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Overview of the Taiwan EV National Promotion Program Driven by Clean Zone Policy

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Abstract

There have more than 14 million units of motorcycle in Taiwan, and the motorcycle's exhaust emission has become one of the causes of air pollution in urban areas. To improve the air quality in urban areas and also seek the business opportunity from the new EV industry, the Taiwanese government starts regulating sales of gasoline motorcycle in 2009 to replace the less competitive 50cc engine motorcycles by e-Scooter of the light electric vehicles (LEV). The government also earmarks NT$1.6 billion (US$49.7 million) over the next four years to subsidize buyers of 2-wheelers electric scooters (2W e-Scooter) with the feature of the advanced Li-Ion battery system. As part of this effort, the Industrial Development Bureau (IDB) of Ministry of Economic Affairs (MOEA) formulated standards for e-Scooter's performance and safety to bring up 8,000 units of 2W e-Scooter in 2009, and to 100,000 by the end of 2012. This is the first phase of the EV national program, and next phase will be focus on the EV fleet promotion driven by the clean zone policy to be discussed hereafter.

As most of the experts predicted, EV won't be popular in next few years till the industry finds the good cost-performance battery solution. Hence, the government should lead the policy like the zero exhaust emission zone, clean zone, to demonstrate the clean and efficient transportation by employing EV solutions. The demonstration from the e-Scooter of LEV, utility van, and mid-size bus will accumulate the fleet operation experiences including the usage scenarios, the effectiveness of the business model, and the product performance. These are crucial for the participated industry to establish the products' interface and standards, for the local government to build up the charging infrastructure system to promote an EV as a convenient and efficient transportation system, and also for industry to develop a series of the competitive EV niche products in Taiwan for the global markets. The in-depth discussion of this clean zone plot will be discussed in this paper.

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1 Introduction

Global warming and oil reservation shortening are both the major concerns worldwide. The use of electric vehicles is considered effective in both reducing greenhouse gas and fuel consuming. Taiwan has 23 millions people and 14 millions motorcycles on the island of 36,000 square km, and it ideally to promote LEV or fleet transportation system in the urban area as the first or last-mile solution to connect the public transportation to office or for leisure. From the other perspective, Taiwan, owing to lacking of natural resources and its strength in light and niche vehicles manufacturing, Government puts EV into National Development Plan as one of the targeting industries, to be beneficial to both environment and economics.

The promotion of LEV is the first phase of the national EV promotion program and to be focus on the electric bicycle, electric scooter, electric mobility and e-Scooter etc. Referring to the Frank Jameson's (Electric Bikes Worldwide) sales report, there had 12.5 million electric bikes and 2.5 million electric scooters sold respectively in year 2006. Although LEV has very high growth rate for past few years, it is still in kindergarten stage. More and more countries will implement LEV as their short-range transportation solution, and we expected it has the double digits' annual-growth in this decade. This is the main reason for Taiwan to put the LEV development as the first phase of the national EV promotion program.

The second phase of the national program will be focus on the fleet demonstration of the e-Scooter, utility van, and mid-size bus to accumulate the fleet operation experiences including the usage scenarios, the effectiveness of the business model, and the product performance. These experiences will assist the participated industry to establish the products' interface and standards, guide the local government to build up the charging infrastructure system to promote an EV as a convenient and efficient transportation system, and provide the system requirements for industry to develop a series of the competitive EV niche products in Taiwan for the global markets. In the meantime, Taiwan will develop the advanced battery and control solutions to enhance the EV cost-performance for industry to launch the competitive mass production in this decade.

2 1st Phase of the EV National Program – e-Scooter

The e-Scooter LEV project was devoting to develop critical technologies for the fabrication of high efficiency light electric vehicles, including whole vehicle design, electric propulsion system, and good cost -performance battery system, and so as to fleet demonstration sponsored by the Ministry of Economic Affairs (MOEA) and EPA of Taiwan Government since 1993 [1~7].

