

Roadmap To Smart Mobility: Inclusive & Sustainable Solutions

What E-Mobility Options Are Effective in Asian Developing Countries?-

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Introduction

- **Number of EVs is rapidly growing worldwide**

- ✓ As of 2017, over three million EVs are registered
- ✓ more than ten-fold EVs have increased since 2013

- **Recently developing countries have been seeking measures to expand the use of EVs**

- ✓ The use of EVs is rapidly expanding especially in advanced countries

- **This paper aims to find out options that are effective for e-mobility implementation for cities in Asian developing countries**

- ✓ 13 cities were selected
- ✓ E-mobility options for Asian cities recommended

Target Cities

- 13 cities were selected for e-mobility impact analysis considering relatively higher e-mobility implementation potential
- Collecting data which are required for e-mobility impact analysis

Country	City	Data
Indonesia	Jakarta/Makassar	<ul style="list-style-type: none">- Socio-economic indicators (population, GDP, etc.)- Electricity Generation by Energy Source- Grid carbon factor- Vehicle type ratio- Fuel type- Pollutant emission base unit by vehicle type- Greenhouse gas emission base unit by vehicle type- Gasoline/diesel sales price- Other
Malaysia	Lang Kawi/Malacca/Penang	
Vietnam	Ho Chi Minh City	
The Philippines	Manila	
Kyrgyzstan	Bishkek	
Georgia	Tbilisi	
Fiji	Suva	
Mongolia	Ulaanbaatar	
Nepal	Kathmandu	
India	Dhaka	

The Cities' Features

Socio-economic features

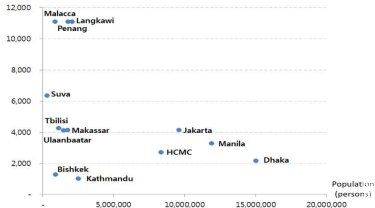
- ✓ Population size from Suva(2.8 mil.) to Dhaka(15 mil.)
- ✓ Per capita GDP from Kathmandu(\$1,500) to Penang(\$11,000)

Vehicle Composition

- ✓ Two and three-wheeler dominant: HCMC, Jakarta, Makassar, Lang Kawi, Kathmandu, etc.
- ✓ Passenger car dominant: Tbilisi, Suva, Ulaanbaatar, Bishkek, etc.

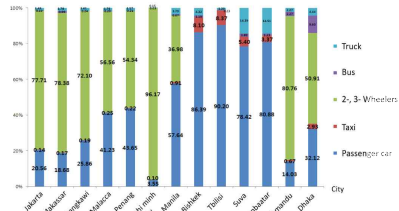
(Per Capita GDP by City Population)

Per capital GDP
(\$)



(Vehicle Composition)

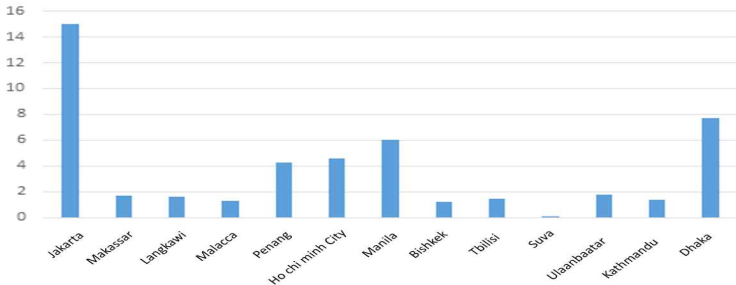
Vehicle type
ratio



Greenhouse Gas Emissions

Various factors have impact on green house gas emission

- ✓ population size (Jakarta, Dhaka)
- ✓ Vehicle composition, e.g, two-three wheelers(HCMC and Jakarta), taxi and passenger cars(Bishkek and Tbilisi), old buses(Kathmandu and Dhaka)



Indicator Data for E-mobility Impact Analysis

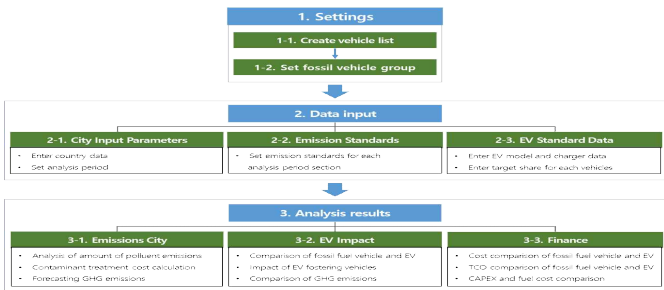
- Indicator data are composed of grid carbon factor, fossil fuel price, electric charge, etc.

