate task failure due to power shortage midway. In addition, financial service providers may help to establish payment system, so as to facilitate different business models cooperate smoothly. They indeed play an important role supporting large-scale operation of electrified vehicles in the long run.

(2) Concept for establishing commercial fleet service system should be distinguished from that of a family system

From the viewpoint of operation and management, commercial fleets have fixed parking spaces and fixed routes. The fleets own the vehicles, make bulk purchase with annual budgets, and require vehicle management system to maintain their operation. They make long-term stable purchase from vehicle dealers and power companies. The fleets also require system managing service routes, so after adopting electrified vehicles they may establish centralized charge stations, so that the vehicles may recharge while loading. The vehicle

manage system may also arrange the delivery route and distance to avoid power shortage. Also, how to conduct capital movement under bulk purchase and lowering purchase cost are important issues for electrified vehicles to be adopted.

(3) Setting up a standard facilitates the service system operation

It is important to establish a standardized service system, including battery specifications, charging interface, of communication interface, and of service charge for different electrified vehicles, so that different vehicles may share the same charge station and batteries, and collecting charge may become easier. From a long-term perspective, setting up the standards is the most important factor in making electrified vehicle service system complete.

4 Evaluation of introducing electrified fleet

4.1 Vehicle condition evaluation

To introduce electrified vehicle into the domestic commercial fleet to conduct freight delivery services, regulations, market demands, and technology of current electrified commercial vehicles should be taken into consideration.

(1) Domestic regulations

According to Article 14 of Regulations Governing Vehicles in the Auto Transportation Industry, domestic commercial fleet must own the vehicles in use; in case of any renting demand, rented vehicles may only serve for flexible use during business peak period and such use may not exceed duration of 6 months. If electrified vehicles are introduced into the commercial vehicle market, the fleets must purchase the electrified vehicles instead

of renting for long term. As a result, the fleet owners have to pay a high cost purchasing vehicles.

(2) Choice of car models

According to survey and interview, in domestic commercial fleet market, medium to heavy loading trucks of the total weight more than 6.9 tons will be the mainstream vehicle model adopted by logistic industries. The main reasons are: a) the 6.9t model has little difference from current 3.5t model in appearance, and would not diminish the convenience of traveling in the city or making U-turns b) In view of loading demand and profit making, 6.9t model has a larger loading capacity. Due to the reasons above, domestic logistic industry tends to purchase new vehicles of medium to heavy-sized loading models more than 6.9 tons.

(3) Current technology

Current technology in battery capacity and loading capacity of BEVs remain insufficient for the logistic industry, even more so to live up to the demands for medium to heavy-sized trucks. However, with even stricter regulations on vehicles being eco-friendly, the goal will be reached alongside other energy conserving technologies, including the technology of incorporating HEV technology along side with combustion engine. Installing generator in the vehicle as supporting power to supply part of the power may also increase fuel efficiency and comply with the regulations.

(4) Promotion in the market

To promote EV fleet, initial projects may start with willing fleet owners operating on proper routes, and conduct a small-scale operation before expanding.

Generally speaking, based on different conditions for domestic commercial fleets and technology for

electrified commercial fleet worldwide, we suggest that fleets of light loading capacity (lower than 800 kg) operating on fixed routes in urban areas may consider adopting lightweight BEV. Those fleets on fixed routes but requiring higher loading capacity demands may evaluate energy conserving

efficiency brought by current energy conserving technologies and consider to introduce BEVs after evaluation, as shown in Figure 2. Evaluation and suggestions for introducing electrified vehicles into domestic commercial fleet are shown in Table 5.

