4 DEVELOPMENT DIRECTIONS OF LOW EMISSION TRANSPORT SYSTEM IN LAO PDR

4.1 Global Trends

1) Overview

4.1 There is growing recognition about climate change and the need for concerted actions among countries across the world. The main culprit is greenhouse gases (GHG). Petroleum consumption of a burgeoning motor vehicle population is a major contributor to GHG emissions. The weather patterns are also foreseen to change dramatically due to global warming. This will lead to rising temperatures, increase in the frequency and intensity of rains, and decreased crop production.

4.2 The global response is to develop alternative fuel sources for motor vehicles. Brazil took the lead 30 years ago in the use of bio-fuels for cars; to date, there is no car on their streets that run on pure gasoline anymore. Other countries have piloted CNG and LPG, with limited converters or adopters. In the last decade or so, many developed countries like the USA, Japan, and Germany have given priority to the development of battery-powered cars, hybrids or plug-in EVs. A few are experimenting with hydrogen-powered cars. For the next two decades, the consensus is toward a varied mix of power for automobiles, with petrol-fed vehicles losing its dominance, EVs rising, and other types becoming more significant. No one, however, is expecting the transition to be short, or for the conventional petrol-based internal combustion engines to disappear.

4.3 Another global trend is the rising cost of petroleum due to the twin pressure of dwindling oil reserves and increasing demand. This, of course, reinforces the impetus toward alternative power trains for motor vehicles. In the short- to medium-term period, however, the price of petrol would fluctuate greatly, rather than exhibit a constant upward trend due to the economic crisis and recession in developed countries.

2) Low Emission Transport Initiatives of Developed Countries

4.4 Industrialized countries with global reach in automotive manufacturing are leading the charge toward alternative propellants for motor vehicles. They are cognizant of the preceding global trends that are impacting their products. On the supply side, their governments are subsidizing the massive R&D spending to develop the cars of tomorrow. Business as usual, i.e., continue manufacturing ICE vehicles, could mean eventual loss of market share, if not irrelevance and technological obsolescence. On the demand side, their governments have granted liberal tax incentives, including rebates and cash grants, to encourage consumers to buy alternative energy vehicles such as EVs. Some countries have even gone to the extent of issuing mandatory emission limits and fuel efficiency targets that can only be met by introducing alternative energy vehicles into the product mix.

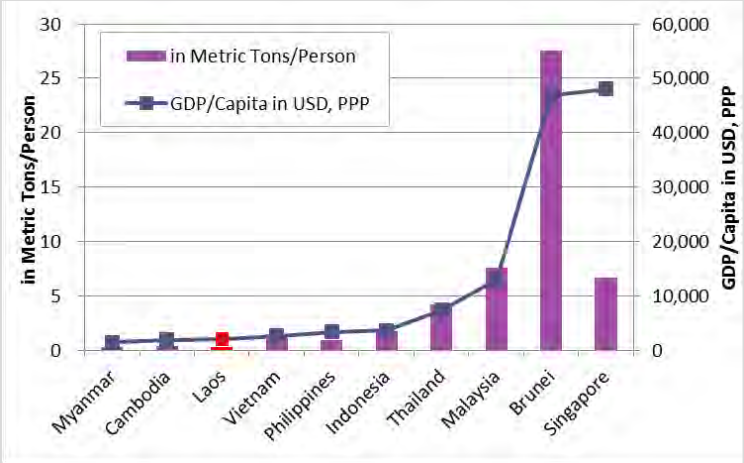
3) Implication for Lao PDR

(1) Climate Change

4.5 The global imperative is to reduce GHG emissions largely due to carbon dioxide generated from the burning of fossil fuels. To a great extent, Lao PDR is still an insignificant contributor. Its GHG footprint is still small, aside from being blessed with hydropower. While other countries can only claim very little renewable in their energy mix,

Lao PDR can claim almost 100%. As can be seen in Figure 4.1.1, the carbon emission per capita of Lao PDR is one of the lowest. It is only 1/16 of the world's average, 1/32 of Japan's, and 1/62 of the USA's.

Figure 4.1.1 CO2 and GDP per Capita in Selected Countries



Source: World Bank Development Indicators

4.6 Global warming, however, could put one of the country's most important resource (i.e., hydropower[1]) at risk, i.e., lower generation during very dry seasons interspersed by overflows during heavy rainfall, compounded by reduced forest cover (down to about 40%). Its arable land would be vulnerable to flooding and landslides. Under the Lao PDR government's seventh Five-year Development Plan, it aims to reverse forest denudation and restore it to 70% by 2020. Boding well for EV prospects, the government has lined up additional hydro plant capacities to ensure surplus power for domestic needs and exports.

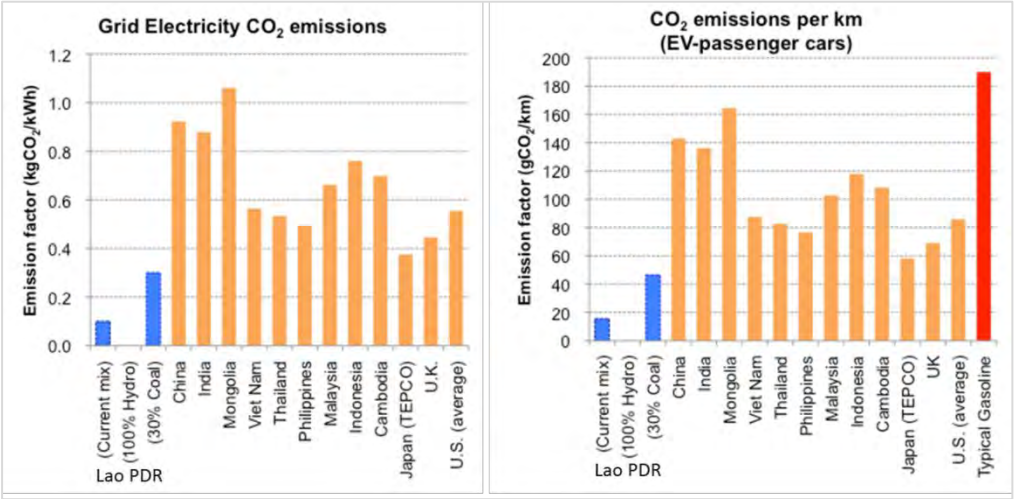
4.7 The promotion of low emission transport often omits the fact about power sources. GHG emissions of EVs/PHEVs are highly dependent on the types of power plants which supply electricity to these vehicles through the grid. Emission reductions are maximized when the electricity comes from renewable or cleaner energy sources.

4.8 In Lao PDR, most of the power plants that are connected to the national electricity grid are hydropower, with a total installed capacity of 2,556 MW in 2011. That represents 99.9% of total capacity in Lao PDR. The diesel power generators connected to the grid are at best for emergency purposes; therefore, from the view point of the generation capacity (MW), the grid CO2 emission factor (kgCO2/kWh) can be deemed as almost zero, because hydropower does not emit any CO2 emission. It is more than three times the global benchmark of 30% renewable as set by UNIDO. This fact is significantly important in maximizing emission reductions through the introduction of low emission transport. Even if it diversifies its power mix and add coal power plants, however, increasing EVs/PHEVs may lead to minimal reduction of emissions compared with ICE vehicles.

4.9 Grid electricity emission factors in other countries are around 0.9 (China), 0.5 (Thailand), 0.4 (EU and Japan), 0.3 (California), and 0.2 (Austria) (in kgCO2/kWh). In such countries, emission reductions are much less than in Lao PDR. Therefore, Lao PDR is in a better position of obtaining larger emission reductions from EV/PHEV projects as long as it keeps its main power sources clean and green (see Figure 4.1.2).

[1] Export of electricity averaged 11.6% of total exports, by value, from 2005-2009, equivalent to about USD132 million. Hence, lower hydropower production means losses in exports for Lao PDR.

Figure 4.1.2 Comparison of CO2 Emissions from Grid Electricity Generation and EV Driving among Selected Countries



Source: JICA Study Team worked out based on Tokyo Electric Power Company (TEPCO), 2011 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting, July 2011, eGRID2012 version 1.0, US EPA, 2012"List of Grid Emission Factor", Institute for Global Environmental Studies (IGES), June 2012

4.10 Current statistics show that electricity is imported from Thailand during dry season and exported to Thailand in rainy season. To be more precise, the imported amount should be taken into account in calculating emission factors. A review of the Power Development Plan 2010-2020 of Lao PDR suggests self-sufficiency after 2015. Therefore, in this study, it is assumed that all electricity is generated by hydropower, without imports from fossil-burning plants.

4.11 The manufacturing of EVs and their batteries, however, is not emission neutral. In their countries of origin, their emission factors are not zero. If they are eventually produced in Lao PDR, and using clean electricity from hydropower, the life cycle emissions from EVs—from original manufacture to use—will become significantly low. In this case, emission reduction compared with those of gasoline or diesel vehicles can also be maximized. For the country itself, however, there is no emission contribution from imports of foreign-manufactured EVs and batteries.

4.12 Within Lao PDR, the use of EVs and their emission impact may differ from one region to another. For a village or town that is not connected to the national grid and that relies on electricity generated from fossil-burning diesel generators, emission reductions will be negligible. The total life cycle emission from EVs might even be higher than conventional gasoline or diesel vehicles. Thus, in some areas of the country, EVs should be an exception unless powered from solar cells, mini-hydro plants, or other renewable sources.

4.13 In 1990, an inventory of GHGs concluded that Lao PDR was a net sink of carbon dioxide (CO2) with a net CO2 annual removal of 121,641 Gg (121.6 million tons) compared to 24.18 million tons of CO2 equivalent (tCO2e) emitted all over the country. A second inventory, which is still under preparation, indicates that the favorable situation has turned for the worse. The indicative figures showed total emission at 54.9 million tons of CO2 equivalent (tCO2e), while the removal was only 2.0 million tons). The precipitous drop on the removal side of the equation was due to loss of forestry cover plus changes in land uses. The emission from the energy sector stood at 1.0 million tons (a mere 1.97% of the total), of which the transport sector accounted for 0.59 million tons, or 51% of the

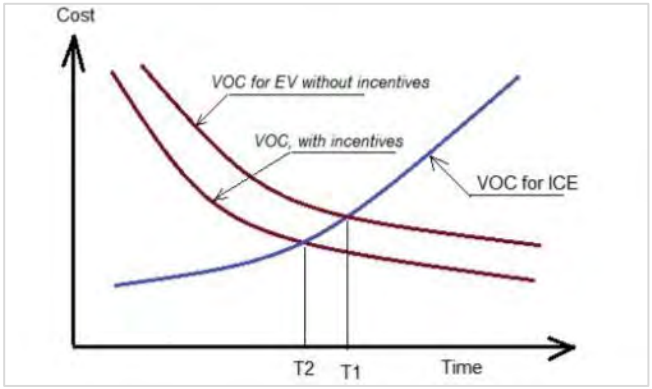
energy sector.

4.14 Clearly, the climate change mitigation strategy of Lao PDR has to focus on agriculture, forestry, water and water resources, and health. On a nationwide basis, very little needs to be done in the transport sector, except to make sure that its future emission remains manageable. That can only be realized if the motor vehicles being added are energy-efficient with declining emissions per unit. In short, the average fuel consumption per kilometer per vehicle must continuously decline. The situation in urbanized areas, especially Vientiane, is more critical because of the concentration of emissions and the threat of traffic congestion.

(2) Reducing transport costs (and technology risks)

4.15 The shift to electric vehicles is a natural path for Lao PDR. However, it is not yet feasible—technically and financially—to convert all types of vehicles. Generally, EVs have lower running costs compared to ICE vehicles. Typical fuel costs for EVs hover at about 0.150 kWh/km (equivalent to about 84 LAK/km in Lao PDR) compared to around 0.2 l/km (equivalent to about 2,200 LAK/km in Lao PDR) for an equivalent petrol vehicle. However, as prices decline and economies of scale become operative for EVs, the cross-over point would be reached in time. This is illustrated in Figure 4.1.3. As discussed in previous chapters, in many developed and developing countries, the cross-over point is being nudged forward (from T1 to T2) by providing incentives to EV manufacturers and users.

Figure 4.1.3 Generalized Cost of EVs versus ICEs



Source: JICA Study Team

4.16 The promotion of EVs is more pronounced in developed countries, where fiscal subsidies are being expended to encourage the conversion and shorten the cross-over point. As technology improves through time, vehicle and battery costs would decline, bringing the cross-over point earlier. If petrol prices continue to increase faster than the cost of electricity, the time period to a viable EV would also be earlier. It should be noted that for motorcycles and lighter or smaller vehicles, the cross-over point may have already been achieved. For example, an e-trike costing USD5,000 can be fully recouped in less than five years solely from the current cost difference in energy.

4.17 The technological challenge at present is the battery, as well as the ancillary charging mechanism. The race is to pack more power on smaller and lighter packages, so as to give the car greater distances between recharging. To approximate the convenience of fuel reloading at gas stations, the recharging must equally be quick. However, this technology is still expensive. Overnight charging at home is cheaper, but unacceptable to vehicles that travel over out-of-range distances during the day. The research and

development effort is bankrolled by several industrialized countries and giant automobile manufacturers. For Lao PDR and other developing countries, it is a game that they could ill-afford to join. Besides, they do not have a car industry to protect. It would be more sensible to wait and simply adopt mature technologies rather than risk huge sums of R&D money on uncertain bets.

4.18 At the current evolution of EVs, lithium ion (Li-ion) batteries for smaller and lighter vehicles are approaching cost competitiveness. Lead-acid batteries have been in use for decades and are the mainstays in many small vehicles in commercial production. They are, however, too bulky and heavy, aside from being pollutants after disposal, in bigger vehicles. Electric motorcycles and electric paratransit with lead acid or Li-ion batteries are already viable even with no or very little subsidy. On the other hand, electric and hybrid cars require substantial government subsidy to be sellable even in developed countries. Considering the low income and low motorization (37.6 per 1000 person, excluding motorcycles) in Lao PDR, it is also not politically defensible to subsidize the few who can afford a car. Subsidizing public transport is easier to justify since it serves the many. In many cities of the world, public transport is already subsidized by the government.

4.2 Approach on EV Introduction Analysis

4.19 In order to analyze the significance, impacts, possibility and constraints comprehensively of introducing EVs as new transport systems in Lao PDR, the following approach was taken (see Figure 4.2.1);

(i) Analyze baseline scenario: to clarify the energy consumption and the environmental conditions in the case of future motorization with conventional vehicles;

(ii) Assess the benefit of EV users: to clarify the significance of cost saving of using various types of EVs by people and organizations;

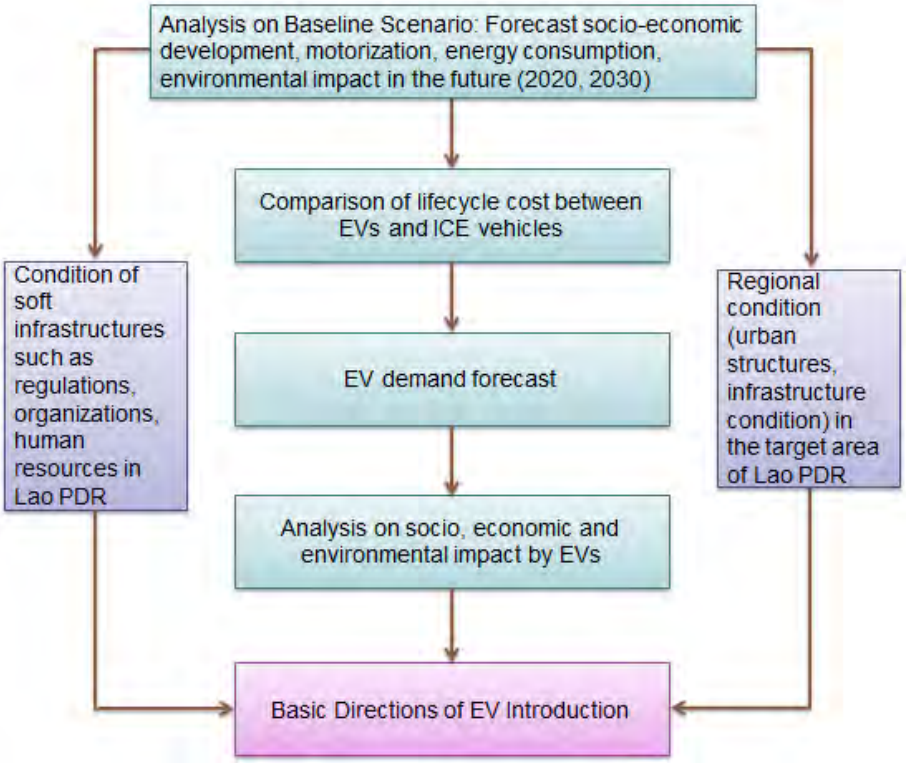
(iii) Forecast the EV demand in the future: to forecast the future vehicle ownership of Lao PDR and determine the share of EVs by the type of vehicles;

(iv) Assess the benefit of EVs in the national economy: To clarify the benefit in the energy saving and environmental aspect comparing the baseline scenario and EV introduction scenario;

(v) Possibility and impact of EV introduction: to evaluate the possibility and impact of EV introduction comprehensively, considering the above results; and,

(vi) Basic orientations of EV introduction: to determine the basic orientations of EV introduction in Lao PDR with considerations in the results of ***Chapter 2*** and ***Chapter 3***.

Figure 4.2.1 Approach on EV Introduction Analysis



Source: JICA Study Team

4.3 Baseline Development Scenario for Lao PDR

1) Socio-economic Outlook

4.20 In the period of 2000 - 2010, the economy of Lao PDR grew at an annual compounded average rate of 6.7%. It is quite high for a developing country, and when compared to the record of developed countries. Fortunately, its population grew slower, at 1.5% per year. These two factors pushed its GDP per capita (which also serves as a proxy for family income) from USD326 in 2000 to USD591 in 2011, equivalent to an annual increase of 5.6%. As a consequence, the number of households below the poverty line went down, from 34% to about 25%.

4.21 Assuming a 6.5% growth rate of the economy from the present to year 2030 and current declining rates in population, Lao PDR is expected to graduate from least developed country status and move into the ranks of middle-income countries. Table 4.3.1 shows the development scenario for Lao PDR. This performance compares favorably with the present GDP per capita, in purchasing power parity terms (or PPP), for Thailand (USD9,700), Vietnam (USD3,300), Indonesia (USD4,700), and Philippines (USD4,100).

4.22 The country is predominantly rural, with only about 33% of its population classified as living in urban areas. It is foreseen that urbanization will increase to 40% by 2020 and probably 50% by 2030, if current trend continues. Although Vientiane is the capital city, its primacy is not as pronounced as in other developing countries. That in itself suggests a more balanced distribution of economic growth and urban population that avoids the ill effects of overconcentration.

Table 4.3.1 Socio-economic Outlook for Lao PDR

Item	2011	2020	2030
Population, in 000	6,374	7,651	8,854
Urbanization	33%	40%	~50%
GDP (in USD Billion, PPP 2012)	17.8	34.3	67.8
GDP (in USD million, MER 2010)	8,356	12,253	23,437
GDP/Capita (in USD, PPP terms)	2,826	4,487	7,652
GDP/Capita (in USD, MER 2010)	1,254	1,495	2,304

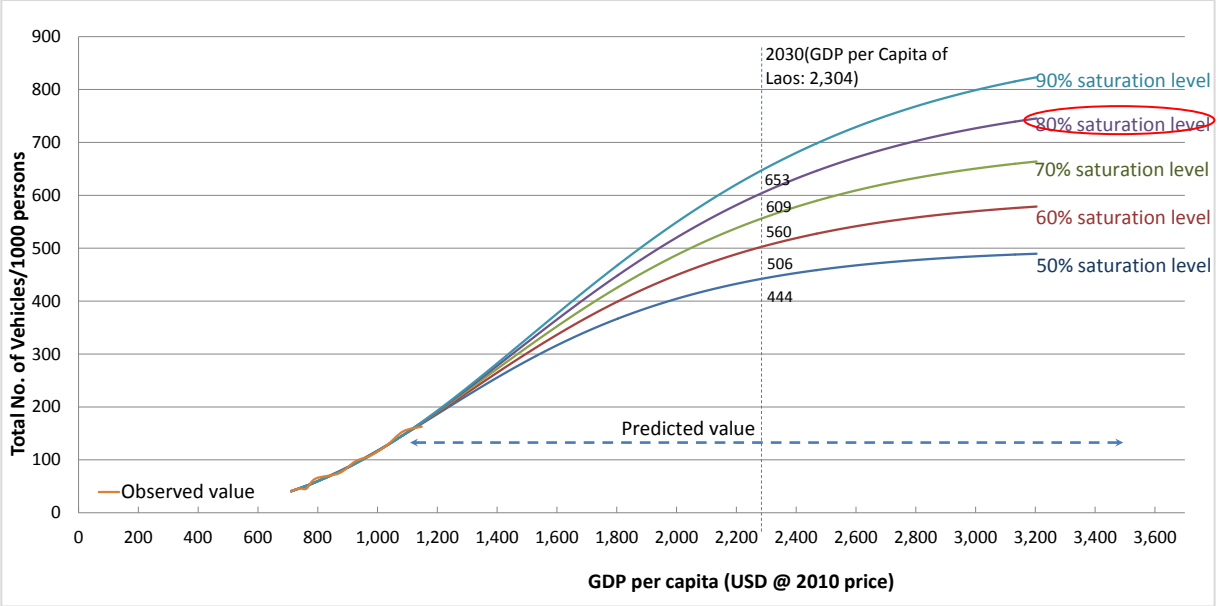
Source: JICA Study Team worked out based on World Development Indicators

2) Increasing Motorization

4.23 Figure 4.3.1 illustrates the predicted vehicle ownership based on the Gompertz model[2], ranging from a low of 50% to a high of 90% saturation level by year 2030. When compared to data from other developing countries, the predicted vehicle population appeared to be overoptimistic (see Figure 4.3.2). For example, the number of cars per 1,000 persons at 79 by 2020 is almost the same as that of Thailand in 2003 but on an income 50% lower. One of the high car ownership in Lao PDR with low GDP per capita is due to the availability of cheap cars from China. Considering those available cars in Lao PDR, for conservatism, the base case scenario for Lao PDR was adjusted downwards by 25% from the lower limit of the 80% of saturation case (see Table 4.3.2).

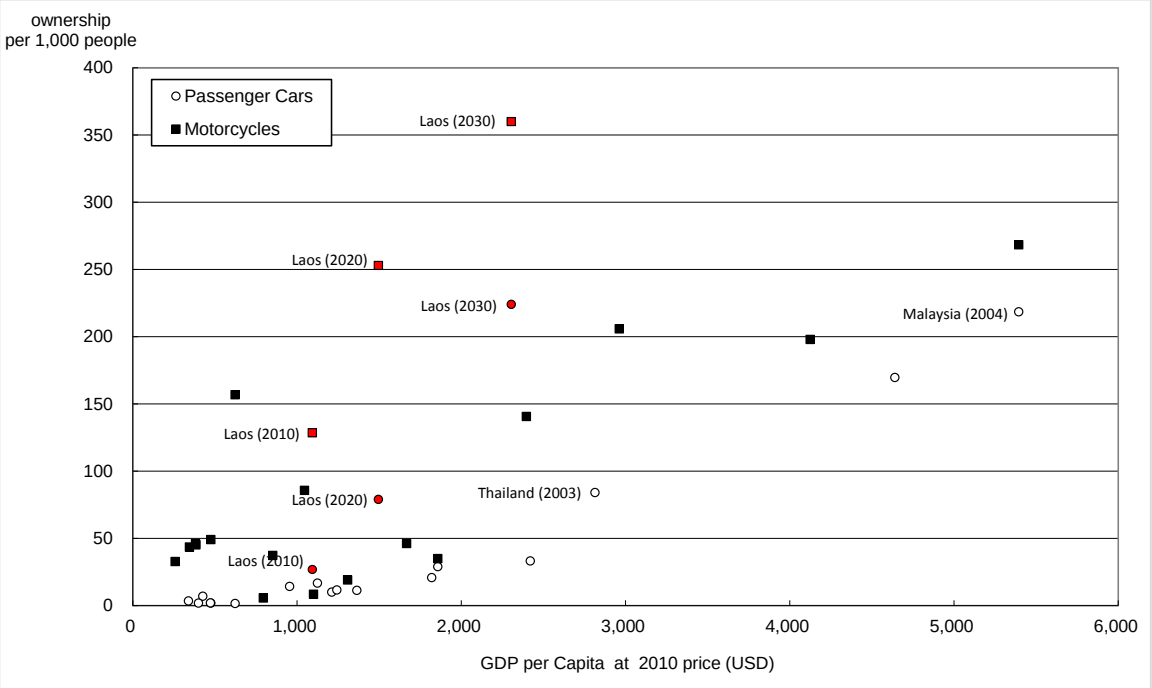
[2] The Gompertz function is expressed as follows: $V = \gamma * \exp(\alpha * \exp(\beta * \mathrm{GPD\_p}))$
V: the vehicle ownership (vehicles per 1000 people),
γ : the saturation level (a known parameter),
α, β: the negative parameters defining the shape of the function, and
GDP_p: denotes the per-capita income.