Country	City	GCF (kgCO ₂ /kWh)	Fossil Fuel Cost			Electric Charge (USD/kWh)	
			Gasoline (USD/Liter)	Diesel (USD/Liter)	CNG (USD/kg)	Household	Industrial
Indonesia	Makassar	0.80254	0.72	0.82	0.327	0.091	0.119
	Jakarta	0.8	0.53	0.78	0.64	0.13	0.16
Nepal	Kathmandu	0	0.95	0.84	-	0.06	0.09
Vietnam	Ho Chi Minh City	0.49991	0.96	0.77	0.63	0.14	0.12
Malaysia	Penang	0.35172	0.46	0.49	0.35	0.158	0.185
	Malacca	0.70344	0.46	0.49	0.35	0.17	0.16
	Kedah	0.70344	0.46	0.49	0.35	0.17	0.16
The Philippines	Manila	0.66779	0.88	0.68	0.185	0.191	0.185
Bangladesh	Dhaka	0.62816	1.06	0.77	0.66	0.106	0.14
Kyrgyzstan	Bishkek	0.17913	0.65	0.65	-	0.045	0.075
Mongolia	Ulaanbaatar	0.859	0.82	0.81	-	0.045	0.075
Fiji	Suva	0.37288	0.99	0.89	-	0.194	0.327
Georgia	Tbilisi	0.10195	0.9	0.93	0.55	0.065	0.095

E-Mobility Impact Analysis Tool

The analysis tool consists of seven modules

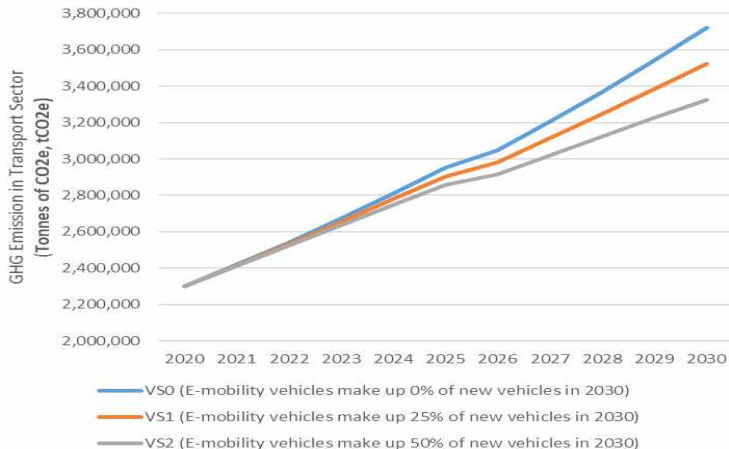
- ✓ Modules relating to data input : settings module, profile module, emission parameter module and EV information module
- ✓ Modules relating to analysis results : emission result module, EV impact module and finance module