In year 2000, as shown in Figure 1 Taiwan was the first country in the world to introduce the 3kW big sit-down 2 wheels scooter (2W e-Scooter) mandate to replace 50cc petroleum motorcycle, unfortunately, the poor VRLA-Battery performance and lacking of the user-friendly infrastructure resulted in aborting this e-Scooter national incentive program in year 2003. Currently, it only has 1000 vehicles running on the road, and this 10% of users provides lots of traceable feedbacks as the future promotion references.

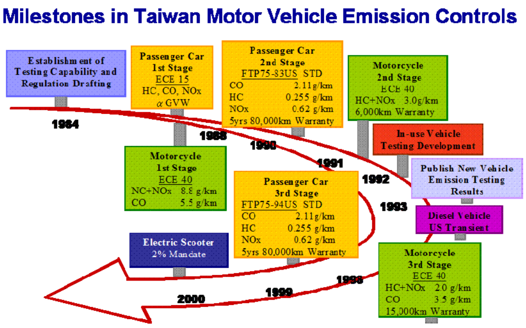

Figure 1: Emission Regulation Milestone

After we carefully reviewed the key failure factors of this e-Scooter national promotion, as the show in Figure 2, the over-expectation of the vehicle cost-performance was the No.1 concern. Most of users wanted the reliable cruise range longer than 40km, weight lighter than 90kg, and the cost lower than 1,200 USD. The big challenge was the cost-effective VRLA battery can't perform, and the Li-Ion battery was too expensive and safety was not completed validated at that time yet.

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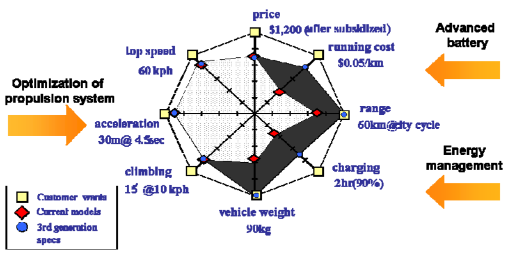

Figure 2: LEV-2W ES Product Features

Thereafter, we made a large-scale focus-users survey and deployed their requirements into the engineering specifications as show in Figure 3 from the ITRI 3rd generation LEV-2W ES model. Although, it still had a big gap between the users' wants and engineering delivery, the industry need focus to find the battery can deliver 100wh/kg performance with the cost less than 500USD/kW and an efficient propulsion system can deliver 43km/ kWh of performance.

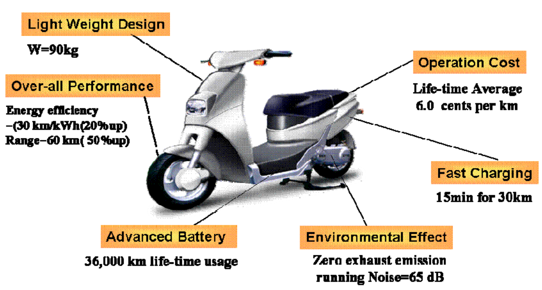

Figure 3: 3rd Generation ES Engineering Targets

This ITRI 3rd generation model is very difficult to meet cost-performance target, hence, the industry developed another model classified as a mini e-Scooter [7] by employing less capacity of Li-Ion battery to the smaller scooter. The mini e-Scooter was equipped with 0.75kW DCB motor and weighted 50kg to deliver 45km/h of top speed and 40 km of range. Once the volume reaches the economic scale, the industry claimed that it will meet the cost target of 1,200 USD. In order to bring up these advanced e-Scooters to the market earlier, the Industrial Development Bureau (IDB) of Ministry of Economic Affairs (MOEA) formulated standards for e-Scooter's performance and safety to bring up 8,000 units of 2W e-Scooter to the market in 2009, and to 100,000 by the end of 2012.

2.1 e-Scooter Promotion Plan

The government intent of this promotional plan was not only to reduce the green house emission also to utilize the industry strength to develop Taiwan to be the centre of excellence of LEV ODM. Therefore, most of this promotion effort was focus on the system interfaces and standards formulating for improving the e-Scooter's performance, safety, and efficiency. From Reference 7, the related validation procedures are listed in Table 1. The corresponding standards include 1) 10 items of the vehicle performance and safety validation, 2) 9 items of the extractable battery safety validation. Especially, the extraction type of battery system's procedure for the scooter's application is new to the world, and it requires lots of engineering efforts to accumulate the sufficient data to finalize the standard's specifications in middle of this year.