Figure 4.3.1 Motorization Scenarios per Gomperts Model Results



Source: JICA Study Team

Figure 4.3.2 Comparison of Vehicle Ownership among Asian Countries



Source: Key Indicators of Developing Asian and Pacific Countries (ADB), World Development Indicators (World Bank), MPWT
Note: Forecasted values of Lao PDR in 2020 and 2030 are based on the Gompertz model with 80% of saturation level by JICA Study Team

4.24 It should be noted that historical growth rates from 2001 to 2010 are quite high, while those for the next two decades are moderate, either on the model's prediction or the adjusted values. Also, the projection is neutral as to whether some of these vehicles will be EVs or ICE based, or whether the trike would be the same vehicle as the tuktuk of today, or the *songthaew* gets replaced by the mini- or medium bus. It was assumed, however, that the number of public transport would continue to grow for policy reasons rather than track the general motorization trend. Figure 4.3.3 shows the relationship between vehicle growths and GDP per capita for Lao PDR.

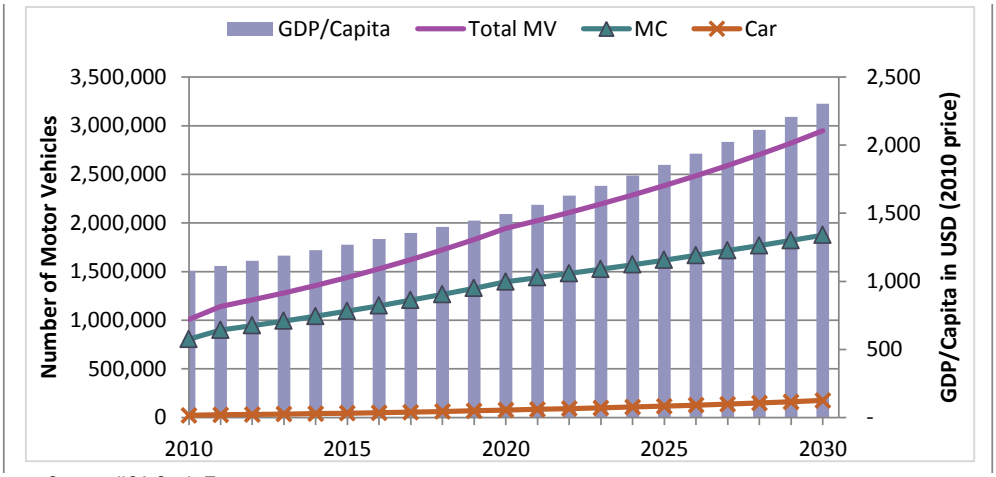
Table 4.3.2 Base Case Scenario on Motor Vehicles Ownership

Vehicle Type			Number of Vehicles				Annual Growth Rates		
			2001	2011	2020	2030	2001-2010	2010-2020	2020-2030
Private	Motorcycle		168,379	899,436	1,395,320	1,875,194	19.0%	5.0%	3.0%
	Cars	Sedan	33,967	27,901	77,372	174,936	19.4%	12.0%	11.0%
		Pick-Up/SUV/Van	21,936	121,517	372,507	732,777	21.0%	10.5%	7.9%
	Truck		11,841	28,673	44,481	72,455	8.9%	5.0%	5.0%
Public	Tuktuk/Minibus		4,405	8,537	11,961	15,311	7.6%	3.8%	3.0%
	Bus & Medium bus		4,502	25,346	42,821	76,687	22.3%	6.0%	6.0%
Total Motor Vehicles			220,491	1,141,858	1,944,462	2,947,360	18.4%	6.5%	5.2%
Total MV, per model (lower limit of 80% saturation)			-	-	2,448,320	3,932,736	-	10.0%	4.9%
Total MC, per model (lower limit of 80% saturation)			-	-	1,820,938	3,187,440	-	8.5%	5.8%

Source: JICA Study Team

1) Lao government policy is to phase out tuktuk (3-wheel), which is assumed to be replaced by minibus (4-wheel) at some point. Also, a portion of the above-mentioned vehicles will be EVs.

Figure 4.3.3 Base Case Development Scenario for Lao PDR



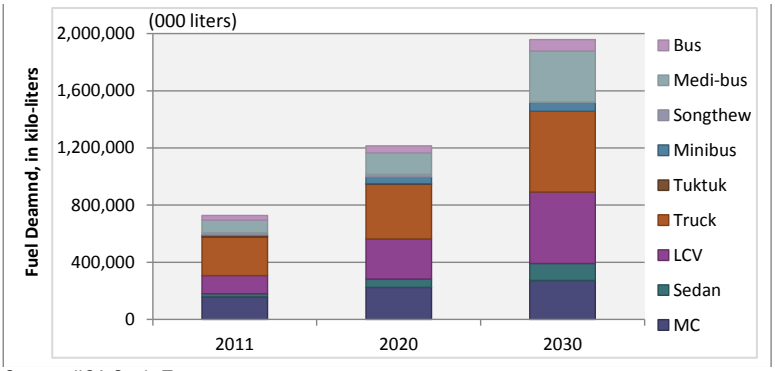
Source: JICA Study Team

Note: Car includes sedan, pick-up, SUV and van

3) Energy Consumption

4.25 With the growth in the number of motor vehicles, fuel consumption will naturally rise, even assuming continued improvement in unit vehicle fuel efficiency. Using the base case forecast shown on Figure 4.3.4, the land transport sector is estimated to consume 1,215 million liters of fuel by 2020. Compared to 867 million liters in 2011, it implies an annual increase of 5.4% against vehicle growth of 6.5%. A disproportionate share of fuel consumption is accounted for by utility vehicles (e.g., pick-ups and SUV) with 42%, followed by trucks and trailers (24% of the total), and motorcycles (12%). In terms of number, motorcycles would comprise about 64% of the total by 2030, but only 12% of the total fuel consumption.

Figure 4.3.4 Projected Consumption of Petrol by Road Transport



Source: JICA Study Team

Note: The assumptions of driving distance a year and fuel efficiency of each vehicle are as follows; (1) MC = 5,840km, 30.0km/l; (2) sedan/LCV = 9,125km, 10km/l; (3) truck = 36,500km, 3.5km/l; (4) tuktuk = 16,425km, 10km/l; (5) minibus = 43,800km, 8.0km/l; (6) songthaew = 18,250km, 10.0km/l; (7) medi-bus = 43,800km, 6.0km/l; and (8) bus = 43,800km, 4.0km/l. At the same time, the energy efficiency of each vehicle will improve 1%/year.

4.26 This base case forecast of fuel consumption assumes no EVs in the motor vehicle population. The same basic ICE technology would remain throughout the forecast period, albeit with annual improvements in fuel efficiency. It implies a demand for fuel that is nearly three times the 2011 level. To that extent, the country's vulnerability to energy supply disruption also increases. There will also be corresponding increase of air pollutants and greenhouse gases from motor vehicles, as will be discussed in subsequent sections.

4) Financial Impact of Fossil Fuel Use

4.27 In 2010, the value of gasoline and diesel consumed had a retail value of USD799 million. Assuming that the October 2012 unit prices[3] would prevail, the retail value by 2030 of fuel consumed by road transport would hit USD2,296 million. To put this in context, the trade deficit of the country averaged USD1,380 million in the period of 2006 – 2010. No one, however, expects the global price of oil per barrel to remain static; the only question is by how much it would move upwards. In the case of Lao PDR, the only option is to reduce total dependency on imported fuel as this would bring down considerably its trade deficit. This can only happen if its land transport system is powered by something other than petrol. Regarding the national revenue and expenditure, there is no subsidy on fossil fuels in Lao PDR[4]. Therefore, reducing fossil fuel use cannot save the national income, but the reduction of fossil fuel use decreases the tax income from the fossil fuel unless the tax rate on the fossil fuels will be increased.

4.28 Considering a hypothetical situation where 50% of motorcycles and cars are electric by 2030. Such a scenario would realize foreign exchange savings of about USD581 million at current prices of fuel. Since that would imply substitution of export with domestic consumption, it represents a potential loss of USD101 million in export of electricity. Net gain to the country of such shift would approximate USD480 million. The 50% EV penetration of car is hard for Lao PDR unless the EV technology develops further and the price becomes lower. Nevertheless, the economic benefits of converting as many of its motor vehicles to EVs is potentially large, more so as the price gap between hydro and oil widens.

[3] The prices of gasoline and diesel are 1.27 USD/l and 1.15 USD/l.
[4] In some years ago, Lao government subsidized fossil fuels, but many Thai people came to Lao PDR to buy cheap fuels. Therefore, the government stopped to subsidize fuels.

Table 4.3.3 Foreign Exchange Saving by EV Penetration in 2030 (USD million)

		EV Propagation Rate					Assumption
		10%	20%	30%	40%	50%	
Foreign Exchange Saving from fuel saving	MC	35	69	104	139	173	Total No. of vehicles: MC= 1,875,194 units, Car = 907,713 units Fuel efficiency: MC= 40.2 km/l, Car = 13.4 km/l Driving distance per year: MC=5,840km, Car=9,125km Fuel price: Gasoline=1.27USD/l Diesel=1.15USD/l Electricity price = 0.093 USD/kWh
	Car	73	145	218	290	363	
Potential Loss of Export of Electricity	MC	8	15	23	30	38	
	Car	12	24	36	48	60	
Net Saving	MC	27	54	81	108	135	
	Car	61	121	182	243	303	

Source: JICA Study Team

5) Impact on Environment

4.29 **CO_2 Emissions:** For the projected number of motor vehicles under a do-nothing scenario and as shown on Table 4.3.4, the environmental impact can be calculated based on typical fuel and emission factors by type of vehicles. Improvements in fuel efficiency every year were also assumed. In the absence of relevant emission coefficients in Lao PDR, the data for Thailand was adopted due to similarity in motor vehicle types. The vehicle kilometerage by type of vehicle was adjudged to be those observed in Lao PDR.

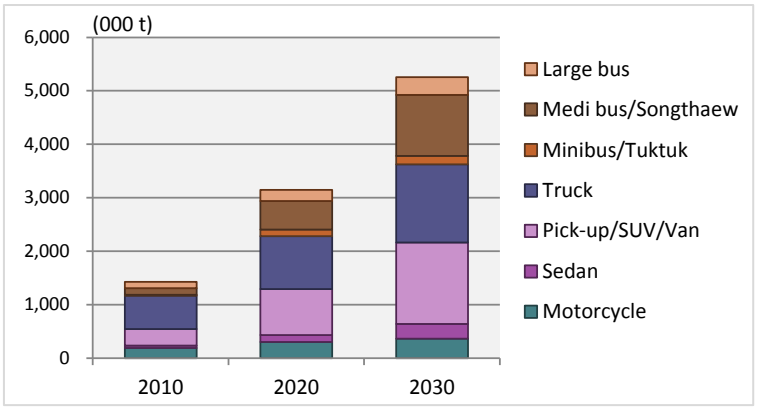
4.30 The estimated volumes of CO2 emissions from ICE vehicles in Lao PDR are shown on Table 4.3.4 and illustrated in Figure 4.3.5. CO2 emissions from transport grew rapidly from 552,915 tons in 2001 to 1,426,497 tons in 2010, which equates to 11% increase per annum. It is estimated that it will continue to increase, albeit at a slightly lower rate, to reach 3,145,873 tons by 2020 and 5,255,267 tons by 2030. The biggest contributors are: pickups/SUV/Vans (29%), trucks (28%), followed by songthaews and medium buses (22%).

Table 4.3.4 CO2 Emissions from Road Transport (2011–2030)

		Amount of CO2 (000 tons)			Increase/Year (%)		Assumptions	
		2010	2020	2030	2011-2020	2020-2030	Emission Factors (g/km)	Driving Distance (km/year)
MC		190	298	363	4.6	2.0	44	5,840
Car	Sedan	42	134	275	12.5	7.4	231	9,125
	Pickups/SUV/Vans	310	858	1,527	10.7	5.9	306	9,125
Trucks		627	991	1,460	4.7	4.0	739	36,500
Bus	Tuktuk/Minibus	13	122	159	25.2	2.7	92/317	16,425/43,800
	Songthaew/Medium bus	126	536	1,139	15.6	7.8	306/528	18,250/43,800
	Large bus	119	206	333	5.6	4.9	1,056	43,800
Total		1,426	3,146	5,255	8.2	5.3	-	-

Source: JICA Study Team

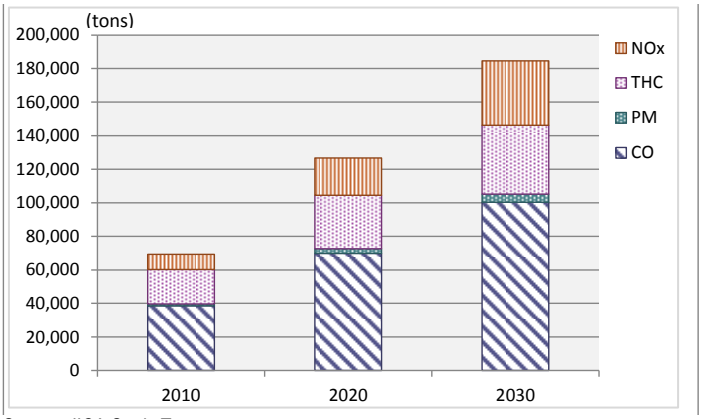
Figure 4.3.5 Projected CO2 Emissions



Source: JICA Study Team

4.31 **Air Pollutants:** Air pollutants from road transport were estimated following the same methodology as in CO_2. The relevant pollutants are PM (particulate matter), NOx (nitrogen oxides), CO (carbon monoxide), and THC (total hydrocarbons). The biggest volume comes from CO, which is 56% of the total.

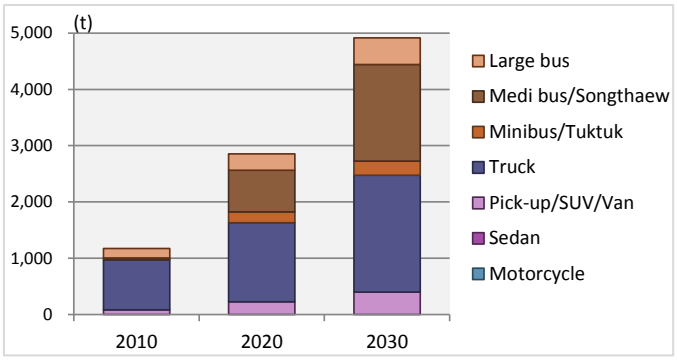
Figure 4.3.6 Projected Air Pollutants by Type



Source: JICA Study Team

4.32 **Particulate Matter:** PM is the air pollutant that most commonly affects people's respiratory health. The most visible parts (>10 microns) appear as dust or soot that creates haze. Road transport is estimated to have emitted 1,175 tons in 2010 largely from diesel-burning trucks and buses. The more dangerous PMs are the invisible ones (<10 microns, particularly 2.5 microns) that can enter the lungs. The total PM is predicted to increase to 2,856 tons by 2020 and 4,918tons by 2030. Emissions will mostly come from heavy duty vehicles, such as trucks and trailers (42%), followed by medi-bus (35%).

Figure 4.3.7 PM Emissions from Road Transport

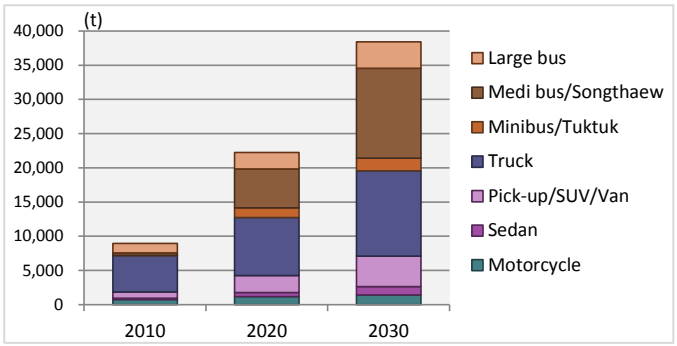


Source: JICA Study Team

Note: PM emission factor of each vehicle are (1) MC = 0g/km, (2) sedan = 0 g/km, (3) LCV=0.08 g/km, (4) truck = 1.05g/km, (5) tuktuk=0 g/km, (6) minibus = 0.5 g/km, (7) songthaew = 0.08 g/km, (8) medi-bus = 0.8 g/km, (9) large bus = 1.05 g/km

4.33 **Nitrogen Oxide:** NOx is a byproduct of combustions, especially of high temperatures like an ICE. When NOx and volatile organic compounds (VOCs) react in the presence of sunlight, they form photochemical smog, a significant form of air pollution, especially in the summer. Children, people with lung diseases such as asthma, and people who work or exercise outside are particularly susceptible to adverse effects of NOx such as damage to lung tissue and reduction in lung function. Contribution of road transport is expected to grow from 8,961 tons in 2010 to 22,229 tons by 2020, and 38,397 tons by 2030. The biggest polluters will be medi-bus (34%), trucks and trailers (33%), and pickups/SUVs/Vans (12%) (see Figure 4.3.8).

Figure 4.3.8 NOx Emissions from Road Transport

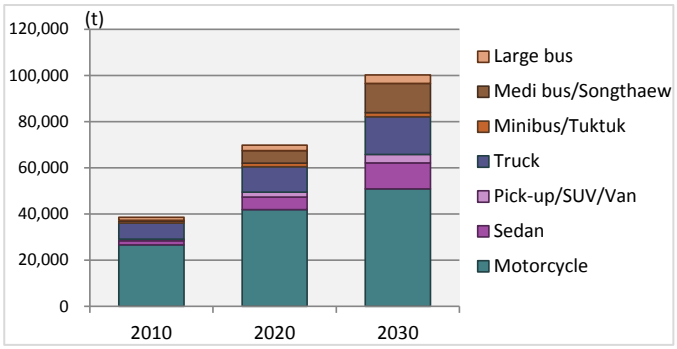


Source: JICA Study Team

Note: NOx emission factor of each vehicle are (1) MC = 0.2g/km, (2) sedan = 1.0g/km, (3) LCV=0.9 g/km, (4) truck = 6.3g/km, (5) tuktuk=0.1g/km, (6) minibus = 3.7g/km, (7) songthaew =0.9g/km, (8) medi-bus = 6.1g/km, (9) large bus = 12.1g/km

4.34 **Carbon Monoxide:** Carbon monoxide is produced from the partial oxidation of carbon-containing compounds, such as petrol; it forms when there is not enough oxygen to react with, such as when operating a stove or an internal combustion engine in an enclosed space. In high concentrations, it can be toxic. Among air pollutants from road transport, CO emission has the largest volume. From 38,590 tons in 2010, it is estimated to rise to 69,757 tons and 100,266 tons by 2020 and 2030, respectively. Emissions will mostly come from motorcycles (51%), followed by trucks (16%), and medi-bus (13%). The growth in, as well as the sources of, CO emissions are depicted in Figure 4.3.9.

Figure 4.3.9 CO Emissions from Road Transport

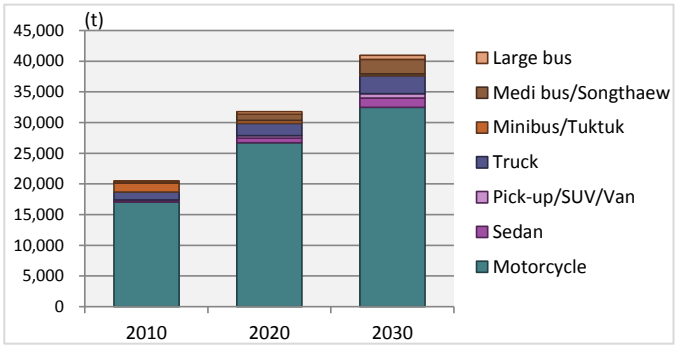


Source: JICA Study Team

Note: CO emission factor of each vehicle are (1) MC = 6.2g/km, (2) sedan = 9.4g/km, (3) LCV=0.7 g/km, (4) truck = 8.3g/km, (5) tuktuk=5.9g/km, (6) minibus = 3.5g/km, (7) songthaew =0.7g/km, (8) medi-bus = 5.9g/km, (9) large bus = 11.8g/km

4.35 **Total Hydrocarbons:** As shown in Figure 4.3.10, THC emissions are expected to increase at the same pace as the other pollutants, from 20,483 tons/year in 2010, to 31,786 tons/year by 2020 and 40,964 tons/year by 2030. Emissions will mostly come from motorcycles (79%) and, to some extent, trucks (7%).

Figure 4.3.10 THC Emissions from Road Transport



Source: JICA Study Team

Note: THC emission factor of each vehicle are (1) MC = 4.0g/km, (2) sedan = 1.3g/km, (3) LCV=0.1 g/km, (4) truck = 1.5g/km, (5) tuktuk=10.9g/km, (6) minibus = 0.6g/km, (7) songthaew =0.1g/km, (8) medi-bus = 1.1g/km, (9) large bus = 2.1g/km

4.36 Evaluating these results, it can be concluded that PM and NOx are attributable mainly to trucks, while CO and THC are mainly from motorcycles. These indicate that electrification of motorcycles can bring significant reductions of CO and THC. On the other hand, mitigation of PM, which can bring immediate relief and health benefits, should look at alternatives to petroleum diesel, such as biodiesel.

4.4 Benefits of EV Users

1) Methodology

4.37 In this sub-chapter, user costs of EVs and ICE vehicles in its lifecycle are compared (see ***Appendix 4.1***). The main considerations are as follows;

(i) Annualized cost of fixed cost and valuable cost are calculated based on the economic life of the vehicle and batteries;

(ii) The types and models of EVs are still limited. Therefore, in case that target EVs are available in Japanese market, Japanese EVs are used for analysis. However, if the price of Japanese EVs is too high, EVs of other countries are also referred.

(iii) The battery price is affected to the running cost of EVs significantly. Therefore, the cost reduction of batteries is assumed for sensitivity analysis in accordance with technology development of batteries. The sensitivity analysis was done for the 3/4, 1/2 and 1/4 of the present battery price.

(iv) The tax rates (import tax and excise tax) on the vehicles are very high in Lao PDR. However, MOF is now considering to revise the tax rates on EVs. So the sensitivity analysis was done with different rate of taxes on EVs.

2) Electrification of Motorcycles

4.38 Phasing in of e-motorcycles is the obvious first target. The technology is most mature among the different vehicle class, with many manufacturers ready for mass production (illustrative models are shown in Table 4.4.1). Also, their deployment can sidestep the need for prior construction, at high front-end cost, of a nationwide network of charging infrastructure. EV-MC can be plugged in at home at night. In terms of numbers, they comprised 79% of registered vehicles in 2011 and will likely to remain sizeable even by 2030 (64% share). While not heavy users of petrol, motorcycles are the number one sources of CO and THC. In a decade, their number is expected to grow to nearly twice their current level.

Table 4.4.1 Selected Models of Electric Motorcycles and Scooters

Name	Country	Top Speed (in km/h)	Power (in kw)	Body Type	Battery			Range (km)
					Type	Life	Capacity	
Honda EV-neo	Japan	n.a.	0.58	Scooter	Li-Ion	3-4 years	1.6 kWh	34
Yamaha EC-03	Japan	43	0.58	Scooter	Li-Ion	2 years	0.7 kWh	43
Terra Motors Seed 60	Japan	55	0.6	Scooter	Li-Ion	3-4 years	1.2 kWh	45
Modenas CTric	Malaysia	80	3.6	Underbone	Nano-gel 5x12v	2 years	20 a-h	60
Zap Xebra	USA	65	-	3-wheel	Lead Acid	3 years	-	40
Zero MX	USA	80	17.4	Off road MC	Li-Ion	-	2kWh	64
Brammo Enertia	USA	96	-	Motorcycle	Li-Ion-Phospate	32,000 km	2.85kWh	80
Vectrix VX1	USA	100	-	Scooter	NiMH	80,000 km	3.7kWh	110
Zero DS ZF6	USA	130	-	Dual sport	Li-Ion	327,000 km	6 kWh	121
Hangzhou HP-EM	China	45	1.50	Scooter	Silicon	n.a.	48v	70

Source: website of each motorcycle manufacturers

4.39 The main driver for converting to EV-MCs is the operating cost differentials, especially on running cost. Table 4.4.2 compares the operating cost of current ICE motorcycles against that of an e-motorcycle. These were derived from available models in the market of Japan. At present, the biggest drawback of EV-MC is the high initial cost, which may range from USD2,000 to USD5,000 depending on models, power ratings, and

the battery at its core motive power. In some countries, the heavier but cheaper lead-acid batteries are more popular, with the lighter but costlier Li-ion battery gaining ground. With economies of scale, and time, the cost of the latter is expected to decline rapidly. Moreover, Li-ion has also longer life (5x) than lead-acid batteries.

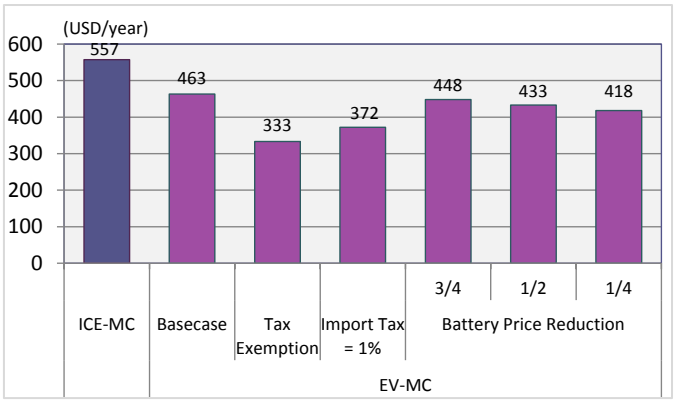
4.40 From the preceding table, it is clear that ICE-MCs have become more expensive to operate when compared to EV-MC, whether the base model used silicon battery or the more modern one running on LiFePO4 battery. When the acquisition cost is excluded, the two types of EV-MCs are more competitive by more than 60%. In the case of SEED48, the total operating cost is already lower than that of ICE-MC. What this means is that the cross-over point has already been reached. The cost advantage of EV-MCs will only increase as EV battery price declines as economies-of-scale kicks in and as the cost of petrol goes up faster (for ICE) than the cost of electricity (for EV). The situation for EV-MCs, therefore, requires no tax preference or incentive to be viable.