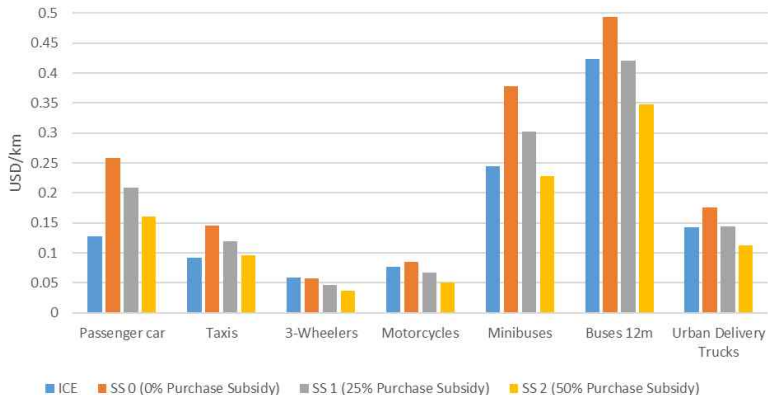
E-Mobility Analysis Scenario

Policy parameter	Content	Result Analysis
Grid Carbon Factor (kgCO ₂ /kWh)	<ul style="list-style-type: none"> Scenario 0 (GS 0): Apply the target city's Grid Factor (BAU) Scenario 1 (GS 1): 25% improvement in the Grid Carbon Factor Scenario 2 (GS 2): 50% improvement in the Grid Carbon Factor 	Greenhouse Gas Emission Volume
Share of Newly Introduced EV	<ul style="list-style-type: none"> Scenario 0 (VS 0): E-mobility vehicles make up 0% of new vehicles Scenario 1 (VS 1): E-mobility vehicles make up 25% of new vehicles Scenario 2 (VS 2): E-mobility vehicles make up 50% of new vehicles 	
Purchase Subsidy	<ul style="list-style-type: none"> Scenario 0 (SS 0): E-mobility purchase costs of the target cities Scenario 1 (SS 1): 25% subsidy for the purchase of e-mobility vehicles Scenario 2 (SS 2): 50% subsidy for the purchase of e-mobility vehicles 	TCO Comparison
Increase of Fossil Fuel Price	<ul style="list-style-type: none"> Scenario 0 (GS 0): Fossil fuel price in the target city Scenario 1 (GS 1): 25% increase in fossil fuel prices Scenario 2 (GS 2): 50% increase in fossil fuel prices 	
Reduction of Electric Charges	<ul style="list-style-type: none"> Scenario 0 (GS 0): Apply the Grid Carbon Factor of the target city (BAU) Scenario 1 (GS 1): 25% improvement in the Grid Carbon Factor Scenario 2 (GS 2): 50% improvement in the Grid Carbon Factor 	

Analysis Results by EVs' Expansion



Analysis Results by Purchase Subsidy



Analysis Implications: EVs' Market Share

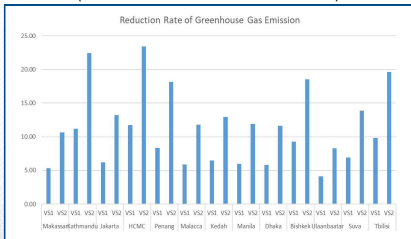
Cities expected to benefit are:

- ✓ HCMC(23.4%, Kathmandu(22.4%), Tbilisi(19.6%), Penang(18.1%)

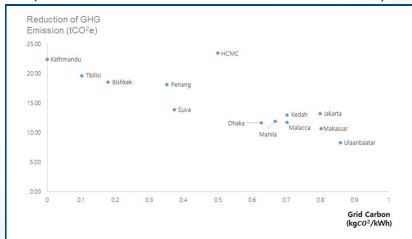
Factors that significantly affect are:

- ✓ Grid carbon factor and the vehicle type
- ✓ In particular, the higher ratio of motorcycle has positive effects on the greenhouse gas reduction such as HCMC and Penang

(Reduction Rate of Greenhouse Gas Emissions)



(Relation of Grid Carbon Factor and Greenhouse Gas Emissions)



Renewable Energy-based Electric Bus

- **The city of Shanghai chose to introduce solar panel buses**
 - ✓ The first practice of combining renewable energy and EVs
- **Electric buses could contribute immensely to environmental restoration**
 - ✓ Enjoying a favorable economic impact by saving energy expenses

(People's Republic of China's Renewable Energy-based Bus)



Analysis Implications : Electric Charge

● The ratio of the TCO for EVs becoming lower then of ICE vehicles is :

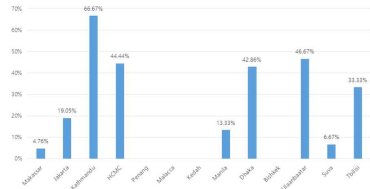
- ✓ 66.7% for Kathmandu, 44.4% for HCMC, 42.9% for Dhaka, 46.7% for Ulaanbaatar