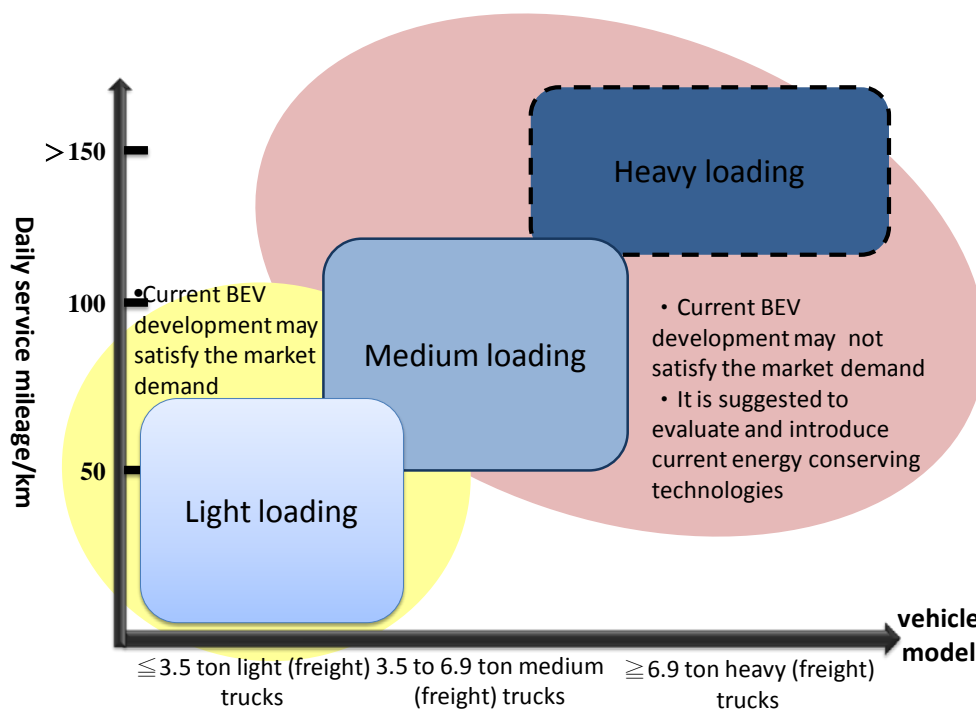


Figure 2. Vehicle condition of logistic fleets in Taiwan

Table 5. Evaluation and suggestions for introducing electrified vehicles into domestic commercial fleet

	Current condition of commercial vehicles	Operational conditions of domestic commercial fleets	Introduction suggestions
Light commercial vehicle	The service distance of currently developed electrified commercial vehicles is mainly between 80 to 100 km, and the loading capacity is between 500 to 800 kg	Loading capacity: 500 kg to 2 t Fixed service route in urban areas Mileage per day may be kept under 100 km	Light loading fleet (under 800kg) with fixed routes may consider introducing light BEV for tentative operation
Medium to heavy commercial vehicles	Currently, hybrid commercial vehicle models have been introduced into the international market, increasing fuel efficiency, loading capacity, and longer service distance	Loading capacity: 4~10t or above Delivery in urban areas or inter-area delivery service distance over 100 km per day	Enhancing fuel efficiency by incorporating various energy conserving technologies

4.2 Operational model evaluation

Business model operation may reduce obstacle for introducing electrified vehicles. Business opportunities for electrified vehicles may be expanded and risk reduced with government subsidies and rental from power companies, and vehicle purchasing by fleet owners. In addition to cost effectiveness, operational flexibility and risk taking between each member should also be taken into consideration so as to effectively reduce risk and obstacles for introducing electrified vehicles.

4.2.1 Four conditional models

By surveying literature and interview with domestic commercial fleet owners, this study concludes three main factors for analyzing conditions for commercial fleets introducing electrified vehicles, including vehicle model choice, government subsidy, and ownership structure, as showed in Figure 3.

(1) Vehicle model choice

Introducing light commercial vehicle is a more concrete and feasible goal to promote electrified vehicles at the current stage. Thus the financial analysis is focused on light electrified commercial vehicles. The analysis target is vehicle model equaling 1,200 cc fuel vehicle.

(2) Government subsidy

The amount of government subsidy affects initial cost for fleet owners. Since costs for electrified vehicles are high, such costs are a major obstacle for fleet owners to introduce electrified vehicles. Thus, government subsidy is a key influence in financial analysis. The limit of government subsidy is capped 49%; that is, the government reimburses

49%² of the cost of purchasing (the whole vehicle or vehicle body).

(3) Ownership structure

Ownership structure affects the initial cost invested by the fleet owner and the operational cost in the future. The ownership structure may be categorized into (a) combined ownership of vehicle and battery: The vehicles, batteries, and charging equipment all belong to the fleet owner. (b) Separated ownership. The vehicles and charging equipment are purchased and owned by the fleet owner; the battery rented from and owned by power company (c) Separated ownership. The vehicles are purchased and owned by the fleet owner, and the battery and charging equipment are owned by and rented from the power company. (d) Whole vehicle rented³. The vehicle, battery, and charging system are rented from the third party (car rental agency).

Based on the three main factors above, this study categorizes the main scenarios of commercial fleets introducing electrified vehicles into Figure 4:

²The government subsidy may amount up to 49% in pioneering project from Industrial Development Bureau.

³ Current regulations in Taiwan require logistic vehicles owned by the fleet owners, and vehicles can be only rented for a short period of time. However, with deregulation in the future, long-term vehicle rental business model may emerge, so the study discusses the model as well.