Table 4.4.2 Comparative VOC for Motorcycles

Item				ICE-MC (Wave 100)	EV-MC (SEED48)	EV-MC (EC-03)	Remarks
Vehicle	Purchase Price (USD)	Unit price		932	965	3,345	CIF cost + management fee
		Tax		553	794	2,005	Can be changed by policy
		Total		1,485	2,190	5,350	-
	Economic life(years)			10	10	10	-
	Running distance per year (km)			5,840	5,840	5,840	The more e-MC is used, the higher the savings
	Fuel efficiency (km/l, km/kWh)			45	41.7	61.4	Catalogue price
	Fuel price (USD/l, USD/kWh)			1.3	0.1	0.1	Average price in October 2012
Battery	Cost (USD)	Unit price		18	536	561	Silicon batteries are safe and lower price than Li-ion batteries. The price of Li-ion batteries will be decreased dramatically.
		Tax		2	101	105	
		Total		20	637	666	
	Type (Capacity (Wh))			-	Silicon (960)	Li-ion (700)	
	Economic life(years)			1	4	4	
VOC	Annualized Cost (USD)	Vehicle		221	326	824	Interest = 8% Batteries of EV-MC are assumed to change once in the life span.
		Battery		20	60	63	
		Sub-total		241	387	887	
	Running Cost (USD/year)	Fuel/Electricity		247	43	43	Fuel/electric efficiency was applied to the estimated figures from the actual data in Lao case. (30km/l for ICE-MC, 13km/kWh for EV-MC)
		Lubricant		35	-	-	Actual price in Lao PDR
		Tyre		0.2	0.2	0.2	
		Maintenance		24	24	24	assumed 3% of purchase price of conventional vehicle
		Insurance, Others		9	9	9	Use insurance cost of AGL
		Sub-total		316	77	77	-
	Total (USD/year)	Including initial cost		557	463	964	Some EV-MC can compete against ICE-MC
		Excluding initial cost (including batteries)		336	137	140	EV-MC is cheaper by 60%.
	Sensitivity Analysis (USD/year)	Tax exemption (Tax =0%)		-	333	635	Tax reduction and technology improvement of battery can bring more benefit for EV-MC.
		Import tax = 1%		-	372	734	
		Battery Cost	3/4	-	448	948	
			1/2	-	433	932	
			1/4	-	418	917	

Source: JICA Study Team

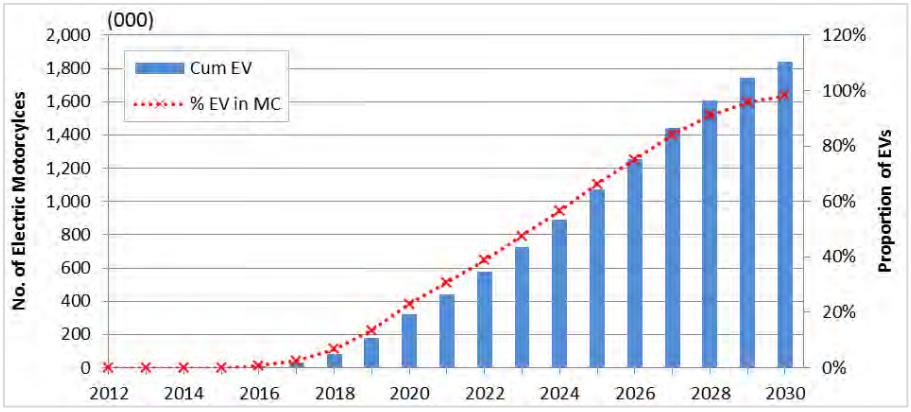
Figure 4.4.1 Sensitivity Analysis on VOC of Motorcycles (Case of SEED 48)



Source: JICA Study Team

4.41 Considering that power surplus in the country is foreseen to occur only after 2015, it would not be prudent to promote EVs as a zero emission transport mode earlier than 2015. The government has several policy options on EV-MC. It could take a hands-off approach and let the domestic market sort itself out. Or, it could take a more pro-active approach and start restricting the imports of ICE-MC beginning 2016 (i.e., only EV-MC can be imported and registered). A moderate approach is to apply a diminishing import quota for ICE-MCs but no quota for EV-MCs. The market shift from ICEs to EVs can be described as exogenous-driven, since an external factor (i.e., government-imposed quota) compels the process of EV adoption. Although all new MCs beginning 2016 will be 100% EVs, the aggregate number of EV-MCs relative to total MCs will only reach 41% by 2020 and 98% by 2030. It is possible to reach a target of 100% EV-MCs by 2030, if all old ICE-MCs (say, above 10 years old) are ordered phased out. Under the moderate conversion scenario (all new MCs beginning 2020 will be 100%), EV-MCs would comprise 29% of all registered motor vehicles by 2020 and 63% by 2030.

Figure 4.4.2 Diffusion Scenario of EVs in Motorcycles



Source: JICA Study Team

3) EV Diffusion in Passenger Cars

4.42 The estimated vehicle operating cost for ICE-car, EV-car and PHEV is compared in Table 4.4.3. While the running cost is very low for EVs, the initial purchase price of EVs is more than double of ICE vehicles because of the expensive EV battery. Assuming the tax component for EVs is removed while that for ICE is retained, the annual VOC would be a little bit cheaper (case of i-MiEV and Prius PHEV). It can be concluded that ICE-cars still enjoy more than 50% advantage in life-cycle cost over EV-car. Since there are no

savings in the running cost (i.e., without the capital cost), it is not possible to reach a cross-over point during the 12-year life of the vehicle. The determinant factor is the cost of battery on which manufacturers have been competing so fiercely that it is expected to reduce in the near future.

Table 4.4.3 Comparative VOCs for Passenger Cars

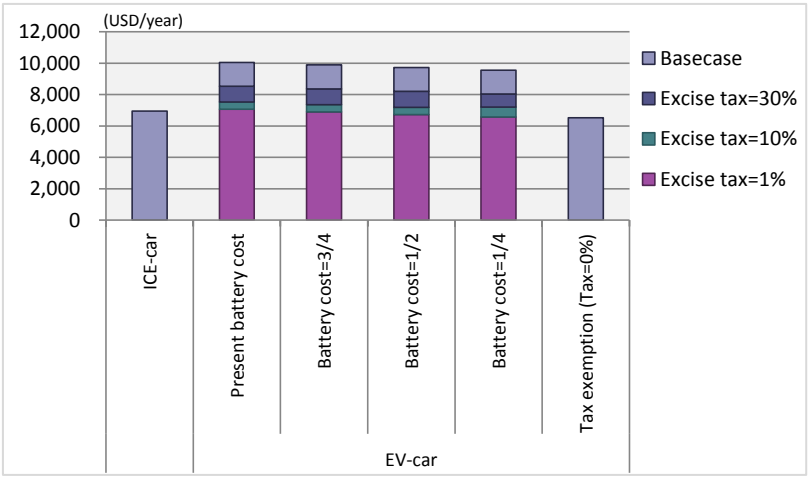
Item					ICE-Car (Corolla)	EV-Car (i-MiEV (M))	EV-Car (LEAF)	PHEV[1] (Prius PHV)	Remarks
Vehicle	Purchase Price (USD)	Unit price			14,346	36,730	47,318	43,087	CIF cost + management fee
		Tax			19,154	24,251	31,241	28,448	Can be changed by policy
		Total			33,500	60,981	78,559	71,535	-
	Economic life(years)				12	12	12	12	-
	Running distance per year (km)				9,125	9,125	9,125	9,125	
	Fuel efficiency (km/l, km/kWh)				12.6	9.1	8.1	8.7	Catalogue price
	Fuel price (USD/l, USD/kWh)				1.3	0.1	0.1	0.1	Average price in October 2012
Battery	Cost (USD)	Unit price			62	8,408	19,217	3,523	The price of Li-ion batteries will be decreased dramatically.
		Tax			13	1,575	3,600	660	
		Total			75	9,983	22,817	4,183	
	Type (Capacity (kWh))				-	Li-ion (10.5)	Li-ion (24)	Li-ion (4.4)	
	Economic life(years)				1	6	6	6	
VOC	Annualized Cost (USD)	Vehicle			4,445	8,092	10,424	9,492	Interest = 8%
		Battery			75	671	1,534	281	Batteries of EV are assumed to change once in the life span.
		Sub-total			4,520	8,763	11,958	9,773	
	Running Cost (USD/year)	Fuel/Electricity			1,159	135	135	135	Fuel/electric efficiency was applied to the estimated figures from the actual data in Lao case. (10.0km/l for ICE and 6.5km/kWh for EV)
		Lubricant			109	-	-	-	Actual price in Lao PDR
		Tyre			6	6	6	6	
		Maintenance			1,130	1,130	1,130	1,130	assumed 3% of purchase price of conventional vehicle
		Insurance, Others			23	23	23	23	Use insurance cost of AGL
		Sub-total			2,427	1,294	1,294	1,294	-
	Total (USD/year)	Including initial cost			6,947	10,057	13,253	11,068	EV is higher by 45-90%.
		Excluding initial cost (including batteries)			2,502	1,965	2,828	1,575	i-MiEV is cheaper by 8%. Comparing ICE vehicles.
	Sensitivity Analysis (USD/year)	Tax exemption (Tax =0%)			-	6,518	8,693	6,915	including import tax, excise tax and VAT
		Excise Tax	30%		-	8,540	11,298	9,288	Only tax reduction on excise tax or cost reduction of batteries cannot increase the competitiveness of EVs.
			10%		-	7,529	9,995	8,101	
			1%		-	7,073	9,409	7,567	
		Battery Cost	3/4		-	9,889	12,869	10,997	
			1/2		-	9,722	12,486	10,927	
			1/4		-	9,554	12,102	10,857	
		Excise Tax =30%	Battery Cost	3/4	-	8,372	10,915	9,218	It is forecasted that the battery cost will be 3/4 by 2015, 1/2 by 2020 and 1/4 by 2030.
				1/2	-	8,204	10,531	9,147	
				1/4	-	8,037	10,148	9,077	
		Excise Tax =10%	Battery Cost	3/4	-	7,361	9,611	8,031	
				1/2	-	7,193	9,228	7,961	
				1/4	-	7,205	8,845	7,891	
		Excise Tax =1%	Battery Cost	3/4	-	6,906	9,025	7,497	
				1/2	-	6,738	8,642	7,427	
				1/4	-	6,570	8,258	7,357	

Source: JICA Study Team

1) assuming that PHEV is operated as EV because of short distance driving in urban area of Lao PDR

4.43 In i-MiEV case, EV will have an advantage compared to ICE vehicles when the battery cost becomes 3/4 of the present cost and the excise tax on EVs is 1%. In similarly, the lifecycle cost of i-MiEV will be lower than that of ICE vehicles when the battery cost becomes 1/2 of the present cost and the excise tax on EVs is 10% (see Figure 4.4.3). Thus, it is effective to reduce the excise tax on EVs in accordance with the cost reduction of EV batteries.

Figure 4.4.3 Sensitivity Analysis on VOC of Passenger Cars (Case of i-MiEV)



Source: JICA Study Team

4.44 The number of vehicles has increased dramatically since 2005. This trend is expected to continue by 2030. The projected number of passing cars including LCV in Lao PDR is 449,879 by 2020 and 907,713 by 2030. A bold estimate predicted a higher number of cars at 500 thousand and 949 thousand, respectively. Especially people prefer to have pick-up or van due to its low tax rates. Although those types of vehicles is larger than sedan type of vehicles, the number of passenger is usually only 1-2 persons and emit more air pollutants than sedan. Replacing these private and commercial vehicles to small size of EVs is effective to improve environment and to save parking spaces for the cities as well as saving fuel cost for EV users considering increase in the fuel price.

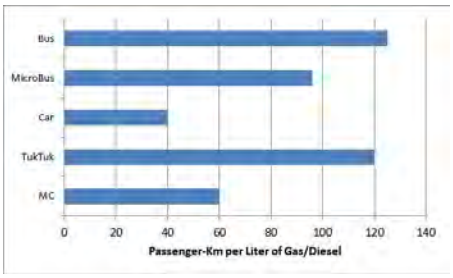
4) EVs in Public Transport

4.45 Introduction of alternative fuel vehicles in public transport entails an entirely different approach from motorcycles or cars. In the first place, public transport is a government responsibility and the number of public transport vehicles—tuktuk, songthaew, minibus, and standard bus—is regulated by government. Hence, unless government acts, nothing will happen.

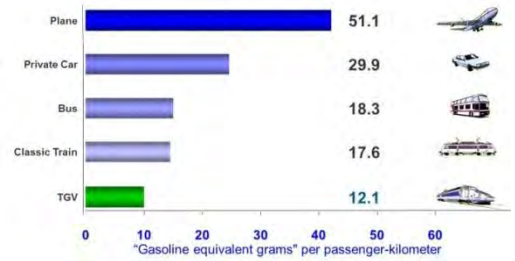
4.46 There are several compelling reasons why public transport should be the first priority for EV deployment in Lao PDR. Firstly, they cater to the many who cannot afford a car, but public transport vehicles in Lao PDR cause a lot of traffic pollution such as emission gas and noise, especially paratransit vehicles. Secondly, the more trips undertaken on public transport, the lesser would traffic congestion be in cities. The need to build more roads would also diminish. Introducing electric public transport vehicles can be a trigger to promote the public transport system. A study of cities in developing and developed countries revealed that sustainable cities have fewer cars coupled with high modal shares of public transport. Examples of such cities are Singapore, Hong Kong, Tokyo, Seoul, and many European cities where rapid motorization was curtailed if not discouraged at the beginning while putting in place a hierarchy of public transport system.

At the other extremes are the car-based city - such as Bangkok, Kuala Lumpur, Manila, Taipei, and many US cities. Subsidizing EV cars would place Lao PDR on the same path as the latter group of cities. Thirdly, fuel consumption per person-trip is substantially less where the share of public transport is high. To reduce the demand for imported and expensive fossil fuel, public rather than private transport should become the dominant mode for Lao PDR. Figure 4.4.4 compares the fuel efficiency of various modes

Figure 4.4.4 Fuel Consumption and Passenger Throughput by Transport Mode



Source: JICA Study Team



Source: Alsthom, "Applying European PPP Experience to the Development of HSR Projects in USA", June 2011

4.47 For Lao PDR, the most compelling argument for investing in EVs for public transport is their relative absence or lack thereof. At present, private transport (primarily motorcycles) is the dominant form of motorized trips in Vientiane. Its bus system is decrepit; with 77 operational buses in eight routes and a ridership of about 8,000 a day in a city of about 700 thousand people. The most travelled route can only claim a headway of 20 minutes, which is nowhere near what an urban transit service should offer. To be attractive, a public transport vehicle should appear every five minutes and be accessible within 500 meters from anywhere in the city. On the streets of Vientiane, public transport in whatever form is hardly noticeable with the exception of the occasional tuktuk parked in some street corner of the city waiting for passengers.

4.48 Vientiane is in a take-off point similar to where Taipei, Jakarta, Ho Chi Minh, and Kuala Lumpur had been long ago—in the cusp of rapid motorization. As motorization booms, the lack of a good public transport system forces households to buy cars as income rises. Without intervention now, the cumulative effect in the long term is a city dependent on cars struggling in traffic gridlocks and a public transport system in a losing proposition. Lao PDR can avoid this end-game by investing in public transport system now, when the tide of motorization is still very low. And since it is starting from virtually nothing, it might as well be electric. There is no legacy problem to surmount nor entrenched ICE-based transport providers to mollify.

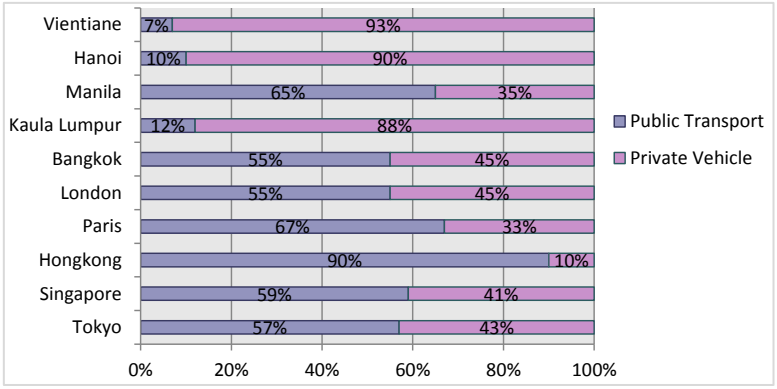
4.49 The most feasible path to sustainable transport is to create an efficient and effective public transport system especially in urban areas like Vientiane, Luang Prabang, and Savannakhet. As stated earlier, Lao PDR is starting from virtually nothing and can start from the ground up by introducing a hierarchy of EVs from e-trikes (modern edition of the current tuktuks), e-taxis, e-minibus (modern edition of songthaew), to e-bus.

4.50 For technical reasons, it is premature to convert heavy vehicles, such as trucks and standard buses, into EVs. They can be considered when the battery technology has advanced to a stage where they can be cost effective, say, by 2020. Special mention needs to be made for the tuktuk. In most developing countries, the lowly tuktuk or tricycle have always been looked down by transport planners as unsafe, ugly, noisy, if not a nuisance to be rid of. They emerged out of necessity despite lack of government support and sometimes despite occasional efforts to banish them from city streets. More

importantly, they provide a cheap transport service without any government subsidy.

4.51 The number of tuktuks and buses are still too small for a country like Lao PDR with more than 6 million people. The base case scenario had pictured 75,000 buses and minibuses in the entire country by 2030. This number is highly dependent on government policy. In the capital city of Vientiane, there are only about 3,439 tuktuk in the official list, and 77 operational buses—hardly adequate for a city with 760 thousand residents. A back-of-the-envelope estimate can easily yield daily motorized trips of 1.2 million commuting trips. Available estimates place the modal share of public transport in Vientiane at only 7%. By way of a guide, the market share of public transport in selected Asian and European countries are shown below.

Figure 4.4.5 Use of Public Transport in Selected Cities



Source: JICA Study Team

4.52 The bus service offered by VCSBE—after planned improvements—can only serve 14,000 trips by 2015. That would imply less than 1% modal share. The target should be no less than 30% modal share on public transport by 2020 and 50% by 2030. Given the present situation in Vientiane, combined with lessons from cities of other developing countries, an appropriate public transport system should consist of a mix of buses (40 or more passenger capacity) on fixed routes at high-occupancy corridors, e-minibus (12pax/capacity on fixed routes at secondary roads, and e-trikes (4-6 pax) as shared taxis operating in districts or villages of about 4-km radius. An intelligent transport system (ITS) can be overlaid to ensure integrated operation of what seem like a fragmented and distributed public transport system. In contrast, transport planners from European and American cities always fall back on the urban paradigm of big buses and rail transit without paratransit.

4.53 A conceptual public transport system for Vientiane envisages 30% modal share by 2030, say, 5% on standard bus, 10% on e-minibus, and 15% on e-trikes. That suggests the allocation of the 30% share of a notional total daily demand of 1.4 million trips (1.4 trips per capita per day for a population of 1 million) shown in Table 4.4.4.

Table 4.4.4 Conceptual System of All-EV Public Transport System for Vientiane

Type of E-Vehicle	No. of Pax Trips/Day	% Modal Share	Required No. of Units	Daily Km-Run/Unit	Total Power Consumption (in kWh/day)
e-Trike (modern tuktuk)	210,000	15%	4,375	80	46,667
e-minibus (songthaew)	140,000	10%	1,400	150	60,000
e-Bus	70,000	5%	194	300	Euro3 diesel, up to 2020. Thereafter EV
Total	420,000	30%	5,969		

Source: JICA Study Team

4.54 With the scale implied in the above table, it is possible to blanket the city with a public transport capable of 5- to 10-minute headways and a route network within 500 meters from any part of the city. This feature can only be realized by deploying smaller capacity vehicles like e-trikes and e-minibus. For example, 70 thousand passengers can either be served by 194 regular buses or by 700 minibuses; but the former will have headways nearly four times longer than the latter. If the former is scheduled to have a frequency of one bus every 20 minutes, the latter will achieve one every 5.5 minutes. Hence, there is shorter waiting time for passengers but in smaller lots. It is also more efficient in areas of low demand as in villages or low-density neighborhoods. Large segments of Vientiane, especially outside the core, are still low-density developments. With a sprawling landscape, demand is dispersed and agglomerates to only a few routes on main arterial roads that can support standard buses.

4.55 Aside from greater coverage of the city at lower costs, there is also a social benefit for preferring small-scale public transport enterprises: The e-trike and e-minibus are amenable to private ownership and operation by small-scale enterprise. They provide bigger employment opportunities; as the 4,375 e-trikes would need 6,125 drivers against 580 workers for the 194 buses. There are no available statistics on household income, but anecdotal evidence indicates that more than 30% of the populace cannot afford to ride a bus daily, much more acquire a motorcycle. Under this circumstance, the poor gets excluded from many social and economic opportunities.

4.56 Table 4.4.5 shows a preliminary comparison of the VOC between ICE and EV for trikes, minibus and medium bus. Since the available electric public transport vehicles in Japan are limited in terms of its price and model, the electric public transport vehicles in other countries were also selected as comparison objects. E-trike was selected from Philippines, and e-minibus and e-medium bus were selected from Chinese products. The comparison results show that the cross-over point has been reached for e-trikes, but still a long way to go for buses if consider the Japanese e-buses. The vehicle operating cost of Japanese e-trike is more than USD1,000 lower than the conventional tuktuks, so that it is possible to introduce e-trikes in Lao PDR soon. However, the initial cost of e-trike is still expensive for the owners of tuktuks. The government needs to establish lease-purchase system or similar systems for the owners.

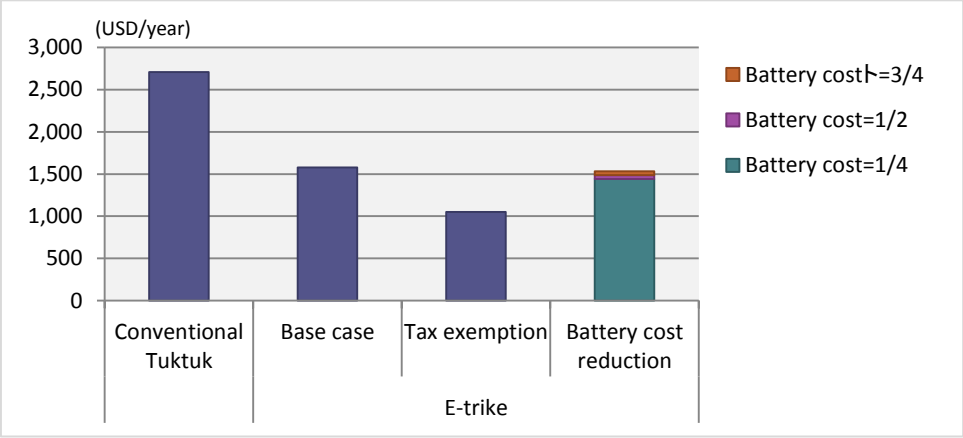
4.57 Regarding the e-buses, the running cost of e-buses is much lower than that of ICE buses. However, the high price of initial cost of e-buses increase the vehicle operating cost of e-buses significantly. This is mainly because the price of e-buses includes the huge research and development cost. When more e-buses are produced, the price of e-buses will be much lower. On the other hand, e-buses in other countries like China already have an advantage against to the conventional buses.