Table 1: IDB e-Scooter Test Code and Standards

IDB e-Scooter National Promotion-Program
Items of Test Procedures and Standards

Items	Test Procedures and Standards	
e-Scooter Performance and Safety	TES-0A-01-01	Grade ability test procedure (CNS14386)
	TES-0A-02-01	Maximum speed test procedure (CNS14386)
	TES-0A-03-01	Acceleration test procedure (CNS14386)
	TES-0A-04-01	Range test procedure (CNS14386)
	TES-0A-05-01	Complete vehicle acceleration endurance test procedure (New Developing)
	TES-0A-06-01	State-of-charge test procedure (New Developing)
	TES-0A-07-01	Electromagnetism compatible test procedure (CNS14434)
	TES-0A-10-01	Special security specifications and test procedure (CNS14386)
Battery and Charger System	TES-0A-08-01	Extraction type battery security specifications (New Developing)
	TES-0B-01-01	Rechargeable lithium battery pack safety test procedure (BATS001)
	TES-0A-09-01	Charge system safety general standard (IEC61851-1)
	TES-0A-09-02	Charge system safety connection standard (IEC61851-1)

Table 2 is the preliminary standards for industry to conduct the development test internally to verify his design intents and product specifications. Once the standards are finalized by IDB, and the industry can submit his vehicle to authorized validation site to apply the type of approval. Each of approved e-Scooter and mini e-Scooter will be qualified for users to receive 11,000NT$ and 8,000NT$ subside respectively.

Table 2: Industry e-Scooter Product Validation Code

IDB e-Scooter National Promotion-Program
Preliminary Standards under Developing

Items	Test Procedure		Standards	
			e-Scooter	Mini e-Scooter
e-Scooter Performance and Safety	TES-0A-01-01	Grade ability test procedure	>20kph @ 18%	>10kph @ 18%
	TES-0A-02-01	Maximum speed test procedure	>50kph	>30kph
	TES-0A-03-01	Acceleration test procedure	<10sec @ 0~100m	<8.5sec @ 0~50m
	TES-0A-04-01	Range test procedure	>40km @ ECE47	>30km @ ECE47
	TES-0A-05-01	Complete vehicle acceleration endurance test procedure	>85% of Initial Range After 5000km Durability	>85% of Initial Range After 3000km Durability
	TES-0A-06-01	State-of-charge test procedure	>2km for Warning @ Initial & After Durability or >85% Accuracy @ Initial & After Durability	

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2.2 Challenges and Future Development

The main concerns of this phase of program are the safety and cost of the Li-ion battery system. The challenges will be the state of arts Li-Ion battery technologies not mature enough for the massive public usages yet, especially for the scenario of the extractable charging at home outlet. Therefore, we encourage to consider to employ the larger e-Scooter, 3~5 kW for the fleet usage like pizza, newspaper, mail, and milk delivery, because, this central management will be easier to implement the fleet management process to secure the safety of the battery and also enhance the efficient and creative clean transportation for the clean living zone.

3 2nd phase of the National Program – Clean Zone Fleet Demonstration

Once the e-Scooter's fleet accumulates sufficient valuable data to improve the effectiveness of the business model, the infrastructure readiness, and the product overall performance, we shall continue to implement more vehicles and more creative business model to kick off the 2nd phase of the program. Recent Chinese government announced that 10 cities to promote 1,000 EV per city annually is the typical government-lead program to boost the EV population.

3.1 Propose Clean Zone Plot

As shown in Figure 4, we propose the clean zone plot has three stages of missions; 1) the stage of policy planning to bring in the strategy, research, industry, and business model as the key elements to establish the promotion goals, 2) the stage of demonstration to focus on the fleet test and validate the effectiveness of the business model, 3) the stage of legislation to formulate all regulations and standards.