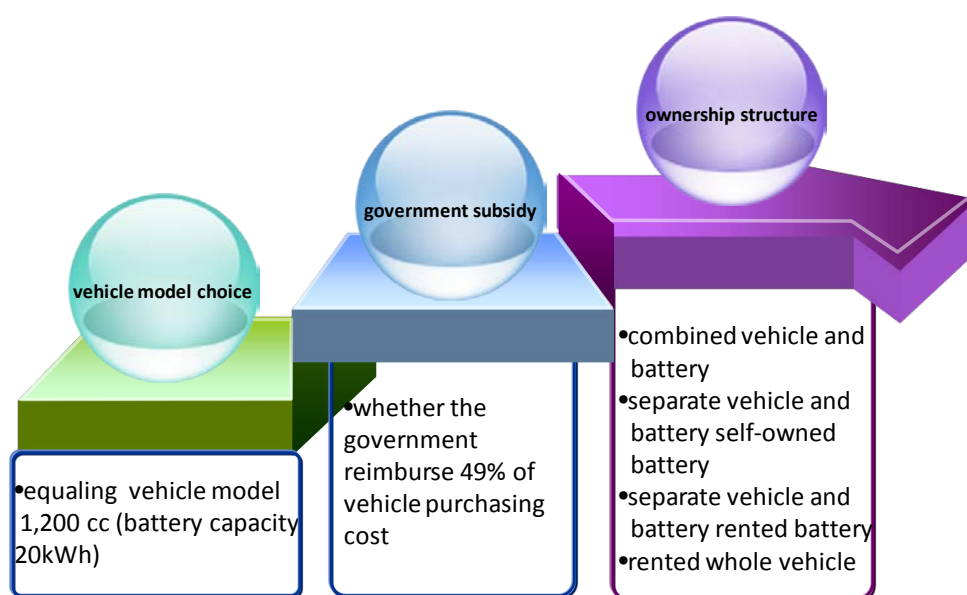


Figure 3. Three main factors affecting analysis of the conditions

With government subsidies without	<ul style="list-style-type: none"> • vehicle cost: logistic fleet owner • battery cost:: logistic fleet owner • charging cost: logistic fleet owner • government subsidy: 49% of vehicle price • maintenance cost: logistic fleet owner 	<ul style="list-style-type: none"> • vehicle cost: logistic fleet owner • battery cost:: rental • charging cost: logistic fleet owner • government subsidy: 49% of vehicle price • maintenance cost: logistic fleet owner 	<ul style="list-style-type: none"> • vehicle cost: logistic fleet owner • battery cost:: rental • charging cost: rental • government subsidy: 49% of vehicle price • maintenance cost: logistic fleet owner 	
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	Model 1	Model 2	Model 3	Model 4
	combined ownership purchased charging equipment	separate ownership purchased charging equipment	separate ownership rented battery and charging equipment	whole vehicle rented
	high	vehicle ownership		low

Figure 4 Four possible conditions of commercial fleets' introducing electrified vehicles

4.2.2 Business model analysis

Model 1:

Fleet owners pay for all the cost, except the government provides vehicle purchase subsidy. The owners have to pay for the cost of purchasing battery, charging equipment as well.

Model 2 and 3:

With the participation of power company, fleet owners may purchase only the vehicle bodies, and rent batteries and charging equipment, so the initial cost from fleet owners may be lowered; the cost may be paid off annually, so that fleet owners may not resist that much the high amount of initial cost.

Model 4:

The vehicle rental agency is in charge of incorporating service from vehicle dealers, power companies, and charging equipment providers. Fleet owners may rent the vehicle, battery, and charging station from the rental agency. However,

fleet owners acquire the right of using vehicles from the rental agency, so they cannot get subsidy from the government.

The four business models evaluate the cost of introducing electrified vehicles paid by the fleet owners and the risk of acquiring key equipment. The risk may be shared with other interested parties, so as to make electrified vehicles more feasible for commercial fleet owners to adopt. Of all the models, model 4 is impossible to implement without deregulation; model 2 and 3 have potential to reduce the cost of introducing electrified vehicles, including key components like batteries and infrastructure like charging station, so as to make fleet owners more willing to introduce electrified vehicles. Table 5 shows how the four business models work and related suggestions.

Table 6. The operation of four business models and suggestions

Business models	Limitation	suggestions
Combined ownership	fleet owner take the highest cost and risk	The fleet owner is relatively unwilling to introduce electrified vehicles, which may hinder the promotion of electrified vehicles. This model also lacks withdraw mechanism for fleets. It is advised to develop other business models. The model should be subject to further evaluation if long-term cost has lowered to a degree acceptable by fleet owners.
Separate ownership with rented battery and purchased charging station	Power companies share the risk from the fleet owners according to the size of incorporated business	It may make the power company to emerge in the market, operate, and find out the best price to prompt the formation of the business model. As far as the withdraw mechanism of the fleet and the risk taken by the vehicle dealer are concerned, a small number of electrified vehicles are introduced at the current stage, while establishing reasonable payment mechanism for large-scale introduction in the long run.
Separate ownership with rented battery and charging station		
Whole vehicle rented	Limited by current regulations The fleet owner takes the least risk, and the	Without violating the law, this model may enable the fleet owner to conduct tentative operation in a small scale and thus evaluation the financial analysis of introducing electrified vehicles.