Table 4.4.5 VOC of Various Public Transport Vehicle Options

Item				Trike			Minibus (10 pax)			Medium bus (28pax)		
				ICE (Tuktuk)	E-trike		ICE (HIACE)	E-minibus		ICE (Poncho)	E-medium bus	
					(Terra Motors)	(Philippine)		MAYU	VCSBE		WEB-03	K9
Vehicle	Purchase Price (USD)	Unit price		1,166	4,514	6,081	25,354	136,605	8,628	222,288	343,440	96,112
		Tax		834	3,230	4,352	14,146	46,630	2,945	124,024	117,231	32,808
		Total		2,000	7,744	10,433	39,500	183,235	11,573	346,312	460,671	128,920
	Economic life(years)			10	10	10	12	12	12	17	17	17
	Running distance per year (km)			16,425	16,425	16,425	18,250	18,250	18,250	43,800	43,800	43,800
	Fuel efficiency (km/l, km/kWh)			10	27.8	12.8	16.4	7.7	5.1	6.5	1.8	1.0
	Fuel price (USD/l, USD/kWh)			1.3	0.1	0.1	1.2	0.1	0.1	1.2	0.1	0.1
Battery	Cost (USD)	Unit price		39	1,610	630	47	4,164	1,984	59	35,231	259,431
		Tax		11	302	118	13	780	372	16	6,600	48,600
		Total		50	1,912	748	60	4,944	2,356	75	41,831	308,031
	Type (Capacity (kWh))			-	Silicon (2.9)	Lead acid (3.0)	-	Li-ion polymer (5.2)	Lead acid (13.7)	-	Li-ion (44)	Li-ion (324)
	Economic life(years)			1	6	2	1	6	1	1	6	6
VOC (USD/year)	Annualized Cost	Vehicle		298	1,154	1,555	5,241	24,314	1,536	37,966	140,615	50,503
		Battery		50	181	261	60	332	1,856	75	3,500	25,776
		Sub-total		348	1,335	1,816	5,301	24,647	3,392	38,041	144,116	76,279
	Running Cost	Fuel/Electricity		2,086	8	8	2,620	292	292	8,384	2,336	2,336
		Lubricant		196	-	-	475	-	-	1,630	-	-
		Tyre		8	8	8	51	51	51	1,260	1,260	1,260
		Maintenance		30	30	30	653	653	653	5,724	5,724	5,724
		Insurance, Others		40	40	40	40	40	40	40	40	40
		Sub-total		2,359	243	243	3,840	1,036	1,036	17,038	9,360	9,360
	Total	Including initial cost		2,707	1,578	2,059	9,141	25,683	4,428	55,079	153,476	85,406
		Excluding initial cost (including batteries)		2,409	424	504	3,900	1,369	2,892	17,113	12,860	34,903
	Sensitivity Analysis	Tax exemption (Tax =0%)		-	1,049	1,346	-	18,877	4,428	-	114,113	71,268
		Battery Cost	3/4	-	1,533	1,994	-	25,600	3,964	-	152,600	78,962
			1/2	-	1,488	1,929	-	25,517	3,500	-	151,725	72,518
			1/4	-	1,443	1,863	-	25,434	3,036	-	150,850	66,073

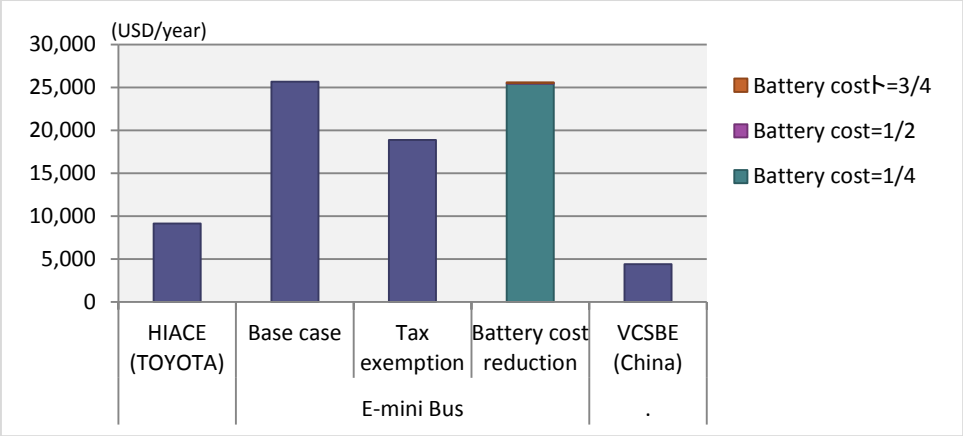
Source: JICA Study Team

Figure 4.4.6 Sensitivity Analysis on VOC of Trike (Terra Motors Case)



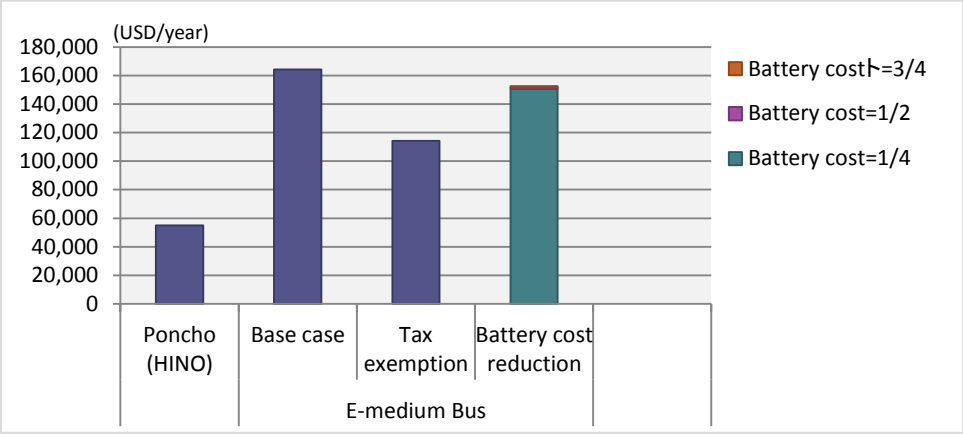
Source: JICA Study Team

Figure 4.4.7 Sensitivity Analysis on VOC of Minibus (Case of MAYU)



Source: JICA Study Team

Figure 4.4.8 Sensitivity Analysis on VOC of Medium Bus (Case of WEB-03)



Source: JICA Study Team

4.58 If the 210 thousand passengers shown in Table 4.4.4 that can be carried on 4,375 e-trikes were to travel by private motorcycles, the required number of motorcycles would be 52,500 units, assuming two riders inbound and another two outbound. In reality, the required number would be more, since most motorcycles have fewer than two riders at any time. In any case, the total operating cost would be 66,833 USD/day on ICE-MC, or 55,577 USD/day on EV-MC. In comparison, the operating cost for the 4,375 e-trikes would only amount to 33,768 USD/day. The savings, therefore, from public transport, would range from USD21,809 to USD33,065 a day. This does not yet consider the decongestion benefits on the road network of Vientiane.

4.59 On the other hand, if the 140 thousand commuters that are supposed to be carried by 1,400 e-minibuses were to travel by car, the total operating cost would amount to USD532,000 against USD50,400 on public transport. The savings would be USD482 thousand. The annual economic benefits from a public transport system of the scale described in Table 4.4.6 (30% modal share) would exceed USD188 million a year. After 2020, when e-buses are also introduced, the saving from public transport will be much higher than this figure.

4.60 Lending credence to the above EV direction for Lao PDR is a recent study by the World Bank on China's aggressive plan to lead the world in vehicle electrification. The approach was likened to what American cities did in the 1960s, which was to build roads

to accommodate more vehicles rather than “manage the shift and treat electric vehicles as only one piece of a system that incorporates car-free modes of transportation.” It concluded that urban congestion, sprawl, inefficient land use, and other problems correlate to the large number of private vehicles regardless of whether they plug in or gas up.

Table 4.4.6 Saving from E-public Transport

	Passenger Capacity (person/vehicle)	No. of Passenger (person/day)	No. of Trip (time/day)	Required No. of Vehicle (unit)	Average Trip Length (km/trip)	Total Trip Length (veh-km)	VOC per distance (USD/km)	VOC (USD/day)
MC (wave100)	2	210,000	2	52,500	6.7	703,500	0.095	66,833
E-MC (SEED48)							0.079	55,577
E-trike (Terra Motors)	4		12	4,375	6.7	351,750	0.096	33,768
Saving from e-trike compared to MC (USD/day)								33,065
Saving from e-trike compared to E-MC (USD/day)								21,809
Car (Corolla)	3	140,000	2	23,333	15.0	700,000	0.76	532,000
E-minibus (VCSBE)	10		10	1,400	15.0	210,000	0.24	50,400
Saving from e-minibus								481,600

Source: JICA Study Team

4.5 Demand Forecast

1) Methodology

4.61 This sub chapter forecasted the number of EV in the future by vehicle types. The main considerations are as follows;

(i) Because the users' benefit of e-motorcycle is obvious, it is assumed that only electric one is available for motorcycle after 2016.

(ii) As a result of SP survey by the Study Team, it is forecasted that 25% and 55% of people will buy EVs at the income level of 2020 and 2030, respectively. Moreover, subsidy and/or tax reductions on EVs can promote people to buy EVs further, so that incentives on EVs were also considered.

(iii) The current EV technologies are not practical for long distance driving such as trucks. Therefore, EV diffusion rate for trucks were not considered.

(iv) Like motorcycle, tuktuk also has economic benefit for users, and tuktuk should be replaced to more environmental friendly vehicles immediately. So, it is assumed that all tuktuk will be electrified by 2015.

(v) Although Japanese e-buses are not practical to use yet, e-buses in other countries has a possibility to use in Lao PDR. Moreover, some e-buses were already operated in Lao PDR. Considering those situations, the diffusion target for e-buses was set properly as a policy target.

2) EV Diffusion Target

4.62 It is clear from the preceding sections that tempering the volume of imported petrol is a far more important consideration to Lao PDR than the issue of reducing GHG and air pollutions. The two, however, are correlated. Therefore, in order to solve the above issues by shifting to low-emission transport system, the Lao government has to craft an EV roadmap based on practicality, strategic importance, and economics or cost.

4.63 Considering the above conditions, the policy target of EV propagation rate is set as follows. Introduced EVs in the initial stage will be selected due to its technical feasibility and its necessity from the view point of environmental aspects. Therefore, propagation rate for e-motorcycle can be higher than others. E-motorcycles are already financially feasible. It is possible for the government to make e-motorcycle use mandatory for the people such as several cities in China.

4.64 The e-cars are still expensive, yet the target figure is suitable for Lao PDR considering the increase in the future income level and taking tax reductions which can increase the EV diffusion according to the results of SP survey by the Study Team. Regarding truck, EVs are not suitable for long-distance trip, and bio-diesel might be more feasible for this kind of trip. Therefore, the propagation rate for truck is not proposed. The propagation rate of public transport vehicles can be set based on the government policy. The number of public transport vehicle is still very small. So if newly public transport vehicle is all EV, the propagation rate will be quickly high. Therefore, the propagation rate of e-tuktuks and e-buses are 100% and 10% by 2020, respectively.

Table 4.5.1 Policy Target of EV Propagation Rate

		Vehicle Ownership (000)				% of EV			No. of EV (000)		
		2012	2015	2020	2030	2015	2020	2030	2015	2020	2030
Private Use	MC	944	1,093	1,395	1,875	10	50	100	109	698	1,875
	Car[1)]	199	270	450	908	0	10	50	0	45	454
	Truck	30	35	44	72	-	-	-	-	-	-
Public Use	TukTuk/Minibus[2)]	9	10	12	15	20	100	100	2	12	15
	Songthew/Medium bus[3)]	23	28	37	67	0	10	50	0	4	34
	Large Bus	3	4	5	10	0	10	50	0	0.5	5
Total		1,209	1,440	1,945	2,947	7	40	80	96	760	2,383

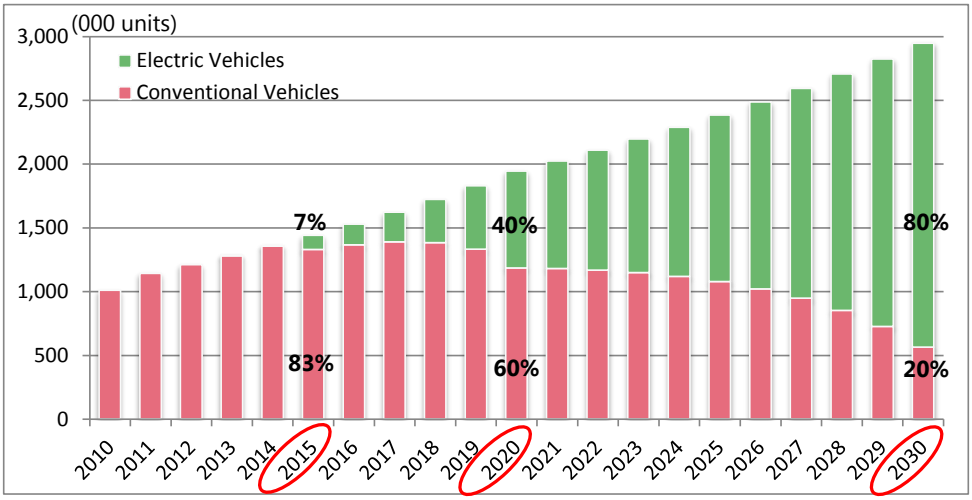
Source: JICA Study Team

1) Including sedan, pick-up, SUV, jeep and van

2) It is assumed that existing Tuktuk will be replaced by modern and safe vehicle with similar function by 2030 (minibus).

3) It is assumed that existing Songthaew will be replaced by modern and safe vehicle with similar function (medium bus).

Figure 4.5.1 Diffusion Target of EV in Lao PDR



Source: JICA Study Team

4.6 Impacts of EVs on Sustainable Development of Lao PDR

1) Impacts on Energy Consumption

4.65 The fossil fuel saving by introducing EVs is very significant. The energy saving was calculated based on the proposed policy target of EV propagation rate. The fuel efficiency was assumed to improve 1% per year, and the prices of fuel were fixed for 2012 prices. As a result, Lao PDR can save 200 million liters of fuel by 2020 and 830 million liters by 2030. It is equivalent to USD180 million by 2020 and USD938 million by 2030 while the reduction of tax income from the fuel will be USD209 million by 2030.

Table 4.6.1 Fuel Saving by EV Introduction

		Baseline Scenario (million litter)			With EV Case (million litter)			Fuel Saving (million litter)		
		2015	2020	2030	2015	2020	2030	2015	2020	2030
MC		185	224	273	166	112	0	18	112	273
Car		214	339	619	214	305	309	0	34	309
Bus	Tuktuk/Minibus	35	50	63	32	0	0	3	50	63
	Songthaew/Medium bus	130	170	360	130	169	208	0	1	152
	Large bus	38	49	79	38	45	45	0	4	34
Total		602	832	1,393	580	632	563	22	200	830
Total Cost of Fuel (million USD)		780	990	1,648	750	810	710	30	180	938

Source: JICA Study Team

Note: The assumptions of driving distance a year and fuel efficiency of each vehicle are as follows; (1) MC = 5,840km, 30.0km/l; (2) sedan/LCV = 9,125km, 10km/l; (3) tuktuk = 16,425km, 10km/l; (4) minibus = 43,800km, 8.0km/l; (5) songthaew = 18,250km, 10.0km/l; (6) medi-bus = 43,800km, 6.0km/l; and (7) bus = 43,800km, 4.0km/l. At the same time, the energy efficiency of each vehicle will improve 1%/year.

4.66 In exchange of saving fossil fuel by introducing EVs, electric consumption of Lao PDR will increase. However, the power demand for EVs will be 407 GWh by 2020 and 1,985 GWh by 2030 (see Table 4.6.2). According to the power balance forecast by EDL, the capacity of power supply by 2020 will be more than 17,200 GWh at least, while the power demand will be less than 15,000 GWh. Thus, even the power demand for EVs by 2030 (1,985 GWh) will be afforded by current power supply plan. The power demand for EVs is very small compared to the total power demand of the country.

4.67 The required electric cost for EVs is also very small compared to fuel cost for ICE vehicles. If Lao PDR can achieve the policy target of EV propagation rate, the country can save USD914 million for vehicle fuel by 2030.

Table 4.6.2 Power Demand for EVs

			2015	2020	2030
Power Demand for EVs (GWh)	MC		43	259	630
	Car		0	53	480
	Bus	Tuktuk/Minibus	3	68	95
		Songthaew/Medium bus	0	8	601
		Large bus	0	20	180
	Total		46	407	1,985
Baseline Scenario	Power Demand (GWh)		11,500	14,600	n.a.
	Power Supply (GWh)		14,950	29,900	n.a.

Source: JICA Study Team

Note: The assumptions of driving distance a year and fuel efficiency of each EV are as follows; (1) MC = 5,840km, 12.5km/kWh; (2) sedan/LCV = 9,125km, 7.7km/kWh; (3) tuktuk = 16,425km, 27.8km/kWh; (5) minibus = 43,800km, 1.0km/kWh; (6) songthaew = 18,250km, 7.7km/kWh; and, (7) medi-bus = 43,800km, 2.0km/kWh. At the same time, the energy efficiency of each vehicle will improve 1%/year

2) Impacts on Environment

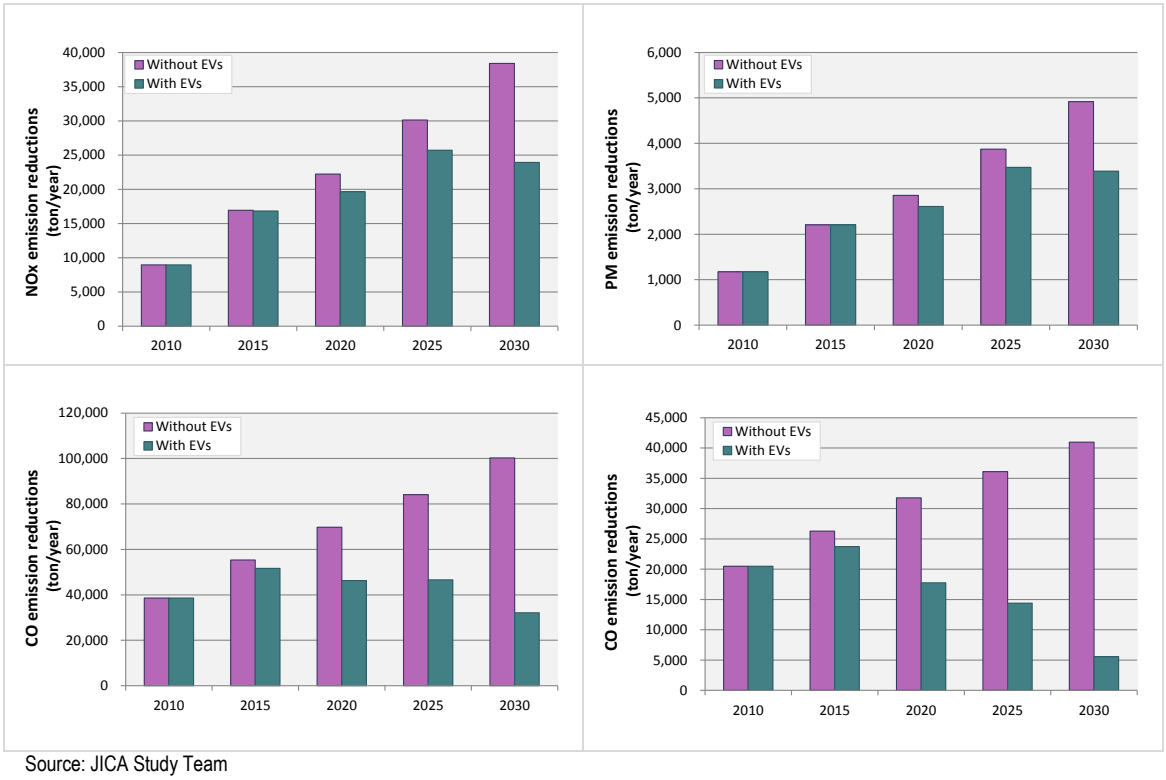
(1) Air Quality

4.68 In general, the major benefit of introducing EVs with regard to air quality is the displacement of air pollutants from urban to rural areas where electric power plants are often located and where population exposure is lower. Same as in CO2 emissions, with regard to the total amount of generated air pollutants, benefits highly depend on the grid mix. If the electricity is generated by renewable energy, such as hydropower in Lao PDR, emission reductions will be maximized.

4.69 Estimated air pollutant emissions from 2014 to 2030 are shown in Figure 4.6.1. In this estimation, processes are limited to vehicle operation (driving), not including vehicle and battery manufacturing processes, and also assuming that electricity is produced 100% by hydropower. Heavy duty vehicles are excluded since no EV introduction is assumed. Air pollutants will be significantly reduced, especially CO and THC.

4.70 As stated in the previous section, CO and THC are mostly emitted from motorcycles in the baseline; therefore, emission reductions are significantly high through introducing numbers of electric motorcycles. NOx and PM emissions mostly from buses including minibuses and medium buses will be reduced. The introduction of different types of EV vehicles can lead to comprehensive reductions of multiple types of air pollutants, and it will bring the greatest benefit to the health of residents in Lao PDR.

Figure 4.6.1 Air Pollutant Emission Reductions by Introducing EVs



Source: JICA Study Team

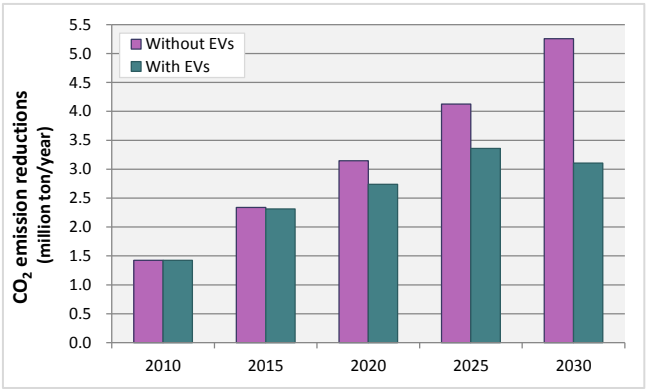
(2) Climate Change

4.71 Estimated CO2 emissions from 2015 to 2030 are shown in Figure 4.6.2. In this estimation, CO2 emission is limited to the process of vehicle operation, not including vehicle manufacturing and battery processes. It is assumed that all electricity is generated by hydropower and no imports. Annual emission reductions by 2020 and 2030 are

estimated to be 0.4 and 2.1 million tons of CO2, respectively. Such high emission reductions can be obtained because of very clean electricity in Lao PDR.

4.72 If the project can be realized as a Bilateral Offset Crediting Mechanism (BOCM) or a CDM project, assuming 1 ton of CO2 emission reduction can be sold at USD 11.5, the additional revenue is about USD 21.4 million by 2030. These additional revenues can be utilized to promote EVs.

Figure 4.6.2 CO_2 Emission Reductions by Introducing EVs



Source: JICA Study Team

(3) Noise

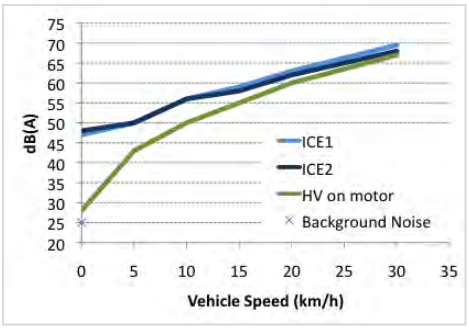
4.73 Road traffic is one of the most significant sources of noise and vibration. Noise from traffic is mainly determined by the vehicle powertrain, the tire-road interaction, and wind resistance. Noise measurements show highest values at around 50 km/h. At lower speeds vehicle noise is dominated by the engine; at higher speeds tires and wind resistance start to cause the major noise.

4.74 In general, EVs can significantly reduce noise and vibration because the electric motor operates considerably more quietly than internal combustion engines. Noise of EVs is mainly limited to noise from tire and air resistance. Therefore, the noise level would be particularly lowered in urban driving situations, especially at low speed driving, idling and acceleration, especially lower than 10 km/h speed (see Figure 4.6.3). Also, since the motorcycle is commonly a major source of noise, electrification of motorcycles could generate greater benefit.

4.75 Noise from motor vehicles will be significantly reduced through the introduction of EVs in the city, specifically in traffic congested area. Sightseeing sites can become quieter by replacing conventional vehicles with EVs.

4.76 Also, the noise inside vehicles can be reduced when using EVs, resulting in a more comfortable drive.

Figure 4.6.3 Comparison of Noise from ICE and Hybrid Vehicles (Motor Driving)



Source: Ministry of Land, Infrastructure, Transport and Tourism, Japan

(4) Others

4.77 A large-scale introduction of EVs, however, will bring large amounts of batteries for disposal unless an effective recycling system can be established. This might cause waste management problems and in a worse case, soil or water pollution may occur. Also, raw material depletion without an appropriate recycling system will be of some concern.

4.78 In the European Union (EU), in order to deal with battery waste, the EU Battery Directive was recently introduced. The directive requires the producer responsibility regulations, which requires battery producers to take responsibility for their waste. Producers who place more than 1 ton of batteries onto the market each year have to pay for the collection, treatment, recycling, and disposal of waste batteries in proportion to their market share. As a result of this legislation, it is anticipated that more batteries will be recycled in future.

3) Total Vehicle Operating Cost

4.79 If Lao PDR introduced Japanese EVs and the cost of Li-ion batteries decreased to 1/4 of the present cost, it cannot expect to gain the benefit from EV introduction except motorcycles. The power demand of EVs is very small compared to the vehicle operating cost of ICE vehicles. Therefore, if the vehicle operating cost of EVs decreases, the benefit from other types of EVs can be expected. As mentioned in ***Chapter 4.3***, the initial purchase cost of EVs increases the vehicle operating cost of EVs. Considering the high tax rate on vehicles in Lao PDR, the benefit from EV introduction will be changed dramatically by tax reduction on EVs and tax increase in ICE vehicles.

Table 4.6.3 Total Vehicle Operating Cost, 2030

		No. of Vehicles (000)			Vehicle Operating Cost (USD mil.)			Benefit from EV Scenario (USD million)[1)]
		Total	ICE	EV	Baseline Scenario	EV Scenario		
						Vehicle Operating Cost	Increase of Power Demand	
Motorcycle		1,875	0	1,875	1,029	791	78.6	159
Car		908	454	454	6,016	6,676	32.7	-693
Bus	Tuktuk/Minibus	15	0	15	139	444	20.0	-325
	Songthaew/Medium bus	67	34	45	4,029	7,434	52.5	-3,458
	Large Bus	10	5	5	-	-	-	-
Total		2,497	565	2,383	11,213	15,345	183.8	-4,317

Source: JICA Study Team

1) The benefit from the reduction of CO_2 and the installation cost of EV charging infrastructures are not included.