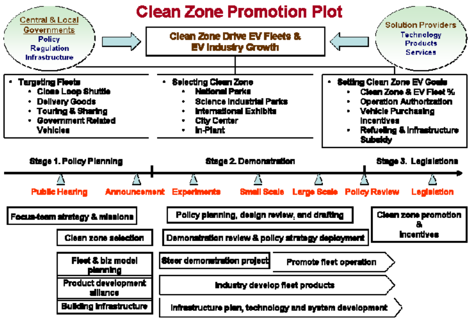

Figure 4: Clean Zone Promotion Process

The critical element of the clean zone policy is availability of the demonstration vehicle, and it should be created and supported by the industry. Hence, government shall create the sufficient demand to attract industry interest. The Government sponsored HOV fleets are the best solution to resolve this demand and supply matching issue.

From the figure 5, we see the industry needs the interface and standards to develop the modular EPS, battery, and charging systems and then to be implemented and matched into various the requested running chassis. Also the Government needs industry to provide the vehicle fleet to prove the business model of the readiness and convenience of the infrastructure including the electricity supply and the justifications of the incentive package. To reduce the complexity of fleet operation, the route is selected to be the close-loop running and central management, which is easier for the champion to lead the stack-holders to accumulate the operation experiences and to establish a HOV best practice for achieving the goals of developing the EV products, system interfaces, standards, and the readiness of the infrastructure.

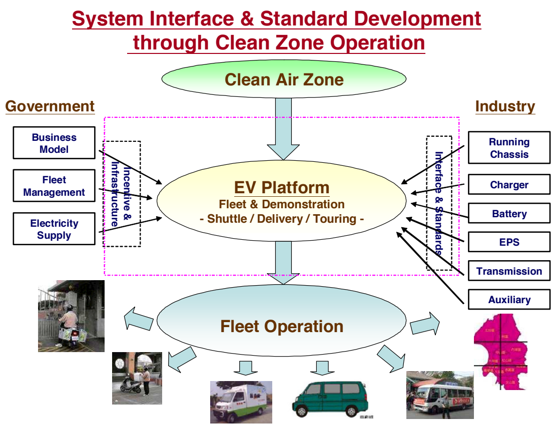

Figure 5: Clean Zone EV Fleet Concept

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3.2 Clean Zone EV Platform

From the perspectives of the availability of the independent running-chassis, the budget scale, the component technology maturity, the infrastructure readiness, and the win-win business model, Table 3 is the EV fleet selection proposition.

Table 3: Vehicle Selection for Clean Zone HOV

Clean Zone EV Platform Selection

Platform		Propulsion Range (km)	Propulsion Power (kW)	W Net (kg)	Power Rate Loading/ Power (kg/ kW)	Application (HOV)	Vehicle Classification
1 Seat	e-Bike	16	<0.6	20	>160		LEV
	Mini e-Scooter	30~50	<2.5	50	50~100		
	Delivery e-Scooter	60	<5	90	36~60	HOV	
2 Seats	NEV	80	<8	300	52		
	LEV (Micro EV)	60	<6	250	61		LEV Or Micro EV
2~6 Seats	Shuttle e-Van	100	<50	1200	36	HOV	Niche Light City Delivery
	Delivery e-Van	100	<50	1200	36	HOV	
20 Seats	Shuttle e-Bus	100	<100	6000	62	HOV	Niche HOV

And also From the EV platform analysis [8], it shows that LEV, e-pickup, e-van, and niche market 20-seater of mini-bus would be the potential candidates for the demonstration fleet, which top level specifications are shown in Table 4. To prioritize the fleet vehicles, an EV industry champion is needed to be convinced to select the HOV (high occupancy vehicle) as the top priority to promote; e-Scooter delivery, e-Van shuttle, e-Pickup delivery, and e-Bus shuttle.