	vehicle dealer takes the highest risk and cost	Considering the risk taken by the vehicle dealer, tentative operation in a small scale may be introduced. After evaluating the benefit of promoting electrified commercial vehicles and energy conserving, related regulations may be amended.
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5 Conclusion

There are many kinds of commercial fleets in Taiwan. Those features “high delivery frequency in urban area with fixed predictable routes” will be the niche markets for electrified vehicles. Since they are introduced to commercial fleets, thus fleet owners will pay special attention to establishment of charging equipment, frequency of use, satisfactory delivery distance, and service & maintenance cost. More than in public spaces, the charging equipment in the commercial fleet parking lot may be most cost-effective and unit cost shared.

In addition to cost, positive corporate image is another benefit. Commercial fleets have high media exposure under keen competition; with introduction of electrified vehicles, the fleet may promote as its image environmental protection, green transportation, and freshness.

5.1 Government subsidy plays an important role in introducing electrified vehicles in commercial fleets

Since the initial cost for developing electrified vehicles is higher, and the cost of commercial vehicles are also higher than that for private vehicles, fleet owners need to consider all these plus the capital and operational cost. Thus, government subsidy and preferential policy play an important role in promoting electrified vehicles in

the commercial vehicle market. In fact, government subsidies provide an incentive and play essential roles in related business model, prompting the promotion of electrified vehicles.

5.2 Since the service system in EV industry is still under development, it is suggested to conduct tentative operations imitating those in model cities abroad.

Since the service system of electrified vehicles is still underdevelopment, some model cities in the world have conducted tentative projects to verify the validity, including the Intelligent City Project in Yokohama, Japan, Clean Vehicle Project conducted by TNT Express in big cities around the world (such as those in the U.K., the Netherlands, and Mainland China). We may refer to these pioneer projects abroad and promote EV via commercial fleets. The government should construct a platform to prompt the cooperation between commercial fleet owners, local governments, power companies, battery manufactures, and vehicle dealers. The project should also incorporate EV information network⁴ (especially introduction of renewable energy) to form a new operation model of electrified commercial vehicle so as to realize the goal of “Low carbon, green logistics.”

⁴ Including vehicle information system for EV fleets to provide the information of battery capacity, charging information, as well as other functions supporting charging.

5.3 Flexibly exploit the policy to lower introduction cost and increase willingness for introduction

One of the most important factors to promote electrified commercial fleet is to lower the cost of introduction. In addition to offering purchase subsidy and reducing taxes for the vehicle, the government may also use other flexible strategies to lower the cost of introduction:

(1) Lowering the cost of vehicles:

Vehicles need to be verified before release. Mass production may reduce the cost by sharing that over each vehicle. However, electrified commercial vehicles are currently introduced in a small number and still need revision, thus the unit verification cost shared by each vehicle is relatively higher. If enhancing the industry and conserving energy may lower the cost, commercial fleet owners will be more willing to rent or purchase electrified vehicles.

(2) Alleviating the pressure on capital of the fleet owners:

If electrified commercial vehicles are introduced in a large scale by renting, vehicle renting agencies are to sustain heavier capital burden. A vehicle may be used for a long time. Thus, how to assist vehicle owners to alleviate capital burden directly affects rental price and willingness for introducing electrified vehicles. We suggest that the government set up special fund from money collected by fund against air pollution to finance fleet owners for the project. Such financing also reduces the cost for commercial fleets to introduce electrified vehicles.

Reference

- [1] S. Lin, N. Shiue, Y. Chao, Research on EV Service and Business Models of Taiwan Commercial Fleet Electrification, MIRDC ITIS Project of MOEA, Taiwan, 2011
- [2] Journal of Society of Automotive Engineers of Japan, Vol.65~66, 2011
- [3] A.T. Kearney, CAR-ELE Japan / EV Japan Technology Conference, 2011
- [4] Dynamometer Testing of USPS EV onversions, Oak Ridge National Laboratory, 2011
- [5] Yearbook of Transportation and communication 2010, Ministry of Transportation and Communications R.O. C, 2011
- [6] Electric Vehicles Demonstration Projects, NWV Market Discovery, 2011
- [7] U.S. Postal Service Fleet Alternative Fuel Vehicle Program Report for Fiscal Year 2010, USPS, 2011
- [8] EU and NA Electric Buses, Vans and Trucks Market-Depot Based Delivery Vehicles expected to Account for 70% of Overall Electrification Share, Frost & Sullivan, 2010
- [9] Fleet Electrification Roadmap, Electrification Coalition, 2010
- [10] TTVMA, Taiwan Transportation Vehicle and Manufacturers Association, [http://www.ttvma.org/], 2011

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