Note: It is supposed that all vehicles are made in Japan, as well as the cost of Li-ion batteries in 2030 will be 1/4 of the present cost.

4) Economic imperatives

4.80 Lao PDR is totally dependent on petroleum imports, of which 95% is consumed by its transport system. The country could therefore be crippled or immobilized should there be an oil supply disruption, a risk compounded by its landlocked geography. The current fuel consumption (gasoline and diesel) in the transport sector is estimated at 867 million liters in 2011. That is more than three times the volume in 2001 (227 million liters), while total vehicles grew by more than five times.

4.81 Reflecting the prices in the global market, the costs of gasoline and diesel in Lao PDR are quite high. As a poor country that imports oil, it cannot subsidize the commodity. Compounded by poor transport infrastructure, this has resulted in high transport cost that in turn, suppressed travel demand. Mobility is constrained, with the poorer segments unable to access economic and social opportunities. To improve its competitiveness in the global markets, as well as give greater mobility to its poorer inhabitants, Lao PDR has to bring down the cost of transport. It could not do this if it keeps its transport system totally dependent on fossil fuel.

5) Impact on Local Economy

4.82 Besides economic benefit due to savings in vehicle operating cost, energy saving, and improvement of environment, introducing EVs in Lao PDR can bring new business opportunities for local industries. Firstly, Lao PDR has an opportunity to participate in the EV value chain in the region using clean and abundant power resource. For example, battery production for EVs consumes a lot of power. If Lao PDR produces batteries for EVs, the CO2 emissions can be reduced not only from the operating EVs but also EV's life cycle. Furthermore, Lao PDR is located in the center of Southeast Asia. Therefore, once good road connections to neighboring countries are established, Lao PDR will be able to export batteries to neighboring countries.

4.83 Secondly, retrofitting ICE vehicles into EVs will be another business opportunity. Lao PDR is targeting a high propagation rate for EVs. However, EVs are still expensive except those for some types of vehicles such as motorcycles. Therefore, retrofitting ICE vehicles into EVs will be one of the important components to achieve the target. Conversion of existing vehicles to EVs can be a good opportunity to train mechanics and technicians in handling EVs.

4.84 Moreover, introducing EVs for tourism can promote new types of tourism activities. Related service activities will be generated to create job opportunities for the local folk.

4.7 Proposed Directions for Introducing Low Emission Transport in Lao PDR

1) Constraints and Opportunities (SWOT Analysis)

4.85 The presence of abundant, cheap, and renewable energy resource in Lao PDR is the main economic impetus for introducing EVs in the country. The benefit of low emission and low pollution is appealing, but not crucial since the country is not yet heavily motorized or industrialized. EV technologies are still in a flux, but those for lighter and smaller vehicles are already cost-competitive. The State fiscal position, alongside the predominance of households that cannot afford cars now and in the medium-term horizon, warrants an approach that focus on the public transport system.

4.86 To provide a better handle on the delineation of the right direction for Lao PDR, Table 4.7.1 puts together, in tabular form, the nation's strengths and weaknesses, as well as its future opportunities and threats (SWOT), relative to EVs in land transport. Weaknesses are constraints to development; they are formidable but not insurmountable.

Table 4.7.1 SWOT Matrix for Laos EV

	PRESENT	FUTURE	
STRENGTHS	• Ample supply of hydropower (after 2015), which provides the country stable energy supply as well as substantial export incomes; • Innate capability to adapt imported technology to meet its mobility needs; • Rapid economic development in the last 10 years	• Future growth of motorization and urbanization can be re-configured into a sustainable paradigm • Keen interest of ODA agencies (like ADB and JICA) to assist Lao PDR navigate the road to a more sustainable model of transport • Lessons from early EV adapters, and other countries, are instructive to Lao PDR • Unabated increase in the price of petroleum in global market can accelerate rapid shift to EV	OPPORTUNITIES
WEAKNESSES	• Insignificant public transport system in cities and rural areas • Low institutional capability of government and private entities involved in public transport • Lack of financial and technical resources to move into low emission transport; • Hard (e.g., network of charging stations) and soft (law and regulations) infrastructure on low emission transpor are virtually absent • Mountainous terrain, landlocked geography, and a poor road network susceptible to natural disasters	• Rapid motorization without as yet a good public transport system would result in severe and costly traffic congestion; • Unproven EV technologies are being peddled, early failures could stunt future adoption; • Oil suppliers will create obstacles, covert and overt, to stall if not abort shift to low emission transpor • Severe changes in eather patterns cut off roads to many villages during rainy season	THREATS

Source: JICA Study Team

4.87 For a country still struggling at the lower rungs of economic development, Lao PDR should avoid becoming a laboratory of the rich countries in introducing EVs. Neither can it afford to invest in research and development, but must rely on adoption and adaptation of proven EV technologies that worked. From the above table, and with due recognition of the unique endowment of Lao PDR, a logical set of a development strategy can be posited. The key elements are shown in Table 4.7.2.

Table 4.7.2 Generic Strategies

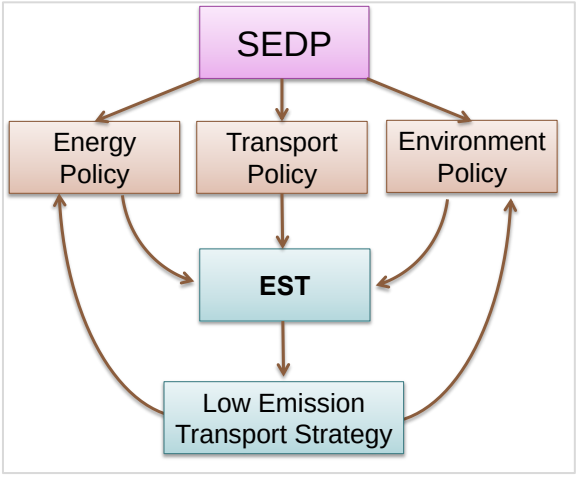
		To Respond to Threats	To Capture Opportunities
Strategy Elements	Capitalizing on Strengths	• Allow domestic prices of petroleum products to reflect global market prices; • Reduce reliance of land transport on imported fuel as quickly as possible • Use abudant electricity to energy source for transport	• HarnessODA to accelerate the development of an effective public transport system anchored on EVs • Allocate a larger portion of dividends from higher economic growths into investments in public transport rather than more roads per se • Introduce atlernative fuel vehicles which ensured the quality already in other countries
	Remedying Weaknesses	• Involve the private sector in the provision and management of public transport services • Draft corresponding laws or technical regulations to permit deployment of EVs on Laos roads • Conduct capacity building for the different levels and branches of government involved in public transport, as well as the association of tuktuk operators	• Co-share with the private sector the responsibilities for expanding and improving public transport • Tap ODA grants in capacity building, in the drafting of technical regulations governing EVs, and in the formulation of a master plan for EV-based public transport • Provide incentives in the importation or assembly of e-tuktuk and e-minibus and map their expanded routes/areas of operations (Vientiane and Luang Prabang as model cities)

Source: JICA Study Team

2) The EST Paradigm

4.88 Introducing low emission transport in Lao PDR cannot and should not be separated from the environmentally sustainable transport (EST) paradigm illustrated in Figure 4.7.1. It goes beyond a simple change of vehicle propulsion from ICE to electric, but must be framed in the context of what makes transport sustainable in several dimensions, i.e., environmental, technical, social, and economic.

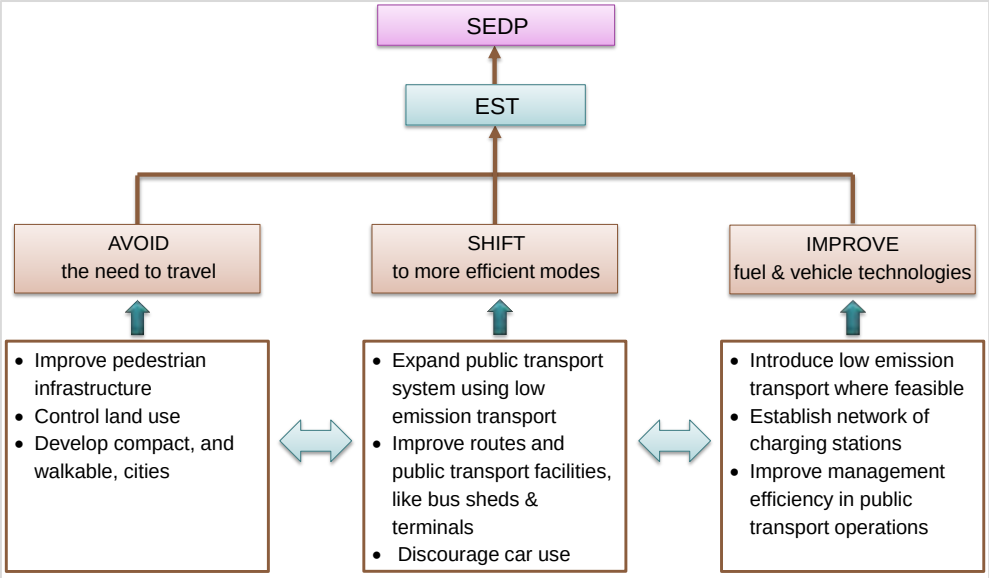
Figure 4.7.1 Low Emission Transport Strategy in EST and SEDP Context



Source: JICA Study Team

4.89 While the EST is a critical policy in the SEDP of Lao PDR, low emission transport is a potential driving force to promote EST in many ways, especially in dramatically reducing air pollutants, decreasing dependence on unstable supply and import of fuels, and saving energy. Low emission transport can also be a catalyst to strengthen sustainable transport policy in integration with traffic and demand management measures. Low emission transport is also expected to enhance the awareness of users and society on sustainable transport.

Figure 4.7.2 Sustainable Transport Framework



Source: JICA Study Team

4.90 Accordingly, specific strategies to propagate low emission transport in Lao PDR comprise the following strands:

(i) Develop institutional capacity at the national and local level to enable stakeholders to participate in low emission transport development such as in formulating low emission transport policy and roadmap;

(ii) Gradually roll out low emission transport infrastructure as the country's road transport network expands and improves, as its power supply system develops, and as urban/ regional development takes place;

(iii) Conduct information and education campaigns to ensure a shared understanding among various stakeholders;

(iv) Adopt the public-private partnership (PPP) scheme, particularly in the provision, management, and operation of low-emission, transport-centric urban public transport system;

(v) Harness international aid and cooperation to ensure funding for specific low emission transport action programs and projects, as well as technology transfer and training;

(vi) Calibrate the national low emission transport policy by tailor-fitting the same to the respective contexts of regions and large cities while bearing in mind the need to do so in an integrated manner for the common good; and

(vii) Design and implement model projects of new business models which can be implemented by a wide range of stakeholders.

3) Action 1: Policy Formulation and Capacity Building for Low Emission Transport

4.91 Understandably, Lao PDR does not yet have policies that will guide the shift and treat electric vehicles as one piece of a broader EST system. Although the development and diffusion of low emission transport is an irreversible trend and many countries are competing in inventing technologies and piloting applications, wide practice in the market is yet to come. At the infant stage of low emission transport development, the government

must take the lead in introducing low emission transport and establishing an effective mechanism for different players to participate. As the development of low emission transport in Lao PDR is a long-term undertaking under a quickly changing global situation, it is important to establish an institutional platform and clear policy related to low emission transport. These include the:

(i) Formulation of low emission transport policy to be included in the EST policy;

(ii) Establishment of an interministerial organization to promote low emission transport; and

(iii) Preparation of necessary institutions and regulatory framework related to low emission transport.

Proposed Actions and Considerations

4.92 Proposed actions to meet the objectives of the strategy are as follows:

(i) Organize a cross-sectoral "low emission transport preparatory task force" under the MPWT in coordination with related ministries, local authorities, and organizations including research institutes and the private sector;

(ii) Prepare a master plan on low emission transport development and strengthen planning and management capacity of the low emission transport preparatory task force; and

(iii) Enjoin the ASEAN Secretariat to organize a "working group on low emission transport" on the development and promotion of low emission transport in the region with Lao PDR as the secretariat.

4.93 **Policy Direction by Mode:** On the basis of the analysis made in the study, the proposed development directions by mode are shown in Table 4.7.3.

Table 4.7.3 Policy Direction by Mode

Mode	Approach
Motorcycle	・ Mandate the shift from ICE to E-MC because the benefits of EV users are high. (regulate the number of ICE-MC, increase the tax rate on ICE-MC) ・ Provide incentives on E-MC to propagate at the initial stage
Car	・ Let the market decides on its own, but encourage the shift by tax reduction because the price of EVs is still very high and available model is limited (already implemented)
Paratransit	・ Promote the retrofitting (or replacement) of existing tuktuks and songthaews ・ Provide tax reduction and necessary support
Bus	・ Wait the technology development because electric large buses does not have economic benefit at present ・ Expand the demand of bus services because the number of bus users is still small in the ruban area of Lao PDR.
Light Commercial Vehicle/ Small Freight Truck	・ Provide tax reduction to propagate

Source: JICA Study Team

4.94 **Review of Government Regulations on EVs:** On a more urgent level is a review of government regulations governing e-vehicles. There may be unintended obstacles. In the Philippines, for example, initially e-vehicles could not be registered legally since they did not have motor engine numbers. In all likelihood, there are no applicable vehicle and safety standards to govern the importation and use of e-vehicles on Lao roads. These rules must be defined and promulgated before e-vehicles (motorcycles, particularly) proliferate. Substandard e-vehicles may be sold in the local market as to create disappointments from early adopters. If such a bad experience happens regardless of

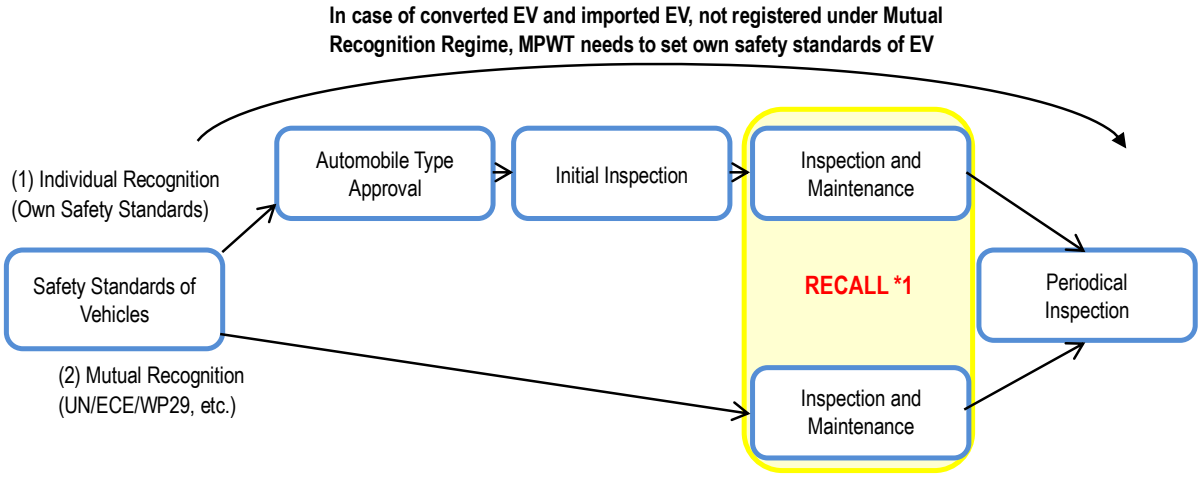
brand or source, the whole image of e-vehicles can be tarnished. The speed of diffusion could be affected and may even endanger the entire EV program.

4.95 In terms of ICE vehicles, safety standards of vehicles, as well as technical specifications and standards, have not been set yet. The MPWT is providing further insights into a mutual recognition scheme, and it seems to be the rational direction for Lao PDR, because there is no automobile manufacturer in the country, and all vehicles are imported. In terms of EV, safety standards of ICE vehicles will be applied for common parts, such as brakes, headlights, tires, and so on.

4.96 In the International Organization for Standardization (ISO), SC21 working group for electrically propelled road vehicles was established and later on in 1969, electric vehicle sectional committee was established under the International Electrotechnical Commission. ISO/TC22/SC21 is responsible for the standardization of EV safety, performance, fuel consumption testing standard, automobile components (like the driving battery system), while IEC/TC22 is mainly responsible for battery, electrical parts, and their components.

4.97 In anticipation of a full-fledged diffusion process of EVs in the near future, international standardization competition is becoming strongly reflected in energy policy, national industrial policy of states where the automobile industry is the driving industry. EVs are deeply interrelated with two industrial technologies, automobile and electronic, so two international organizations of standardization, ISO and IEC, have come to relate to each other. International standardization of EV is under way, so there is now one answer to follow in terms of EV and charging station system's standardization; likewise with the safety standards of ICE vehicles. Hence, Lao PDR needs to determine which international standard to follow and use as national standards. In addition, a localization of EVs as paratransit vehicle is most likely to happen. Lao PDR also needs to consider the technical specifications and standards, as well as safety standards, for EVs remodeled in Lao PDR and those imported from neighboring countries.

Figure 4.7.3 Safety Standards of EVs



Source: JICA Study Team

*1: Either individual or mutual recognition is selected, MPWT has to decide whether MPWT will recall or not; which means, MPWT does need necessary knowledge of automobile in market to make such decision.

4.98 The following shows regulations, guidelines, and standards that should be developed before EVs are introduced in the country:

- Automotive standards for EVs;
- Electric instrument standards used for EVs;
- Battery charger and storage standards for EVs;
- Electrical wave (radio wave): standardization of affirming abnormal reaction to radio wave and limitation of radio wave;
- Communication facility: standardization of external communication function from EVs and/or battery chargers to other facilities.
- ISO standards for functional stability of parts and control system used for EVs;
- Standards for remodeled EVs (paratransit);
- Electricity business regulation for building charging stations;
- Building standards and fire protection regulation for building charging stations; and
- Accreditation system for electricians and automobile mechanics specializing in EVs.

4.99 **Priority to Attend to Public Transport (Paratransit):** While it is ideal to formulate a national EV Roadmap first, the government should give higher priority to the problem of public transport, particularly of the paratransit variety. There appears to be no standards in this sector, as can be seen in a songthaew or tuktuk which could be retrofitted or modified into a minivan or a pickup. As these classes of vehicles would be the first target for conversion to low emission transport, the shift might as well conform to the appropriate national standards.

4.100 **Organization of Interagency Committee:** An interagency (involving the ministries of energy and mines, public works and transport, natural resource and environment, education and sports, information and culture, planning and investment, finance, commerce) or a cross-sectoral committee (relevant departments within the MPWT), separated from the National Transport Committee (NTC), should be organized to jumpstart the EV strategy of Lao PDR. A unit within the MPWT can take the lead or act as Secretariat, until a more formal structure is set up. How this EV coordinating body is organized depends on the content of an EV Development Roadmap, which, by itself, is still inchoate.

4.101 The NTC is currently overhauling two land transport-related laws, i.e., the Land Transport Law and the Land Traffic Law. In parallel to these revisions, the EST is also under discussions to be reformulated into a national transport policy paper for long-term, sectoral sustainable development. The committee is responsible for: (1) formulating strategic plans and transport development plans, (2) determining technical standards for transport vehicles, (3) determining safety standards and regulations, and (4) giving advice to goods and passenger transport service providers. In accordance with the given responsibilities, the NTC will be a focal point in developing low emission transport strategies and legal frameworks, although there is a suggestion to set up a separate task force type committee, which will focus on promoting and diffusing low emission transport since administrator and implementer should not be in one body.

4.102 **Main Areas for Capacity Development:** The following persistent weaknesses in the development and management of the transport sector have been identified and should be addressed by filling the capacity gap in the transport sector:

(i) Insufficient coherent policy guidance to those concerned with the planning and

development of the transport sector leading to non-coherent plans and programs;

(ii) Insufficient coordination and consultation among stakeholders;

(iii) Shortage of trained and experienced personnel in transport planning and other related matters;

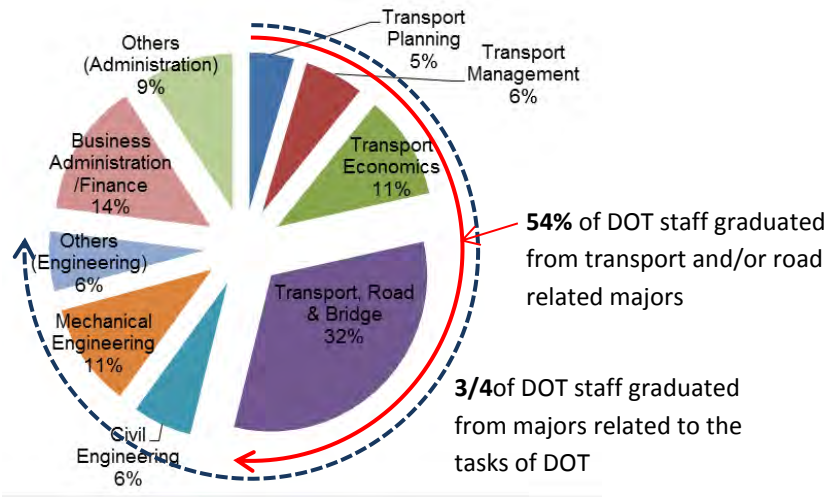
(iv) Lack of regulatory bodies equipped to control and monitor the sector; and

(v) Insufficient dialog between public and private sector due to poorly developed service providers as well as service users or consumer associations.

Rapid Capacity Assessment of DOT

4.103 The educational attainment of officers at the DOT is higher than that of officers in similar agencies in other Asian nations. Moreover, their educational backgrounds are directly related to their work. To illustrate, three fourth of DOT staff graduated with majors related to transport, mechanical engineering and civil engineering, while more than half of the entire staff studied transport and/or road traffic-related subjects. More than 40% of staff, excluding administrative staff, holds master's degrees or higher and most of them are appointed to positions directly related to their background. However, one drawback is that many staff members are still in their 30s, except those in the managerial level, which implies they might not have necessary empirical knowledge and skills. According to human resources division, unless officers have an opportunity to receive a scholarship, it is rare for them to have an opportunity to continue higher degree education. Also, after graduating from university, because there is no opportunity to receive specialized extension program or short program, there is little opportunity to learn advanced knowledge at higher educational institutions (see Figure 4.7.4).

Figure 4.7.4 Educational Attainment of DOT Staff



Source: DOT, MPWT

4.104 Personnel system at DOT has a distinct feature compared to that in government agencies in Japan. It does not basically have a staff rotation system. There is, of course, a promotion system; yet, higher than sub-directors are directly appointed by a minister, so there is personnel change but not like a reshuffling or rotation. One of merits of not having the staff rotation system is that officials will be an expert of in specific areas, while they could have limited insight about their tasks and division, and may cause a vertically-segmented administrative issue, in other words bureaucratic sectionalism, because of not

having much knowledge exchange through personnel rotation and technical trainings, which issue was also pointed out in the hearing at DOT. Cross-sectoral issues, like environmental issue, shall be aware and discussed throughout the department, but most divisions concern about the issue from their division's point of view only, and they do not much know what other divisions related to the cross-sectoral issues. Since the concept of knowledge management is not well known and practiced in the department, information and accumulated expertise at each division are not shared and utilized in the department.

4.105 Training can be categorized into two, in the context of public officers' training; structural and technical trainings. The structural training is organized and conducted by the Ministry of Interior (MOI) and common administrative trainings, such as accounting, language, administrative procedures, are operated by the MOI. MPWT also has its own structural and technical trainings, but most of technical trainings are meant to be information dissemination or sharing regarding new regulations, guidelines, and also administrative matters. In addition, DOT coordinates training funded by donors and those trainings are not periodic or structured ones, but incidentally or irregularly offered by donors. Those trainings are rather being designed along the needs of the DOT necessarily, but being conducted as a part of implementing projects by donors.

Table 4.7.4 Domestic and Overseas Training Programs of DOT (2011 – 2012)

No.	Institution (Fund providers)	Training Program	Program Length	No. of Participant
Domestic Training Program				
1	Administration division	Public administration	Short	1
2	Lao – Singapore Centre	English (PPP)	3 months	5
3	Vientiane Collage	English	3 months (2 terms)	3
4	US Embassy (MLI)	Watershed management	2 weeks (2 terms)	5
5	Initiative for ASEAN Integration (IAI)	English	20 days	2
Overseas Training Program				
1	Government of India	English, Environment	3 months	2
2	JICA	Trainings in Japan (part of Technical Cooperation Projects)	14 days	5
			10 days	1
3	JICA	Transport development training	2 months	1
4	JSPP21 (Japan-Singapore Partnership Program for the 21st Century)	Road safety engineering & management		3
5	Japan	Business supervision and safety	10 days	2
6	China	E-commerce and logistics	20 days	2
		Agricultural products circulation system building for developing countries	20 days	
7	Korea	Urban energy	8 days	1
Total				33

Source: DOT, MPWT

4.106 Given that the total staff number of DOT is 65 officials, if excluding managerial level, it is 45, about a half of officials received some kinds of training in FY2011/2012; yet, most of them got language or non-technical trainings. Technical training is little to no, except overseas trainings offered by donors. According to the personnel division, every year the division proposes various trainings but it can only get barely 50% of the budget it proposed, and the trainings are mostly for non-technical or information sharing seminars for provincial officers.