● The vehicle type's impact is :

- ✓ Three-wheelers(77.8%), two-wheelers(37.0%), taxi(30.8%)
- ✓ Commercial vehicles(taxis and three-wheelers) are significant in terms of the TCO

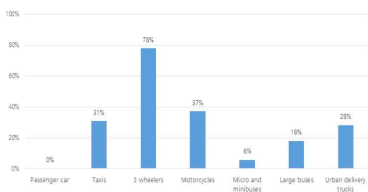
(Effects of Electric Charge by City)

Impact (%)



(Effects of Electric Charge by Vehicle Type)

Impact (%)



Taiwan's Electric Motorcycle : Gogoro

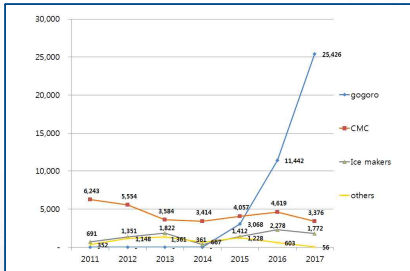
- Representative business model for electric motorcycles
- Battery swapping system is a key element for the sales of electric motorcycles

(Gogoro Electric Motorcycle)



Source: Gogoro, via RideApart (<https://cleantechnica.com/2018/11/08/gogoro-scores-dhl-taiwan-post-as-battery-swap-partners/>)

(EV Sales by Manufacturer)



Source: BM Lin (218), "E-mobility Policy and Technology in Taiwan", ADB Workshop Source

Analysis Implication : Fossil Fuel Price

Cities having significant impact or the TCO are:

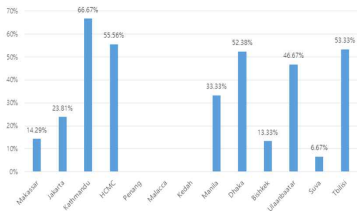
- ✓ Kathmandu(66.7%), HCMC(55.6%) and Dhaka(52.4%)

vehicle types having significant impact on the TCO are:

- ✓ Commercial vehicles including minibuses, buses, urban delivery trucks and taxis

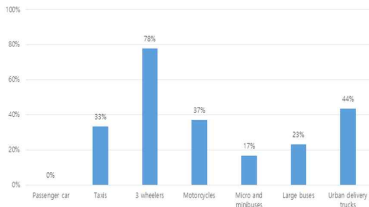
(Effects of Fossil Fuel Price by City)

Impact (%)



(Effects of Fossil Fuel Price by Vehicle Type)

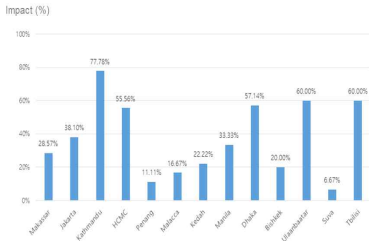
Impact (%)



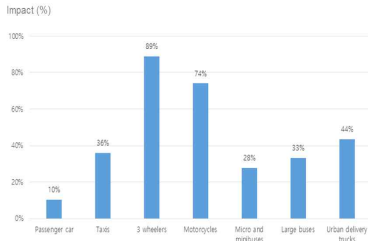
Analysis Implication : Purchase Subsidy

- The impact of E-mobility implementation is found to be high is in:
 - ✓ Kathmandu(77.8%), HCMC(55.6%), Dhaka(57.1%), Ulaanbaatar(60.0%) and Tbilisi(60%)
- The impact is high by vehicle type on:
 - ✓ Two-three wheelers, taxis, minibuses, buses and urban delivery trucks

(Effects of Purchase Subsidy by Cities)



(Effects of Purchase Subsidy by Vehicle Type)



Analysis Implications : Electric Charge

○ Cities having significantly positive impact are:

- ✓ Kathmandu, HCMC, Tbilisi, and Bishkek

○ Effective e-mobility options are:

- ✓ Prioritizing taxis, buses and three wheelers,
- ✓ Need to convert to renewable energy, and
- ✓ Two-wheelers are also important as the e-mobility option

Country	City	EV Expansion	Grid Carbon Factor	Electric Charges	Fossil Fuel	Purchase Subsidy
Indonesia	Makassar	v	vv	v	v	vv
	Jakarta	vv	vv	v	vv	vv
Nepal	Kathmandu	vvv	-	vvv	vvv	vvv
Vietnam	Ho Chi Minh City	vvv	vvv	vv	vvv	vvv
Malaysia	Penang	vvv	vvv	v	v	v
	Malacca	v	v	v	v	v
	Kedah	v	v	v	v	v
The Philippines	Manila	vv	v	v	vv	vv
Bangladesh	Dhaka	v	v	vvv	vvv	vvv
Kyrgyzstan	Bishkek	vvv	vvv	-	v	vv
Mongolia	Ulaanbaatar	v	v	vvv	vvv	vvv
Fiji	Suva	vv	v	v	v	v
Georgia	Tbilisi	vvv	vvv	vv	vvv	vvv

Note: v: minor, vv: moderate, vvv: significant

Recommendation(1)

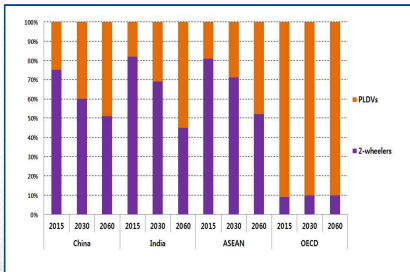
Work out effective measures for two and three-wheelers

- ✓ Considering high usage of two and three wheelers

Develop customized E-mobility policies

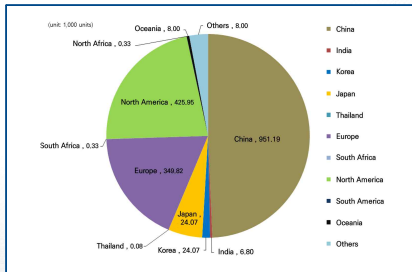
- ✓ Taking into account target city's features

(Two-wheeler Ratio in Key Asian Regions)



Source: Harrison (2018), "Fuelling Europe's Future: How the transition from oil strengthens the economy"

(Number of BEVs in People's Republic of China, India, and Thailand)



Source: IEA (2017), "Energy Technology Perspective 2017"

Recommendation(2)

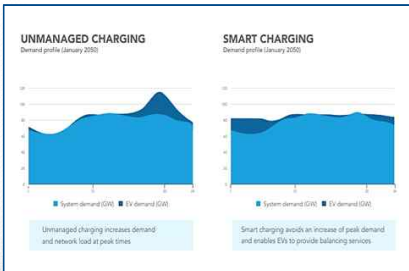
Renewable and smart grid is a key element

- ✓ More organic response is required in the response to the additional electricity demand, e.g, vitalizing smart grid

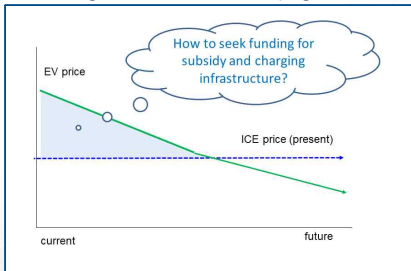
Focus on “smaller size”, “lower price”, “public usage”

- ✓ Needing to find a way to overcome financial issue

(Hourly Electric Usage Before and After EV Smart Charging)



(Financing Issues in ASEAN Developing Countries)



Recommendation(3)

○ EVs' Sharing mobility should be emphasized

- ✓ To reduce the need for vehicle ownership,
- ✓ To resolve traffic congestion and air pollution, and
- ✓ To contribute to reduction of social cost

(People's Republic of China's Car2Go and Singapore's BlueSG)



Conclusion

● E-Mobility Policy Strategy

- ✓ **Electric two and three-wheelers**
- ✓ **Customized**
- ✓ **New renewable and smart grid**
- ✓ **Focusing on smaller size**
- ✓ **Introducing sharing mobility**