Table 4: HOV Engineering Specifications

Specification Matching of HOV Fleet EV

Vehicle Specification(Simulation)				
Vehicle	Type	Shuttle e-Bus	Shuttle/Delivery e-Van	Delivery e-Scooter
	Seat	20	6	1
	Curb Weight(kg)	5000	1200	90
	Palyload(kg)	1500	600	125
Motor	Type	[illegible] Motor	PMSM	PMSM
	Max. Power(kW)	90 @ 2000~4500rpm	50 @ 2500~4000rpm	3 @ 900~1800
	Max. Tq(N.m)	510 @ <1500rpm	200 @ <2000rpm	35 @ <900
	Max. Speed(rpm)	7500~8000	7000~7500	2500
Transmission	Type	Single Speed	Single Speed	Single Speed
	Gear Reduction	12	8	3
Vehicle Perormance	Test Weight(kg) @ 80% Payload	6200	1680	190kg
	Max. Speed	~90kph @ 0%	~95kph @ 0%	~60kph @ 0%
		~80kph @ 3%	~90kph @ 3%	~55kph @ 3%
	Grade-ability	~24.4% @ Starting	~31.6% @ Starting	~26.5% @ Starting
		~15% @ 30kph	~31.4% @ 30kph	~25.6% @ 20kph
		~8.2% @ 50kph	~10.5% @ 72kph	~10.5% @ 40kph
	Acceleration	~6.1 Sec @ 0~40kph	~6.8 Sec @ 0~60kph	~5.6 Sec @ 0~40kph
Battery	Type	Li-Mn Base	Li-Mn Base	Li-Mn Base
	Battery Capacity(Ah)	40	30	40
	Battery Configuration	4PX96S	2PX84S	12S
	Rated Energy @ C/3(kWh)	55.30	18.14	1.73
	Available Energy @ 1C(kWh)	49.77	16.33	1.56
Energy Economy	Test Weight(kg)	5750	1350	180
	Energy Consumption @ ECE(Wh/km)	500	160	25
	Range Between Charge @ ECE(km)	90	100	60

Referring the clean zone promotion plot in Figure 4, three stages of action plan require the corresponding vehicles to support the engineering, government sponsored, and biz driven fleet operation. As shown in Figure 6, three vehicle platforms; e-Scooter, e-Bus, and e-Van/ e-Pickup are targeted and the numbers of vehicles are planned for the HOV fleets promotion in next five years. The key success factors are the engineering fleet to provide the feasible technology solution, the government sponsored fleet to drive the readiness of regulations, infrastructure and standards, and the business driven fleet to prove the commercial feasibility for the public promotion. To speed up the plan realization, government shall assign few events like international exhibition or spot of interest like the national park as the demonstrating zone to kick-off the fleet preparation and operations.

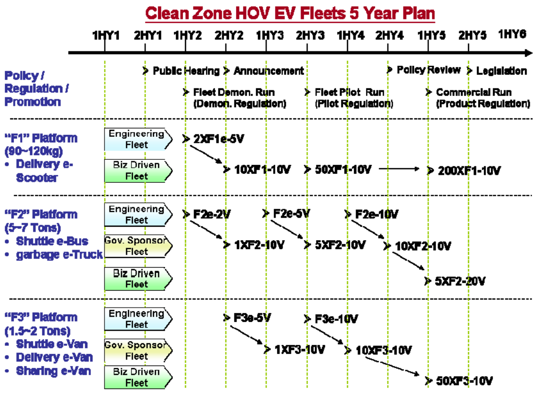

Figure 6: Clean Zone HOV Plan

At the engineering fleet stage, it requires R&D funding to develop system technology and experimental vehicles. In 2008, MOEA sponsored an EV key module technology development project, and a 35 kW electric propulsion system was under developing by TARC. Also, there is a parallel R&D project executed by TARC to conduct the fundamental research for the modular battery pack, larger capacity battery cell, modular EPS and power IC.

Conclusion

The 1st phase of the EV national program has started and expected to face some challenges, and TARC will assist government and industry to develop technology platform to for industry to improve the product reliability and cost performance. For the 2nd phase, the main tasks are strategic planning on clean zone fleet promotion, vehicle platform development, key component development, and EV industry cluster forming. As the leading EV research consortium in Taiwan, TARC will seek the international collaboration and

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consolidate the domestic industry strength to establish the best practice to promote this national program to improve the quality of environment and also enhance the global competitiveness of the EV industry.

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