4.107 One of the weaknesses of DOT, in terms of institutional aspect is that there is no specialized division, legal division, to draft and review regulations, ordinances and

guidelines formulated by DOT. MPWT does not even have a legal specialist to verify the consistency and legality of drafted documents with preceding laws and regulations. Drafting regulations and ministerial decrees are under respective directors to verify the contents and overall responsibility is taken by the vice-minister to validate the drafts. In the case of other countries, a legal division is usually set-up in a ministry and legal officers are appointed to draft regulations and ministerial decrees. Training programs to cultivate legal officers will be one of challenge that DOT encounter in near future to develop and improve legal systems on road transport and traffic systems.

4.108 The following tables show a rapid capacity assessment of DOT and one of examples of training programs corresponding to the rapid capacity assessment. Capacity building for government agencies, in general, can be divided into institutional and human resource capacity building. Institutional and individual capacity building can be further classified by issues and functions of respective agencies. Institutional capacity building and issued-based/functional categories of capacity building are clarified in the table.

Table 4.7.5 Rapid Capacity Assessment of DOT

Category	Required Capacity/Tasks to Carry Out	DOT	Corresponding Program (ideas)
Institutional			
Establishment of governing structure for transport sector	- Clarification of the central government's responsibilities and authority and strengthening practical ability in the transport administration - Strengthening of implementation capacity of local governments in the transport administration - Expansion of private sector participation in project implementation	B	ST1–ST7
Legal Reform	- Legal systems and standards development for transport service delivery - Legal systems development toward market economy (ASEAN Economic Community by 2015) - Strengthening of institutional capacity and improvement of legal systems for collaborating with private sector (PPP).	B	ST6, ST9 PP1-PP5
Financial resources for transport sector	- Secure financial sources needed for transport sector - Introduce a benefit principle (beneficiary liability) concept into transport sector - Leverage private capital for transport sector development	C	ST8 PP1-PP5
Human resources development	- Strengthening the capacity of public officers - Strengthening the knowledge and skills of human resources in transport sector in general, such as automobile mechanics, automobile safety inspection's inspectors, road development and maintenance contractors	C	ST1-ST5
Issued-based/Functional			
Facilitating international passengers and goods movement	- International road arterial traffic network infrastructure development (E-W & S-N economic corridors) - Standardization and upgrading technology for road transport - Strengthening of safety and security measures	C	UR10-UR15
Road transport improvement	- Developing and upgrading arterial roads - Strengthening of road and bridge maintenance - Establishing and strengthening technical specification and standardization - Improvement of land transport service (freight)	B	UR11-UR16
Multimodal	- Developing multimodal freight systems - Facilitating traffic safety measures - Facilitating disaster prevention countermeasures for road transport	C	UR10, UR14-UR16
Urban Transport Planning and Traffic Demand Management	- Traffic survey and urban transport planning - Public transport service assessment and planning - Leverage private capital for urban transport planning and implementation - Controlling and administrating the management and service delivery of urban public transport - Improvement of transport operation and efficiency of traffic demand - Traffic safety education - Law enforcement for traffic safety measures	C	UR1, UR3, UR10, UR13 ST8, PP2 UR14-UR16

Category	Required Capacity/Tasks to Carry Out	DOT	Corresponding Program (ideas)
	- Research for traffic safety engineering - Transport planning and land-use control management - Environmental countermeasures originated from urban transport		
Transport planning for suburban city and rural areas	- Traffic survey and suburban and rural area's transport planning - Public transport service assessment, planning and service delivery to meet civil minimum - Developing and upgrading basic transport infrastructure to meet civil minimum - Traffic safety education - Law enforcement for traffic safety measures - Environmental countermeasures originated from transport sector	C	UR1, UR3, UR10, UR14-UR16
Cross-cutting issues	- Data collection and database management of traffic related statistics - Formulation of technical and administrative guidelines for urban and regional transport planning - Controlling and cultivating human resources capable of providing consulting services in transport sector - Providing a training ground for mentoring national consultants in transport sector	C	UR1-UR20

Source: The Study Team. (except from "Thematic Guidelines for Traffic and Transport. JICA. March 2010")
Note: A – Sufficient, B – Less Sufficient, C – Need Capacity Enhancement

Table 4.7.6 Training Program Concept for DOT

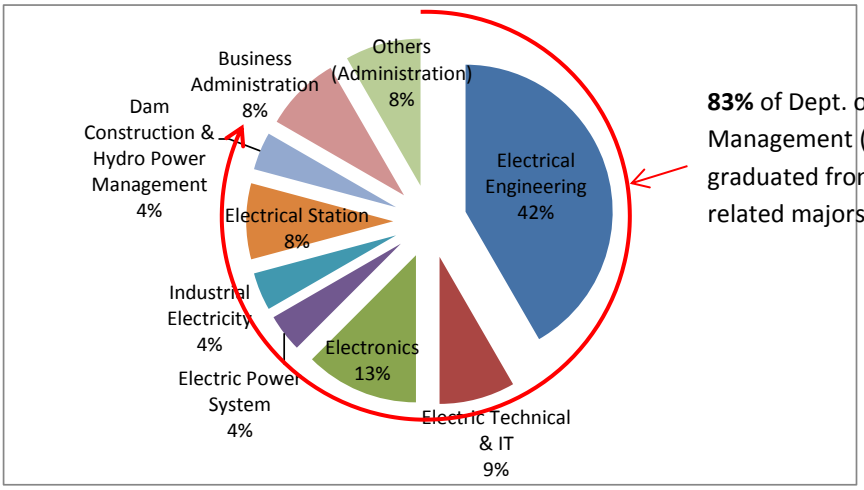
Area	Training Program	No.
Structural Training	Administrative skills (General)	ST1
	Management (General)	ST2
	Government administration (Basic)	ST3
	Managerial officer training (Intermediate/Advance)	ST4
	Managerial officer training (provincial officer)	ST5
	Disaster/Risk management (institution/regulation)	ST6
	Disaster/Risk management (operation)(provincial officer)	ST7
	PPP/PFI	ST8
	Legal document drafting	ST9
Public Procurement/ Operation	Infrastructure development (construction) business	PP1
	Public procurement system	PP2
	Technical review and evaluation	PP3
	Construction production system	PP4
	Land condemnation (acquisition) and resettlement regulation and procedures	PP5
Urban & Regional Planning	Land-use assessment and planning	UR1
	Park and green planning and management	UR2
	Street and urban transport	UR3
	Urban renewal policy and redevelopment	UR4
	Urban development administration (building code, etc.)	UR5
	Land readjustment	UR6
	Landscape and regulation of outdoor advertising	UR7
	Tourism and historical township management administration	UR8
	Local revitalization planning	UR9
	Integrated transport system planning (regional mobility strategy formulation)	UR10
	Road management (General)	UR11
	Road maintenance (General/Technical course)	UR12
	Traffic analysis and road planning	UR13
	Road traffic safety (automotive safety)	UR14
	Road traffic safety (pedestrian/bicycle)	UR15
	Road facility and environmental concerns	UR16
	GIS	UR17

Area	Training Program	No.
	GIS for urban planning and road network planning	UR18
	GIS for local disaster prevention planning	UR19
	Technical knowledge for automobile safety inspection	UR20

Source: JICA Study Team

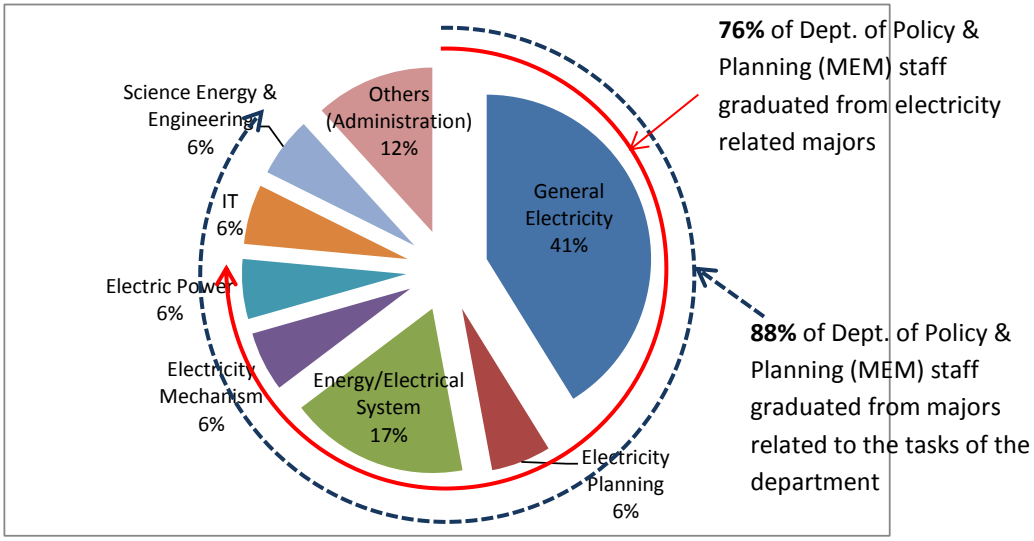
4.109 **Rapid Capacity Assessment of Other relevant Departments:** The main energy related department in MEM is composed of Department of Energy and Management and Department of Policy and Planning. The educational background of staffs in two departments is directly related to their task. 83% of officers in Department of Energy and Management and 76% of officers in Department of Policy and Planning studied related electricity. Furthermore, 21% of the former department and 44% of the latter department has master's or higher degree. Place where they got higher degree is varied by people, including Vietnam, Russia, Japan, Thailand, etc. Department of Policy and Planning has concrete human resource development plan. Officers is studying or plan to study more related subject to their task such as energy policy, energy management, energy economy, and so on. On the other hand, there is no human resource development plan in Department of Energy and Management. They join some training courses provided by international organizations. Although they have high educational attainment, the number of officers is relatively small. Department of Energy and Management has 24 officers, and Department of Policy and Planning has only 16 officers.

Figure 4.7.5 Education Attainment of Department of Energy & Management, MEM



Source: MEM

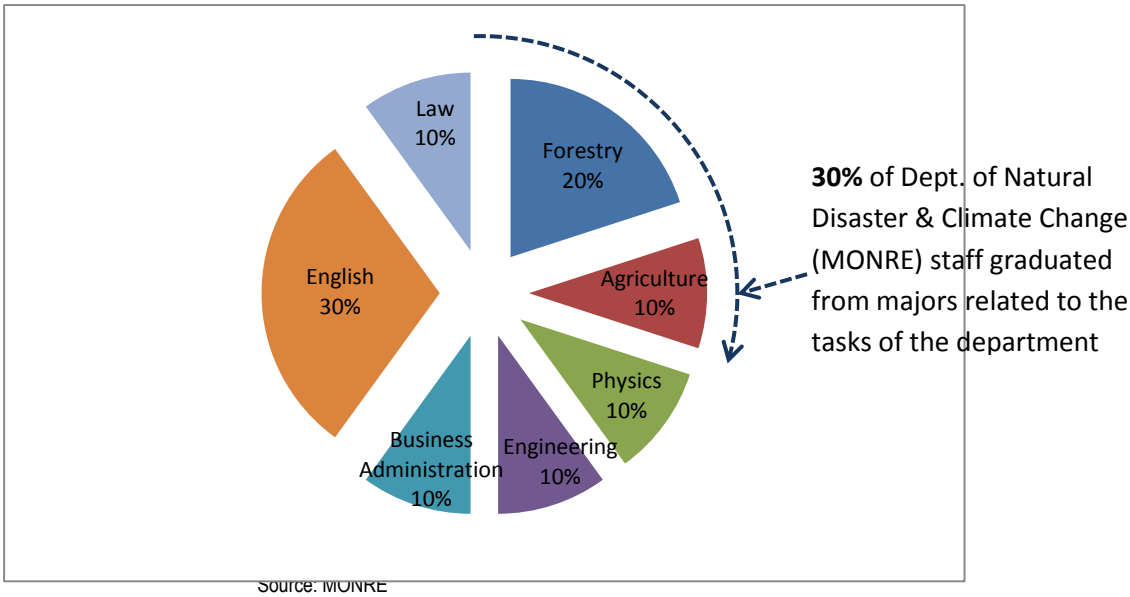
Figure 4.7.6 Education Attainment of Department of Policy & Planning, MEM



Source: MEM

4.110 The situation of Department of Natural Disasters and Climate Change in MONRE is difference from that of DOT and departments in MEM. None of them studied environment while 30% of officers studied subjects related to their task. And only 10 people in the deparment. This is mainly because this deparment was newly established in 2012. They also do not have any human resource developmnet plan yet.

Figure 4.7.7 Education Attainment of Department of Natural Disasters & Climate Change (MONRE)



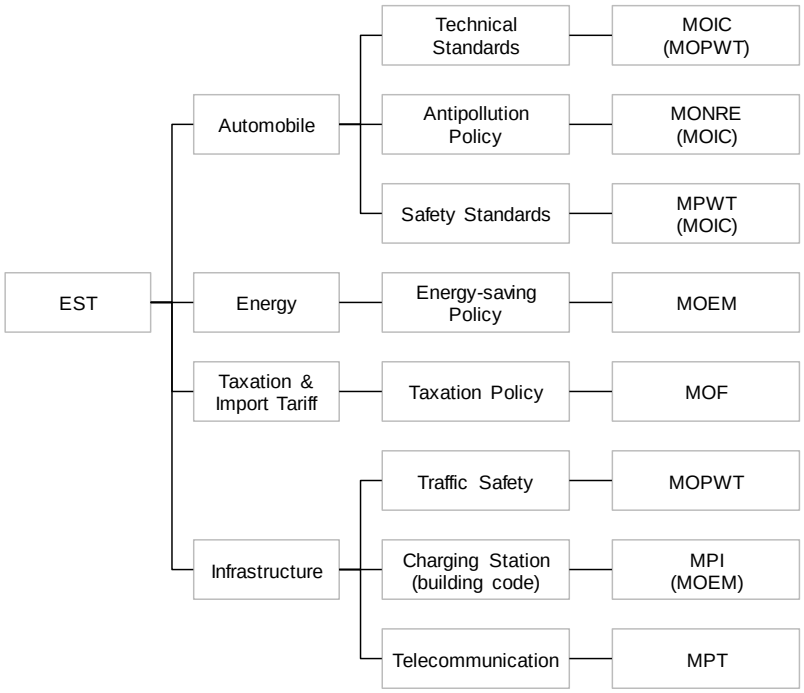
Source: MONRE

4.111 **Strengthening Capacity of Academic and Training Institutions:** The academic and training institutions play a vital role in development of the comprehensive policy and planning tools and provision of the skillful workforce. However, the capacity of academic and training institution in Lao PDR is limited, which lags behind in strengthening transport database management, conducting training on transport planning, drafting laws and regulations, drawing up technical standards and guidelines, and conducting necessary transport researches and evaluations. In order to strengthen transport-policy making,

planning, legalization capacity and functions of major urban authorities, it is suggested to establish the focal point for the transport studies in the field of transport policy making and planning.

4.112 **Defining Functions of Line Ministries on EV:** Introduction of low emission transport needs to take into accounts various aspects, such as new technical standards, safety standards, electricity law, battery recycling regulation and so on. The main capacity required by the MPWT is to draft a systematic law, regulation, ordinance, directive regarding to low emission transport in close cooperation with the MOIC. In advance to introducing low emission transport to Lao PDR, related laws and standards must be established, such as safety codes for electric charging station, technical standards and accreditation system for electric vehicles for imported and converted ones, telecommunication systems used for low emission transport, and so on in the preparatory stage by 2015.

Figure 4.7.8 Outline of Presumed Functions of Line Ministries



Source: JICA Study Team

4) Action 2: EV Infrastructure Development

4.113 Road transport in Lao PDR has not been fully developed, but is it expected to grow at accelerating speed. The number of vehicles will increase from one million of which 80% are motorcycles in 2010 to about three millions of which 1.9 million are motorcycles in 2030. Net increase in the next two decades is almost two millions. In 2010, there are 7,240 km of national roads and 7,960 km of provincial roads which provide backbone network for intercity transport services in the country. However, they are not paved adequately. There is a significant need for upgrading and improvement roads and power supply network as motorization makes progresses and economy grows. This is a weakness but can be considered as an opportunity to develop EV infrastructure hand in hand with roads and power supply network in integral and effective manner. Integrated development of EV infrastructure with urban and rural development is also important.

Table 4.7.7 Current Status of Related Infrastructure

No. of Vehicles

Type	2010	2030	'30/'10
MC	804	1,875	2.3
Car	168	908	5.4
Others	62	164	0.2
Total	1,034	2,947	2.9

Source: JICA Study Team

Road Conditions (2010)

Road	Length (km)	% Paved
National	7,235	61.3
Provincial	7,961	8.8
Others	24,389	4.0
Total	39,585	15.4

Source: MPWT

Power Grid Coverage

	2010
HH coverage (%)	71.3
Transmission (km)	32,274

Source: MEM and EDL

Proposed Actions and Considerations

4.114 Proposed actions to meet the objectives of the strategy include;

(i) Prepare EV infrastructure plan in integration with other related plans including national transport, urban and rural transport, urban and regional development, power supply, environmental management

(ii) Prepare a guideline for private sector investment including technical standards, regulations and incentives

(1) Overview

4.115 Electric vehicle does not mean the change of the vehicle. It changes the energy supply system completely. The following issues are the fundamentals for this electric vehicle shift.

4.116 **Charging Type:** (1) Home charging: Mainly the electric vehicle charging will be done at home at night. In case of business cars the charging will be done at office after working hours. (2) Convenient charging: Convenient charging outdoors is important for electric vehicle penetration. The convenient charger will be located at public parking lots, offices, shopping centers, and so on.

4.117 **Charging system:** Charging system is standardized by each country. And International harmonization of standards and regulations is still in progress. The outlines of these rules are as follows.

(i) Level: Charging level is categorized into 3 types. Slow Charge (Level1), Normal Charge (Level 2), Fast Charge (Level 3). The most essential charging is Level 2 Normal Charge; home charge and convenient charge use this Level 2. And Fast charge is used for emergency purpose. Slow charge (Level1) is only used for lightweight electric vehicles such as E-bike.

(ii) Equipment: Two types of charging equipment exist. One is an on-board charger and the other is an off-board charger. Most of the normal chargers use the on-board charger. Currently most fast charging uses the off-board charger.

(iii) Connector: Dedicated connectors of electric vehicles are used for level 2 and level 3 charging. These connectors are standardized within each country and compatibility among different types of the vehicle is guaranteed. Level 2 connector is standardized by SAE 1772 in US and Japan. However, other connectors have not been harmonized yet.

(iv) Safety: There are several regulations and safety standards for charging. The EVSE (electric Vehicle Supply Equipment) contains GFCI (Ground Fault Circuit Interruption) and the detection of perfect connecting equipment, which is mandatory. This

equipment is installed in the wall mount power supply or attached in the charging cable.

(v) Emerging technology Current charging technology uses the conventional method. In the near future, inductive wireless charging will become familiar. Most of the major OEMs are developing this technology, and several cities in Italy and New Zealand have been using the wireless charger for route buses as experimental projects.

(2) Charging Infrastructure Implementation Strategy

4.118 The following issues should be considered for the EV charging infrastructure. The charging infrastructure is a very essential part to reduce the customers' range anxiety.

4.119 **Number of Charging Equipment and Locations:** The number of normal charging equipment should be more than 1 per one EV. The rough guideline is 1.7 chargers for one EV. One is a home charger and 0.7 is a convenient charger. The location of convenient charging should be considered based on customer demands. Ideally it should be located on the office parking for EV commuting users, and the major public parking lot for most of the EV customer use.0.03 unit fast chargers will be enough per one EV. The location of the fast charger will be the parking area of main route for long trips. Based on these assumptions, the number of charging equipment of each category is estimated in Table 4.7.8.

Table 4.7.8 Required No. of Charging Stations

Type of Vehicle	No. of Vehicle			No. of Charging Stations at Home			No. of Charging Stations at Destination		
	2015	2020	2030	2015	2020	2030	2015	2020	2030
MC	109,327	697,660	1,875,194	-	-	-	-	-	-
Car	-	7,737	87,468	-	7,737	87,468	-	5,416	61,228
LCV	-	37,251	366,389	-	37,251	366,389	-	26,075	256,472
Trucks	-	-	-	-	-	-	-	-	-
Tuktuk/ Minibus (12pax)	1,983	11,961	15,311	1,983	11,961	15,311	1,388	8,372	10,718
Medium bus/Songthaew (25pax)	-	3,743	33,518	-	3,743	33,518	-	2,620	23,462
Bus (50 pax)	-	539	4,826	-	539	4,826	-	377	3,378
Total MV	111,310	758,891	2,382,705	1,983	61,231	507,511	1,388	42,861	355,258

Source: JICA Study Team

Table 4.7.9 Installation Cost of Charging Stations

Type of Vehicle	At Home (million USD)			At Destination (million USD)			Total (million USD)		
	2015	2020	2030	2015	2020	2030	2015	2020	2030
MC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Car	0.0	11.6	131.2	0.0	19.0	214.3	0.0	30.6	345.5
LCV	0.0	55.9	549.6	0.0	91.3	897.7	0.0	147.1	1,447.2
Trucks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tuktuk/ Minibus (12pax)	3.0	17.9	23.0	4.9	29.3	37.5	7.8	47.2	60.5
Medium bus/Songthaew (25pax)	0.0	5.6	50.3	0.0	9.2	82.1	0.0	14.8	132.4
Bus (50 pax)	0.0	0.8	7.2	0.0	1.3	11.8	0.0	2.1	19.1
Total MV	3.0	91.8	761.3	4.9	150.0	1,243.4	7.8	241.9	2,004.7

Source: JICA Study Team

4.120 **Grid Capacity:** The level 2 charging consumes around 6kw, and the fast charging consumes more than 50kw. So the grid capacity of electricity should be considered when a charger is installed. Transmission and power generation of electricity usually does not become a big concern at the early stage of electric vehicles implementation.

Figure 4.7.9 Example of Charging Equipment for EVs

Home Charge | Public Charge | IT Service

SOURCE: ecotality, JICA Study Team

4.121 **Type:** Charging equipment of home and public parking should have EVSE. And most of US charging equipment have EVSE and the Internet connection shown in Figure 4.7.10.

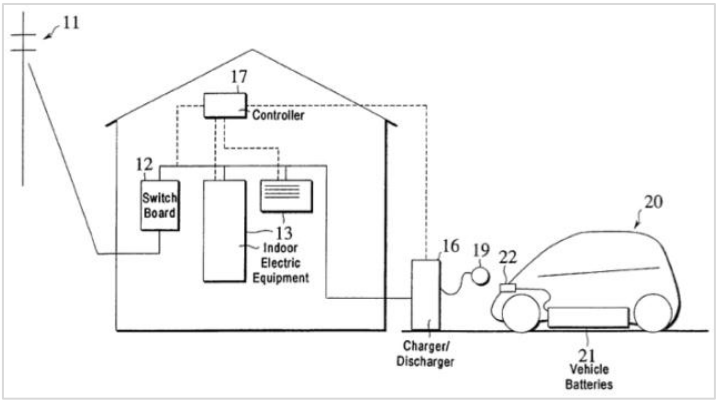
(3) Smart Grid

4.122 For load leveling, the electric vehicle can take an important role, as it will work as grid energy storage. This technology is called V2H and V2G.

(i) **V2H:** V2H (Vehicle to Home) connects the electric vehicle to the home wiring system. The customer charges the vehicle at night or in the low demand time period, and can use the stored energy at the peak time. By this method household energy can be leveled. And also this methodology is beneficial when the electricity power shuts down.

(ii) **V2G:** V2G (Vehicle to Grid) connects the vehicle to the smart grid, and an electric power company will control the charging and discharging of the electric vehicles to optimize the grid load balance. This is a very good solution for the smart grid, but several rules and standards are necessary. Currently the standardization activity is in progress.

Figure 4.7.10 V2H Block diagram



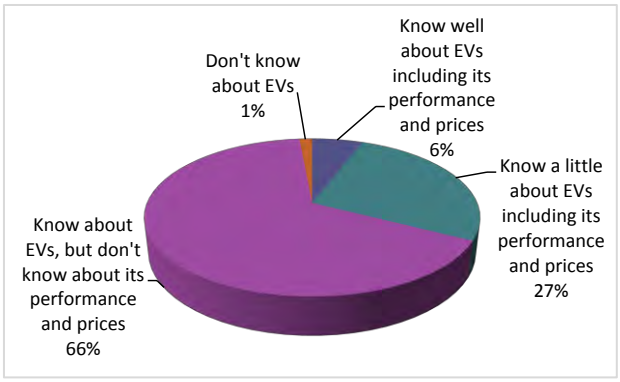
Source: US patent 6104160

5) Action 3: Information and Education Campaign (IEC)

4.123 While EV is still at experimental stage in many countries, EV is not properly understood by the people. Although EVs are relatively popular through mass media in Japan, many people just know the presence of EVs. Only 33% of people answered that they also know the price of EVs and how it works. (see Figure 4.7.11) Furthermore, the saving fuel cost is one of the benefits to use EVs. However, about 80% of people do not

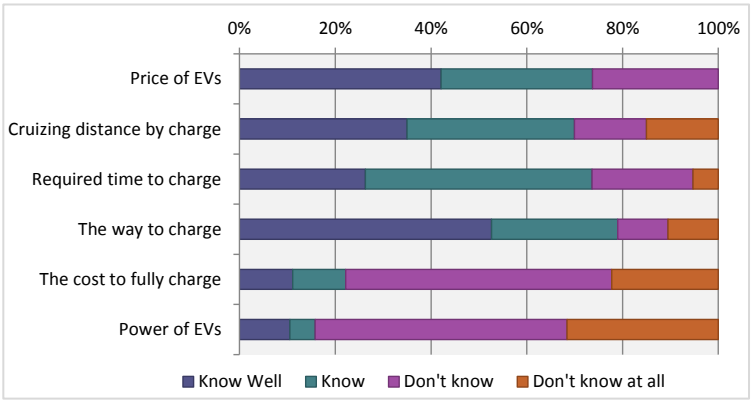
know how much it costs to charge EVs fully. Thus it must need to put a lot of effort to promote and enhance people understanding on EVs.

Figure 4.7.11 Recognition of EVs in Japan (Nagasaki Prefecture)



Source: EV/PHV Town Master Plan of Nagasaki Prefecture

Figure 4.7.12 Understanding of People on EVs in Japan (Nagasaki Prefecture)



Source: EV/PHV Town Master Plan of Nagasaki Prefecture

4.124 In Lao PDR, the recognition level on EVs was clarified through Transport Attitude Survey by the Study Team. As a result, many people do not know the presence of EVs and PHEVs. Even they know about EVs and PHEVs, they do not know how it works. On the other hand, e-motorcycle is relatively well-known compared to EVs and PHEVs. Chinese e-motorcycles are already used in Lao PDR, so that many people know about it. (see Table 4.7.10) The similar results were also seen in Hanoi, Vietnam. More than 50% of people know about e-motorcycles and e-bicycles. Moreover, they also have correct knowledge about performance of e-motorcycles in general.

Table 4.7.10 Recognition of EVs in Lao PDR

	Don't Know	Know only Name	Know how it Works	Total
EV	67.5	25.3	7.2	100
PHEV	81.9	14.4	3.7	100
E-motorcycle	37.1	45.7	17.2	100

Source: Transport Attitude Survey by JICA Study Team (2012)

4.125 **Strategic Approach to Knowledge Dissemination:** The introduction of low emission transport in Lao PDR is no different from the diffusion of new ideas and technology in other countries. Everett Rogers, a professor of rural sociology, who pioneered research on, and published a book (Diffusion of Innovations) on it, categorized the five stages of the diffusion process as: knowledge, persuasion, decision,

implementation, and confirmation.

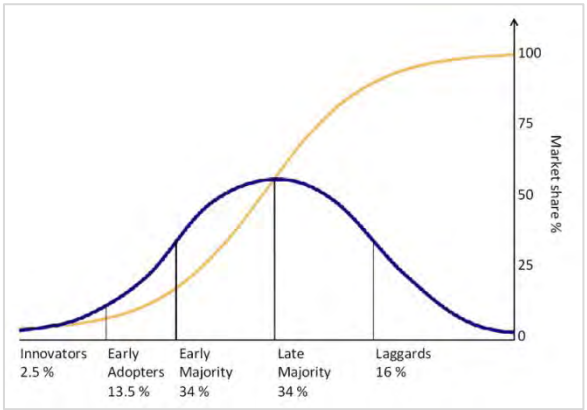
Table 4.7.11 Five Stages of the Adoption Process

Stage	Definition
Knowledge	In this stage the individual is first exposed to an innovation but lacks information about the innovation. During this stage of the process the individual has not been inspired to find more information about the innovation.
Persuasion	In this stage the individual is interested in the innovation and actively seeks information/detail about the innovation.
Decision	In this stage the individual takes the concept of the change and weighs the advantages/disadvantages of using the innovation and decides whether to adopt or reject the innovation.
Implementation	In this stage the individual employs the innovation to a varying degree depending on the situation. During this stage the individual determines the usefulness of the innovation and may search for further information about it.
Confirmation	Although the name of this stage may be misleading, in this stage the individual finalizes his/her decision to continue using the innovation and may end up using it to its fullest potential.

Source: Diffusion of Innovations (Everett Rogers, 1962)

4.126 In theory, information about the low emission transport has to be communicated to as many people of Lao PDR as possible through various channels (TV, prints, internet, billboards, bulletins, pamphlets, etc.), and at various times and occasions, so that he gains knowledge (1st stage). The awareness stage can be re-enforced through actual trials or driving of demonstration vehicles, those interested would seek additional information and may be persuaded to adopt EV. In reality, there would only be few 'early adopters' at the start. But if these small groups are Opinion Leaders in society – such as high government officials, business executives, civic leaders, etc. - they could influence the others with their positive (or negative) information about low emission transport. Thus, the IEC will be more effective at the beginning if it target a select group of leaders and individuals with the characteristics of being 'early adopters'. Once a critical mass in number of EV users is reached, the speed of adoption accelerates and becomes self-sustaining, following the well-known Logistic curve shown on Figure 4.7.13.

Figure 4.7.13 Technology Adoption Life Cycle



Source: Diffusion of Innovations (Everett Rogers, 1962)

4.127 Information dissemination and building awareness of EV can be done sorely by public government administration; but it is suggested, empirically, to set-up a public and private partnership, a committee, a council, a user consultation group, whatever the form is, to formulate information dissemination strategies and plans aiming at describing strategies and activities for effectively promoting EV. In order to effectively deploy information and education campaign, it is also essential to identify target audience, potential dissemination tools and channels to which address effective messages.

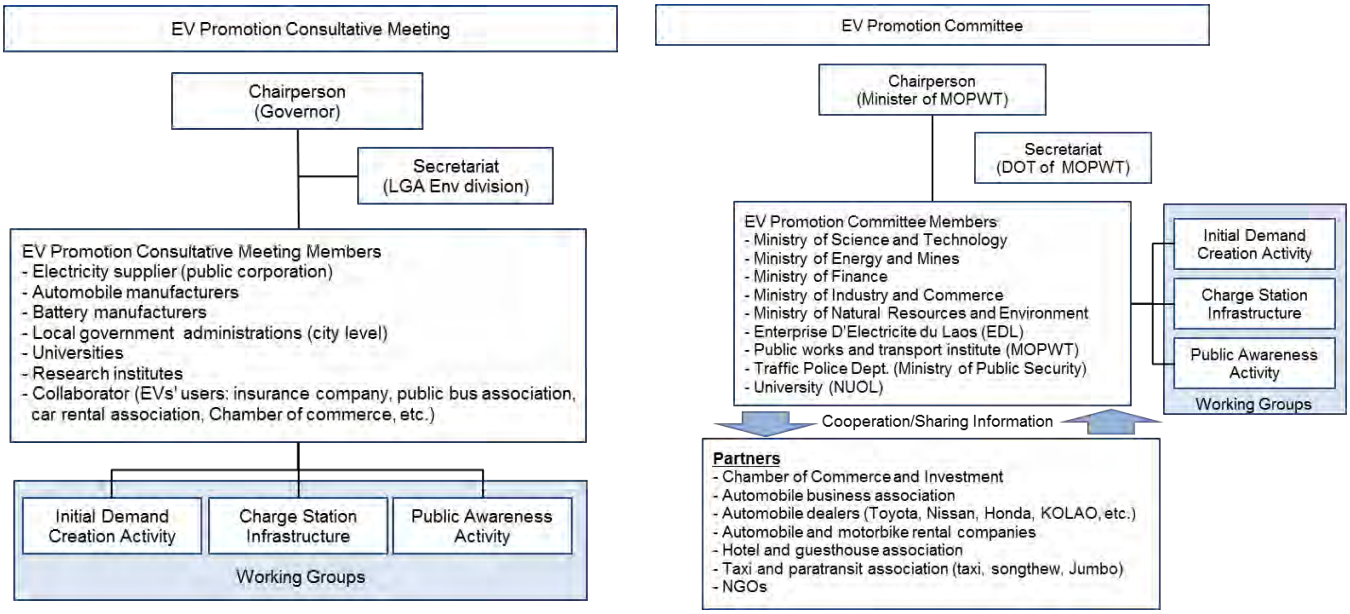
4.128 In case of Japan, the first Eight EV/PHEV Towns have set up a driving force system, a committee, council, partnership team; the name differs but the objectives and main functions of those institutions are alike. They usually consist of local government administrations, private companies, such as automobile manufacturers, battery manufacturers, electricity supplier (public corporation, in case of Japan), public transport service suppliers, universities, research institutes and NGOs. A typical organization set-up is shown in Figure 4.7.14. It is chaired by a governor of local government administration, at the province level in most cases, and one division, normally from environment or energy agency, will take the tasks of being a secretariat (see Table 4.7.12). Under the committee, there are working groups, divided by interests of the members and also activities, such as charging station infrastructure development, ITS infrastructure, zero carbon tourism projects, and so on. Figure on the right-hand shows a possible institutional set-up at national level in Lao PDR. Unlike Japanese case, governmental agencies will play more significant roles in the introduction stage of EVs, since there is no strong driving force, like automobile industry, in Lao PDR.

Table 4.7.12 Institutional Set-up of the First Eight EV/PHEV Towns in Japan

		Aichi	Aomori	Kanagawa	Kyoto	Tokyo	Nagasaki	Niigata	Fukui
Implementation body	Local government	✔	✔	✔	✔	✔	✔	✔	✔
	Auto manufacturer	✔	✔	✔	✔	✔	✔	✔	✔
	Electric utility	✔	✔	✔	✔	✔	✔	✔	✔
	Battery manufacturer	-	✔	✔	✔	-	✔	-	-
	University/Research institute	-	✔	✔	✔	-	✔	✔	✔
	Others	✔	✔	✔	✔	✔	✔	✔	✔

Source: Best Practice of EV/PHEV Town, Action Plan of each EV/PHEV Town

Figure 4.7.14 Example of EV Promotion Body and Possible Institutional Set-up in Lao PDR



Source: JICA Study Team

4.129 Needless to say, ICE activities are continuous process to achieve widespread public awareness of EV's technologies and benefits, which results will facilitate current potential users to choose EVs, and possibly next generations to favor EVs over gasoline vehicles; therefore, it is indispensable to clearly identify target stakeholders for ICE

activities. Target audience can be identified as shown in Table 4.7.13.

Table 4.7.13 Target Audience

Audience Type	List of the interested relevant target audience
Decision makers	National assembly members
Central government administration	All ministries and committees
Sub-national government administration	Vientiane, Luang Prabang, Savannakhet, Pakse
Automobile dealers	Toyota, Nissan, Honda, KOLAO, Hyundai, etc.
Automobile workshops	Automobile dealers' workshops
Public transport service providers	VTE bus corporation, taxi and paratransit association
Car rental company	Europcar, Chaleunxay Rental Service, etc.
Freight carrier, logistics company	DHL, OCS, UPS, Fedex, Lao Freight Forwarder (TNT)
Hotel and guesthouse	Hotel and guesthouse association, registered hotels and guesthouses
Tourism industry	Tourism association, travel agent association
Academics	National University of Laos, etc.
End users and residents	Residents in Vientiane, Luang Prabang, Savannakhet and Pakse

Source: JICA Study Team

4.130 Information dissemination shall be clearly expressed in concrete terms to reach potential audience. Different dissemination tools and channels shall be used to approach different target audience. Addressing different information dissemination and communication tools to specific targets encourage the establishment of an effective and continuous information flow, involving a wider community as much as possible. For example, study reports and technical papers, such as policy study, comparative study on other nation's EV promotion policy and technical specification standard shall be delivered to decision makers, governmental agencies at seminars and workshops, while EV promotion policy and action plans to be delivered by Lao Government shall be distributed through E-newsletter, press release, mass media advertisement. E-newsletter is an effective way to convey updated messages and information to business entities and associations, e.g., new technical specifications, regulations, ordinance and administrative procedures. On the other hand, paper-based newsletter is useful to distribute at specific information dissemination events, such as workshop, exhibition and test-drive event (see Table 4.7.14).

4.131 As for information sharing about technical matters among related government agencies, i.e. DOT at MOPWT, MOST and MOIC, universities and research institutes, a periodical EV conference will encourage researchers, experts and government agencies' staff to obtain cutting-edge technologies of EV and peripheral technologies. It is suggested that DOT will take a secretariat position, so the staff of DOT will be able to have more opportunities to keep themselves updated with cutting-edged technologies and to enhance their capacities through preparing for conference, i.e. selecting research papers for conference, being a moderator of subcommittee meetings, and so on.

4.132 Conventional but effective PR tool is designing a logo and a mascot. They are used in almost any kinds of events nowadays, like Olympic, Expo and EV promotion (see Figure 4.7.15). A logo and mascot can be designed by local artists or maybe inviting designing ideas from the public; in that case, the public will get involved from the initial stage of PR activity, so they will have better idea about EV, once the IEC is fully implemented. The secretariat of the IEC may contact schools to encourage students to submit designing idea, or it could be proposed as a competition among schools. Teachers could teach about how environment is valuable for future generations, and how EV will benefit society, and encourage students to take a part of the activity. It is suggested,

though, that the secretariat will prepare a teaching material for teachers and some informative presentation materials to be presented to students to make them easily understand.

Table 4.7.14 Target Audience and ICE Channel

Target Audience \ Channel	E-newsletter	Press release	Exhibition, test-drive, showroom	Seminars, workshops	PR materials (leaflets, posters, demo-video)	TV commercial	Advertisement (newspaper, free paper, billboard)	Website
Decision makers (parliament members)			X	X				
Central government administration	X		X	X				
Sub-national government administration	X		X	X				
Automobile dealers	X	X		X				
Automobile workshops	X	X		X				
Public transport service providers	X	X	X	X				
Car rental companies	X	X	X	X				
Freight carriers, logistics companies	X	X	X		X			
Hotels and guesthouses	X	X	X		X			
Tourism industry	X	X	X		X			
Academics	X	X	X	X				
End users and residents	X	X	X		X	X	X	X
Teachers and students			X		X	X	X	X

Source: JICA Study Team

Figure 4.7.15 Logos for EV Campaign

“Green Mobility: Test Drive an Electric Car!” BNP Paribas (France)	Aichi Prefecture (Japan) *with Main Mascots of Aichi Expo	Aomori Prefecture (Japan)
Electric Auto Association (USA)	“Working, in partnership, toward electric future” (UK)	Association for the Promotion of Electric Vehicles (Japan)

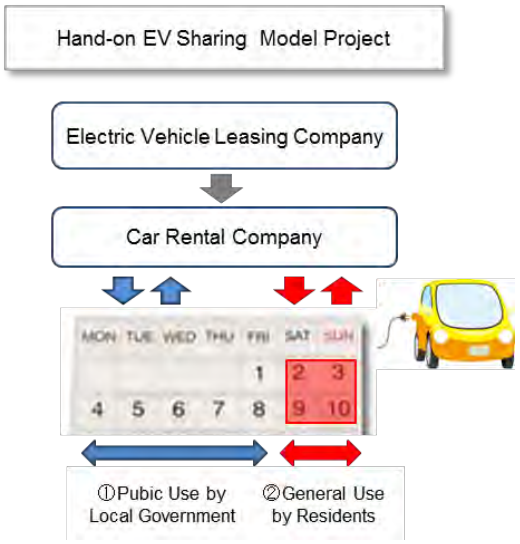
Source: compiled by JICA Study Team based on various sources

4.133 Priority adoption for public sector usage is also a popular activity conducted by EV

advanced countries as one of ICE activities. In order to create the initial demand, the adoption of EV was promoted along with the introduction of various initiatives to promote EV as a public vehicle. In addition, in some areas in Japan, local governments established a mechanism to get to take advantage of EV by car sharing, car rental, usage for taxi, in order to increase awareness of EV, in cooperation with the car rental and taxi companies. For example, Kanagawa prefecture, one of EV/PHEV Town in Japan came up with a unique EV sharing model activity. The local government uses EV as a public vehicle during weekdays, while citizens have an opportunity to rent EV in weekends and public holidays. The local government can increase public awareness by demonstrating EV daily during weekdays, while citizens interested in EV have an opportunity to try EV.

4.134 Another example, which is more educational, was conducted in Nagasaki Prefecture, targeting vocational school students studying to be automobile mechanic. EV automobile dealer sent engineers from its workshop to a vocational school and gave lecture about the mechanism of EV. Like this case, educational institutions can be one of mass target audience, e.g. elementary, junior and high schools. Traffic safety education is quite common in other countries, so maybe in conjunction with such educational activity, EV, in the context of environmental issues, can be introduced and promoted as well.

Figure 4.7.16 Hands-on EV Sharing Model Project in Japan



①Public use by Local Government

Local government rents an EV from a leasing company on lease during weekdays.

②General use by residents

Residents rent an EV from a car rental company, which contracts with the leasing company, where leases same EV to the local government during weekdays.

One EV can be utilized by separating the leasing contracts, one to the local government and another to a car rental company.

Source: JICA Study Team

Proposed Actions

4.135 As EV is a new type of vehicle and requires proper handling manner to maximize the benefits of EV, it is necessary to promote social recognition and understanding of the people on EV and its proper use. Proposed actions include followings;

(i) Establish common database on EVs by “preparatory low emission transport taskforce”;

(ii) Provide and disseminate the data and information on EVs to stakeholders through website, media, handbooks, campaigns, meetings and workshops, etc.; and,

(iii) Include alternative vehicles/EVs in school curriculum.

6) Action 4: Public-Private Partnership (PPP) in EV Development

4.136 To a country inured in socialist mold of governance, the concept of public-private

partnership in the development of Lao transport infrastructure may seem strange. It is, however, not without precedents. The Nam Theun 2 Hydropower project was built through a partnership with public company Lao Holding State Enterprise, private company Italian-Thai Development Public Company Ltd. of Thailand, and independent power producer Electricity Generating Public Company Ltd. of Thailand (which has both public and private shareholders). This is the largest public-private hydro project built and one of the largest internationally financed projects in Asia since the 1997 financial crisis.

4.137 There are many reasons why PPP is particularly suited to Lao EV development. One, the government does not have the financial and technical resources to invest in this kind of undertaking. Neither can it afford to grant generous subsidies to the few citizens who can afford a motor vehicle. Majority of the Laotians do not own (as yet) a motorcycle, much less a 4-wheel car. Two, the technology is rapidly evolving and the government is not equip to evaluate the competing options and select the most effective and economical one for the country. Three, the private sector can bring in the desired management and technical expertise that is not currently available within the public sector, or will take long lead time if made available. Four, the demand for EV or for public transport is still at its infancy, and therefore would necessitate appropriate risk sharing between Public and Private Sector parties in order to materialize.

4.138 Lao PDR is also not in a position to follow the PPP example of Singapore, which partnered with Mitsubishi Motors of Japan to pilot EV cars in the city with seed money of 20 million SGD. The City is providing a test-bed for Mitsubishi and other suppliers to deploy a number of electric cars, presumably for use by selected individuals willing to participate in the pilot test.]

Opportunities for PPP in Laos EV

4.139 For Lao PDR, the project most amenable to PPP arrangement is in the area of public transport. A private entity can be granted a concession to supply, finance, operate, and maintain a fleet of, say 20 e-minibuses (10-12 passengers). The route or service area can be defined in Vientiane, or in such cities as Luang Prabang and Savannakhet. Ideally, the operator should recover his investments by charging fares. However, the market is still undeveloped and commercial risk is too high for the venture to be bankable. The government could mitigate this risk, by guaranteeing a minimum revenue threshold; this can be done through a fixed payment for every trip or by vehicle-kilometer for a period of 10 years. At the end of the concession period, ownership of the assets is transferred to the government. Implicitly, the government subsidizes this kind of arrangement – which it would do, in any case, whether under public or private. Under a PPP deal, the resulting subsidy would likely end up lower. The technology risk is assumed by the private sector, as it is in a better position to handle the whole-of-life management of the assets. A similar project can be implemented in the capital city of Savannakhet province.

4.140 A shuttle service – using EV minibus or EV-tuktuks – to serve tourists in the heritage site of Luang Prabang is also a suitable project for implementation via PPP. The EVs can be designed to showcase, if not reflect, the culture of Lao PDR. As a UNESCO heritage site, making EV the exclusive transport mode will re-enforce and enhance the town's unique appeal and conservation ethos.

4.141 A grass-root model of PPP arrangement can be conceptualized in the deployment of e-tuktuks. A cooperative of Tuktuk owner-drivers can be organized as to be the recipient of a new fleet of e-trike (to replace their old and gas-guzzling, units). The

acquisition price shall be subsidized by the government, but the cooperative will take care of paying back the government part of the cost of the unit – say, over 5 years. It collects the daily rental payments from its members. Once the member is able to complete a specified number of payments (60 monthly payments), ownership of the unit is transferred to the member. The cooperative or association takes care of the charging station in their service area of operation, coordinates the operating schedules as well as vehicle maintenance.

Proposed Actions

4.142 Although it is quite clear that there will be no success without active participation of private sector including individuals, community, domestic and foreign firms and other investors, it is necessary for government to establish adequate institutional mechanism and to facilitate investment and participation of private sector in EV development and service provision. Main actions include following;

(i) Prepare and update list and profile of EV projects and actions to guide investments;

(ii) Establish one-stop window for EVs related investments; and,

(iii) Provide necessary support including technical issues, communication, access to funding, etc.

7) Action 5: International Aid and Cooperation

(1) International Aid

4.143 Lao PDR relies on external sources on EV technologies, products, information, operation and management. The situation has been quickly changing while Lao PDR must adopt and extract the most appropriate inputs to realize the envisioned EV system. It is important to establish a proper network for information update, research, human resource development, technological improvement, regulations and standards setting, investment promotion at different levels such as government, academic organizations and private sectors.

4.144 The presence of many ODA entities in Lao PDR is both a boon and a bane. It is a boon in the sense that it gives a poor country access to cheap or no-cost financial and technical resources that would otherwise not be available. On the other hand, it can also be a bane in that it could engender an array of confusing technologies and approaches that could derail the diffusion process. This is highly possible, because these bilateral and multilateral aid agencies are not immune from the intense rivalries of global car manufacturers. Therefore, it is important for the success of low emission transport to harness their cooperation – and coordinate their contributions.

4.145 ASEAN is a regional body in which Lao PDR is a member, and which can be tapped on low emission transport. It can initiate a discussions on low emission transport policies and strategies among member countries, propose the establishment of a data base for sharing of information, and set up a network of research and development centers on low emission transport.

(2) Academic Society

4.146 Cooperation through the channel of academic society is another way to extend international cooperation. In Asia, Eastern Asia Society for Transportation Studies is one of the prominent academic societies for transportation and Lao PDR has its domestic charter already with 21 members. The contact person of Lao-EASTS is an officer of DOT,

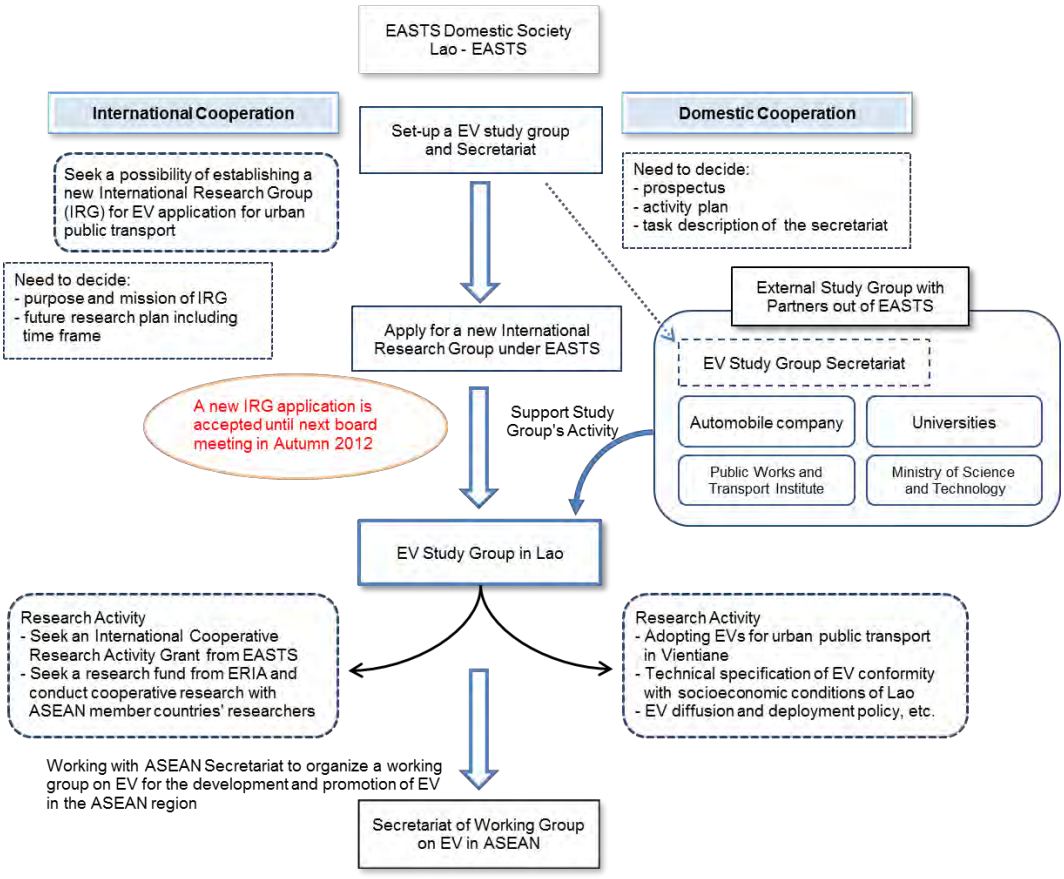
so it is convenient for DOT to establish a study group for EV; yet, it is identified through a hearing that the society is not much active nowadays, so major revitalization is necessary.

4.147 It is suggested to set up a study group first within the Lao-EASTS to start EV related activities. Outside of the society, an external study group, as partners of the study group, shall be also set up to discuss issues in broad. The members could be from automobile dealers, universities and relevant governmental agencies.

4.148 After establishing the study group, the domestic charter could seek a possibility of applying for a new international research group (IRG) to EASTS. The application requires naming researchers, so the study group is expected to build a human network with researchers abroad to form the group in advance. For that, professors and practitioners who joined the Study Team may support the study group. Association for the Promotion of Electric Vehicles in Japan can be the focal point to support networking as well as supporting research activities.

4.149 Once the study group is accepted as IRG, it can seek a research fund from international cooperative research activity grant from EASTS, and may possibly start talking with ERIA to initiate a cooperative research on EV in the context of the energy or environmental issue in ASEAN region, with neighboring countries.

Figure 4.7.17 Conceptual Flow of EV Study Group Set-up



Source: JICA Study Team

4.150 Although some universities in Indonesia, Thailand, Singapore and the Philippines seem to have already started researches on EV, there is no network among universities in ASEAN countries, so far. The government of Singapore is implementing an EV operation test with Mitsubishi Motors, and ADB supports the government to extend new E-trike in

the Philippines, so more or less, there must be some seminars or workshops conducted in those countries to present the research outputs, but information of those are not available. By initiating an EV networking, Lao PDR could take a leadership in this field, and organize a region-wide EV development and promotion committee.

Proposed Actions

4.151 Proposed actions to meet the objective of the strategy includes following;

(i) Establish channels to coordinate with related organizations internationally for exchange of information and experts;

(ii) Organize international conferences/workshops and events on EVs; and,

(iii) Establish an EV research and development center in close coordination with ASEAN and EV developed countries.

8) Action 6: EV Introduction Strategies by Region

4.152 It is a long-term vision that EV is introduced across the country. It is not limited to certain specific areas such as tourist sites, city center nor to specific activities such as delivery and public utilities services. It is intended that EV as a core component of EST is expected to replace existing transport activities based on ICE with those of EV. With a clean energy source of Lao PDR which is few in the world, nation-wide EV will make transport sector of Lao PDR almost entirely free from emission.

4.153 In order to formulate EV development directions in Lao PDR, the entire land can be broadly classified to (i) urban areas, (ii) rural/mountainous areas, (iii) tourist sites/specific activity areas, and (iv) main transport corridors. With this, areas with different characteristics can be integrated each other by main transport corridors. (see Figure 4.7.18) They are briefly as follows;

(a) Urban areas: Cities and urban areas are the space with the best fit for introduction of EV. They include large cities such as Vientiane Capital, medium-sized cities such as Luang Prabang, Savannakhet, Pakse and other small ones. EV development directions in urban areas must focus on the following;

  (i) Expansion and improvement of public transport including conventional paratransit with government initiatives;

  (ii) Facilitation of shift from ICE private vehicles to EV through incentives and regulations; and,

  (iii) Integration of EV development measures with overall urban transport infrastructure and stakeholders to facilitate understanding and proper use of EV.

(b) Transport corridors: Main roads are composed of national and provincial roads including the areas along the roads. Those main roads play very important role to support long-distance trip by low emission transport, especially EVs. EVs still have a disadvantage for long-distance trip. The cruising range by a charge is very limited (about 100km/charge). The presence of charging stations along the main transport corridors can realize the long-distance trip by EVs. It is advisable to develop charging stations at least each 10 - 20km to make comfortable environment for EVs users.

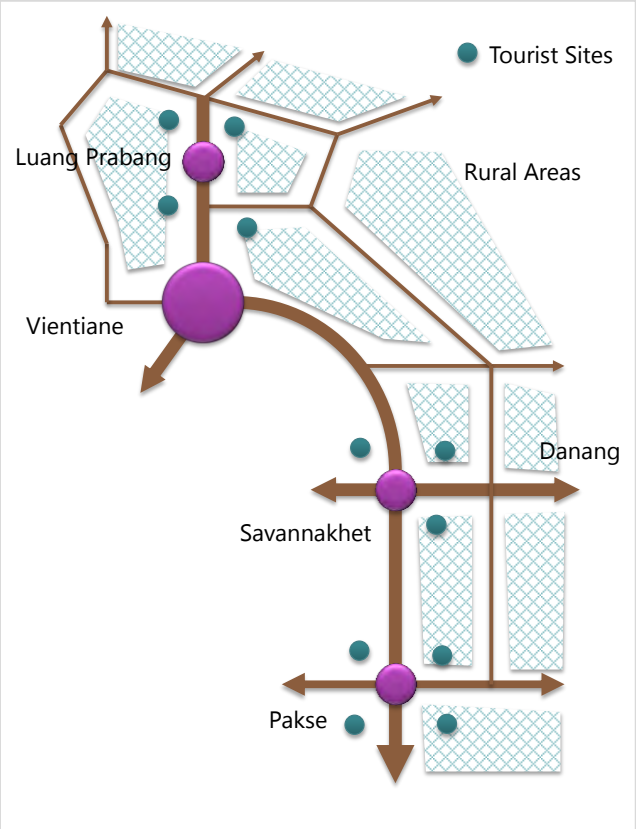
(c) Rural area: In rural areas, some of villages do not have access to the national electricity grid. Therefore, small hydropower plant or other kinds of renewable energy plant can be utilized as shared charging stations. The types of low emission transport

also differ from that in urban centers. EVs can be introduced not only as transport modes but also agricultural machineries to develop agricultural activities.

(d) Tourism area: EV introduction strategies for tourism sites should be formulated in consideration of balance between tourism development and improvement of living environment for residents.

4.154 EV introduction and promotion plan should be composed of development goals and visions, objectives, concrete targets, development strategies, development actions, concrete projects and implementation measures. Formulating plans is not the purpose. The plans have to be implemented. The neighboring countries, especially China, try to introduce EVs to Lao PDR. Without development vision of area, introducing EVs by many organizations may create disordered city or area. However, if Lao government takes time to formulate plans, it will be too late to implement it when the plan is finalized. It is recommended that the framework of development direction for low emission transport introduction should be formulated and shared first, and then put detail later together with taking actions for introducing EVs.

Figure 4.7.18 Classified Spatial Structure for EV Introduction



Source: JICA Study Team

9) Action 7: Effective Model Projects Design and Implementation

4.155 Implementation of model projects have the following objectives;

(i) To examine economic and financial feasibility of EV introduction: Results of economic and financial analysis needs to be proof in the actual conditions;

(ii) To obtain inputs to establish institutional framework: The experiences of other countries can be model to establish institutional framework. However, those institutional framework needs to be rearranged to fit Lao PDR condition through

model projects;

(iii) To facilitate human resource development: Before going to full-fledged stage, human resource should be developed and trained to facilitate EV introduction and promotion. Human resource includes not only government officers but also vehicle drivers (private and public), mechanic and technician, management board for individual projects, etc.; and,

(iv) To examine and promote social acceptance: It is very difficult to understand properly what EVs are unless people see and experience actual EVs. As a promotion method, implementation of model projects is very efficient.

4.156 In order to achieve the above objectives, the model projects have symbolism, social acceptance, economy, industrial linkage, appropriate technology, infrastructure development, financial viability and positive environmental impact. As basic orientations for designing model projects, the government plays as facilitator to encourage private and individual to participate. At the same time, ODA should be effectively introduced for technical assistance and funding. Furthermore, considering the next introduction stage (diffusion stage), the model projects can be replicable, scale-up and applicable to other areas in the country.

10) Assessment on Proposed Actions

4.157 Proposed actions were evaluated by the stakeholders through questionnaire survey (see ***Appendix 4.2***).

4.158 Introduction and promotion of EVs in Lao PDR is new concept for the country, so that the main concern of people is actions at early stage such as organizing taskforce and formulating strategies and plans. So Action 1.1 “Organize “preparatory low emission transport taskforce””, Action 1.2 “Prepare a Master Plan”, and Action 2.1 “Prepare EV infrastructure plan” have high importance. In strategy 3, people understand the necessity of promotion activities to get social acceptance while they are not sure the importance of learning EVs in the school to develop human resources for new types of EVs.

4.159 Regarding the cooperation with private sector and international organizations, people understand its big challenge for them, so that it is important to have cooperation with private sector and international organization. However, they do not have any clear idea how to carry the EV introduction and promotion. On the other hand, private sector put high importance, high adequacy and high priority for Strategy 4 “PPP in EV Development”.

4.160 Many people think that EVs are not suitable for unpaved roads and slope, and that EVs are vehicle for urban areas. Therefore, people selected urban centers and main roads as important locations to introduce EVs. The designing and implementing model projects will come after policy and plan formulation and other preparation, so that the priority of Strategy 7 is relatively low.

4.161 Several people answered negatively to most of the strategies and actions. However, there is not specific organization or agency that has negative attitude to introduce EVs in Lao PDR.

Table 4.7.15 Assessment on Proposed Strategies and Actions (% of respondents)

Proposed Strategies and Actions		Importance		
		Low	Middle	High
Action 1: Policy Formulation and Capacity Building	1.1 Organize "preparatory low emission transport taskforce"	2.1	12.8	85.1
	1.2 Prepare a Master Plan	2.1	8.5	89.4
	1.3 Work on ASEAN Secretariat	6.7	26.7	66.7
Action 2: EV Infrastructure Development	2.1 Prepare EV infrastructure plan	6.5	8.7	84.8
	2.2 Prepare a guideline for private sector investment	7.3	17.1	75.6
Action3: Information and Education Campaign	3.1 Establish common database on EVs	4.2	22.9	72.9
	3.2 Provide the data and information	4.2	22.9	72.9
	3.3 Include alternative fuel vehicle/EV in school curriculum	11.1	31.1	57.8
Action 4: PPP in EV Development	4.1 Prepare and update list and profile of EV projects	4.3	19.6	76.1
	4.2 Establish one-stop window	14.3	19.0	66.7
	4.3 Provide necessary support awareness	6.4	8.5	85.1
Action 5: International Aid and Cooperation	5.1 Establish channels to international organizations	11.9	16.7	71.4
	5.2 Organize international conferences, etc.	9.5	19.0	71.4
	5.3 Establish a EV R&D center	4.7	23.3	72.1
Action 6: EV Introduction Strategies by Region	6.1 To formulate EV plan for main urban centers	5.1	17.9	76.9
	6.2 To formulate EV plan for main roads	8.5	8.5	83.0
	6.3 To formulate EV plan for rural areas	13.3	31.1	55.6
Action 7: Effective Model Projects Design and Implementation		15.4	30.8	53.8

Source: JICA Study Team

11) Road Map of EVs Introduction Strategies

4.162 The EVs introduction stages are divided into three; preparatory stage (2013 - 2015), diffusion stage (2016 - 2020) and full-fledged development stage (2021 - 2030). The vehicle industries are not active in Lao PDR, so that the government should lead the EV introduction. However, in the full-fledged development stage, it is expected that the private sector will take lead to propagate EVs further. The main activities in each stage are as follows (see Table 4.7.16).

(i) **Preparatory stage:** Main activities are composed of establishing EV introducing organizations including a low emission transport preparatory taskforce, collecting EV related information such as EV introduction conditions in other countries, drafting EV related regulations, developing the government capacities to implement EV projects, preparing for model projects. EV related regulations and standards include technical standards and safety standards on EVs, service standards of public transport system, guidelines for model projects, and so on.

(ii) **Diffusion stage:** Main activities are implementing model project, EV promotion campaign, developing EV infrastructures, finalizing EV related regulations, shifting from preparatory committee to official committee, and establishing framework for PPP. Those activities promote social acceptance and develop basic infrastructures for EV diffusion.

(iii) **Full-fledged development stage:** In this stage, EVs will be really propagated with EV uses by citizens and increase in investment in EV introduction by private enterprises.

Table 4.7.16 Road Map for EVs Introduction

Actions		2013-15 Preparatory Stage	2016-20 Diffusion Stage	2021-30 Full-fledged Development
Target % of EV (all types of vehicles)		7%	39%	81%
Actions	1. Policy formulation, institution building, EV taskforce			
	2. Infrastructure development including charging facilities, road improvement, traffic management			
	3. Information, education campaign			
	4. Public private partnership			
	5. International coordination			
	6. Regional Strategy on EV introduction			
	7. Model projects design and implementation			
Role-sharing		Government		Private Sector

Source: JICA Study Team

5. REVIEW OF SOCIO-ECONOMIC, ENVIRONMENTAL AND TRANSPROT CONDITIONS IN LAO PDR

5.1 Vientiane Capital

1) Overview

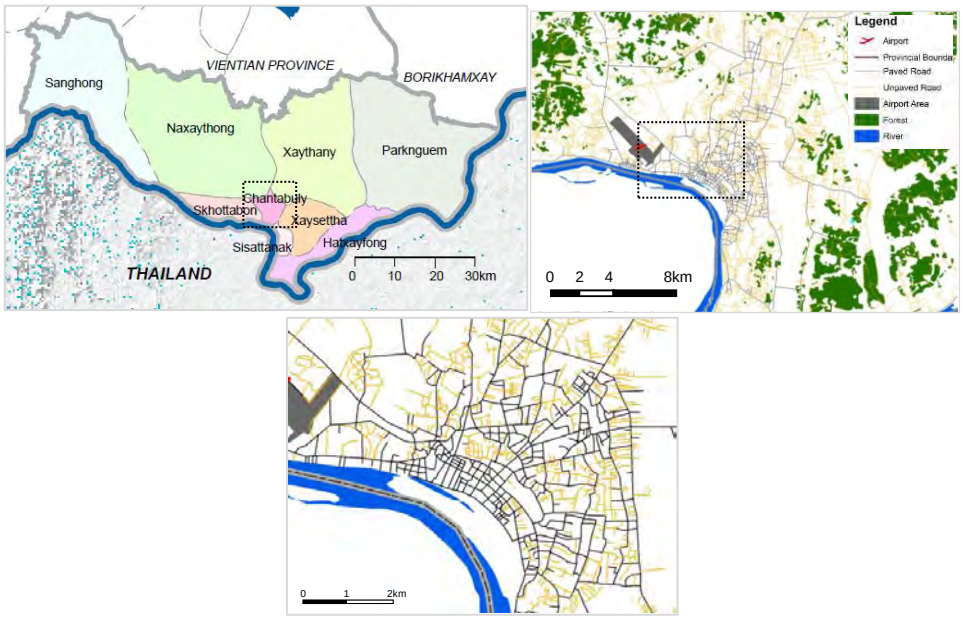
5.1 Vientiane Capital is the capital of Lao PDR as well as the economic center of country, which locates in the northern part of Central Region. It borders Vientiane Province, Borikhamxay and Nong Khai Province and Loei Province of Thailand. (see Figure 5.1.1) The land of Vientiane Capital is relatively flat with 160 – 180m elevation. And there are three major rivers, namely the Mekong River, the Nam Ngum River and the Nam Ton River. These rivers play an important role for the drainage system of the capital. Furthermore, Vientiane Capital is also rich in natural environment including two National Protected Areas and four Provincial Protected Areas located within the boundaries of Vientiane Capital City covering 28.4 % of its total surface area (1,111 km^2).

5.2 Vientiane Capital has a tropical monsoon climate with two seasons; rainy season (May to October) and the dry season (November to April). The temperature is relatively stable through a year (25 °C to 30 °C in average). Annual rainfalls have fluctuated between 1,500 - 2,200 mm/year over the last decade, and more than 35% of total rainfall concentrated in August. Floods seldom caused due to the rainfall. According to the HIS survey by JICA Study (2010), only 5% of households in Vientiane have experienced a flood.

5.3 Vientiane Capital is the largest city in Lao PDR in terms of population and area (840,500 people and 3,920 km^2), which functions as administrative capital and economic center of the country. Vientiane Capital is composed of nine districts with 491 villages. Vientiane Capital became a capital of Lao PDR since 1867 when French arrived at Vientiane and rebuilt the city. Vientiane Capital used to be a part of Vientiane Province, but it was split off from the province in 1989.

5.4 In 2010, the 6S (secure (SaNgob), lighted (Savang), clean (Sa-ad), green (Sikhiao), civilized (Sivilay) and charm (Sa-ne)) was officially launched as slogan of Vientiane. Although Vientiane Capital is the capital of Lao PDR, the city is still far from hustle and bustle. Aside from ancient temples and French colonial style architecture, the charm of Vientiane is simplicity of lifestyle and unpretentious approach to life. Vientiane aims to develop tourism sector utilizing those strengths of the city together with its slogan.

Figure 5.1.1 Location of Vientiane Capital



Source: JICA Study Team

Table 5.1.1 Basic Urban Indicator of Vientiane Capital

Indicators				2005	2010
Area (km^2)				3,807	3,920
Population	000			691.7	840.5
	Annual Growth Rate (%/year)			2.8	4.0
Economy	GRDP (LAK billion@ 2005 price)			9,764	15,569[1)]
	Sector Share (%)	Primary		20.6	15.0[1)]
		Secondary		48.2	45.5[1)]
		Tertiary		31.2	39.5[1)]
	Per Capita (LAK million@ 2005 price)			14.0	20.6[1)]
	Main Industry			-	Food and beverage
Socio	Poor Household Rate (%)			-	0.2
	Unemployment Rate (%)			-	-
Infrastructure	Water Supply	Household coverage (%)		40.1	47.0
	Electricity	Household coverage (%)		97.0	98.4
	Public Service	Village with Primary Healthcare (%)		13.6	-
		Village with Primary School (%)		11.2	-
	Transport	Urban Road (km)		-	503.6
		Vehicle Ownership	MC	144,507	309,659
			Car	43,220	93,681
		Public Transport	No. of bus fleet[2)]	48	36
			No. of bus route[2)]	13	8
			No. of tuktuk	3,695	3,439
Governance	Revenue and Expenditure[3)]	Revenue	Total (LAK million)	999,147	496,704[1)]
			Independent source (%)	-	-
		Expenditure	Total (LAK million)	5,462916	231,602[1)]
			Public investment (%)	0.5	31.5[1)]
	Organization	No. of village		499	491
Consumer Price	Gasoline (LAK/l)			7,840	8,790
	Electric Tariff (LAK/kWh)			-	559
	Bus Fare (LAK/ride)			-	3,500

Source: Statistical Yearbook 2010 of Vientiane Capital, 7th SEDP of Vientiane, Decide Info, information from relevant agencies
1) data in 2009, 2) data of Vientiane State Bus Enterprise only

2) Socio-economic Condition

5.5 **Population:** The population of Vientiane Capital has increased dramatically from 691,721 in 2005 to 840,489 in 2010. The rapid increase in population is largely a result of internal migration. About 40% of the population in Vientiane Capital is in-migrants from other provinces. Most of the immigrants traveled from Vientiane, Xiengkhuang and Huaphan Provinces to search for better life in the Capital City. Although the population density in inner urban areas is still low, i.e. only less than 3,000 person/km^2, urban sprawl can be seen from the higher population growth rate of outer urban area in the period of 1995 – 2005. One of the reasons for people to live in suburban area is lower land price of those areas.

Table 5.1.2 Population Distribution and Growth in Vientiane Capital

		Area (km^2)	Population			Distribution (%)			AGR (%)		Population Density (person/km^2)
			1995	2005	2010	1995	2005	2010	'95 -'05	'05 - '10	
Inner Urban	Chanthabuly	29	58,855	68,858	83,667	11.2	10.0	10.0	1.6	4.0	2,885
	Sisattanak	31	58,178	68,686	83,458	11.1	9.9	9.9	1.7	4.0	2,692
Outer Urban	Sikhottabong	140	74,251	99,908	121,395	14.2	14.4	14.4	3.0	4.0	867
	Xaysettha	147	75,255	97,514	118,487	14.4	14.1	14.1	2.6	4.0	806
Outer District	Naxaythong	1,131	44,104	58,368	70,921	8.4	8.4	8.4	2.8	4.0	63
	Xaythany	916	97,829	150,793	183,224	18.7	21.8	21.8	4.4	4.0	200
	Hatxayfong	258	64,962	78,338	95,186	12.4	11.3	11.3	1.9	4.0	369
	Sanghong	622	16,728	24,215	29,423	3.2	3.5	3.5	3.8	4.0	47
	Parknguem	646	33,945	45,041	54,728	6.5	6.5	6.5	2.9	4.0	85
Total		3,920	524,107	691,721	840,489	100	100	100	2.8	4.0	214

Source: LSB

5.6 **Economy:** The GRDP of Vientiane Capital increased relatively faster with 12.4% of annual growth rate. In 2009, the GRDP of Vientiane Capital reached at LAK15,569 billion (2005 price) which accounts 44.7% of the GDP in Lao PDR. Regarding the sector share, the secondary sector has had highest share since 2005. 66% of large scale factories locate in Vientiane Capital, which is mainly apparel industry. On the other hand, the sector share of tertiary sector has increased rapidly with 6.1%/year. (see Table 5.1.3)

5.7 Several major events such as SEA games, 450th Anniversary of Vientiane Capital helped to boost the economy of Vientiane Capital in term of job creation in the construction and supporting services. According to HIS by JICA Study (2010), workforce accounts 47.8% of total population of Vientiane Capital. The economic sector share of workforce is 27.6% in primary sector, 21.5% in secondary sector and 50.8% in tertiary sector, respectively. The primary sector share is quite lower than that of national average. (78.5%)

Table 5.1.3 GDRP of Vientiane Capital

		2005	2009	AGR (%/year): '05 - '09
GRDP (LAK billion, 2005 price)		9,764	15,569	12.4
Economic Sector Share	Primary	20.6	15.0	-7.6
	Secondary	48.2	45.5	-1.4
	Tertiary	31.2	39.5	6.1
GDP per capita (LAK million, 2005 price)		14.0	20.6	10.2

Source: 7th SEDP of Vientiane Capital

5.8 **Foreign Direct Investment (FDI):** FDI in Vientiane Capital was about USD795.6 million in 2009 which was five times of that in 2005. FDI in Vientiane Capital concentrated on “industry and handicraft” (29.6%) and “commerce” (29.4%). They are followed by “service” (14.0%) and “mining” (14.1%). “Industry and handicraft” and “Service” had also high share of the number of projects. Regarding the investment size of each project, “mining” is the highest with about USD18.8 million, followed by “commerce” with USD11.7 million. Main investment countries are Vietnam and China.

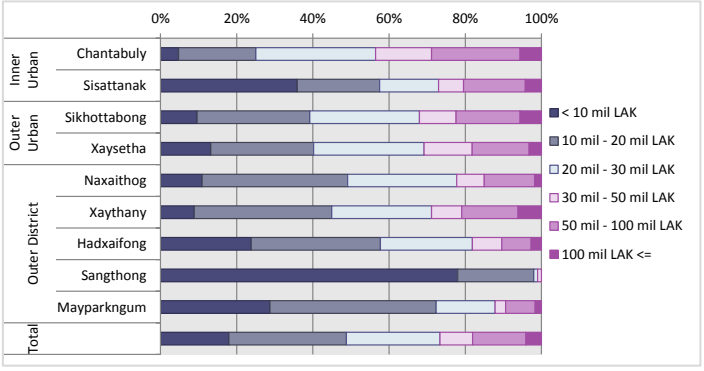
5.9 Investment environment of Vientiane Capital is better than other provinces of Lao. Therefore, the Capital has more opportunities to attract the investors. However, the competitiveness of Vientiane Capital is still very low comparing the neighboring countries.

5.10 **Tourism:** The main tourist resources in Vientiane Capital are Phou Khao Khouay National Protected Area (PKKNPA), Ban Pako Resort, several waterfalls, and the cultural and historical sites include many temples such as Pha That Luang, Patuxai, etc. Many cultural and historical sites are located in and around the city centers, but the natural sites locate more than 40km from the city center. The tourism facilities such as accommodation, restaurants, etc. are mainly located in Chantabouly District. There are 378 accommodations with 9.496 rooms in Vientiane Capital. The average occupancy rate of them is 65% in 2010.

5.11 The number of tourists to Vientiane Capital has dramatically decreased from 683,500 in 2005 to 68,900 in 2009. It may be due to open new entry ports in other provinces. Many tourists, especially tourists from neighboring countries go to other provinces directly. It affected to the tourism revenue. The tourism revenue in 2009 (about USD9.2 million) was less than 1/6 of that in 2005, which is only 12% of target in 2009 (about USD75 million). On the other hand, the tourism revenue per tourist in 2009 (USD134.2) was about 1.5 times of that in 2005 (USD87.3).

5.12 **Household Income and Poverty:** Household income is generally related to the engaged economic sectors. Therefore, the yearly household incomes in urban areas are higher than that of outer district area. The average household income is more than 35 million LAK/year in urban areas and less than 30 million LAK/year in outer district, respectively (see Figure 5.1.2). Poverty ratio of Vientiane Capital has improved gradually from 16.7% in 2002 to 15.2% in 2007 which is about half of national average (33.5% in 2002 and 27.6% in 2007, respectively). Vientiane has the second lowest poverty ratio. (The lowest is Champasack with 10.0 %.)

Figure 5.1.2 Distribution of Yearly Household Income

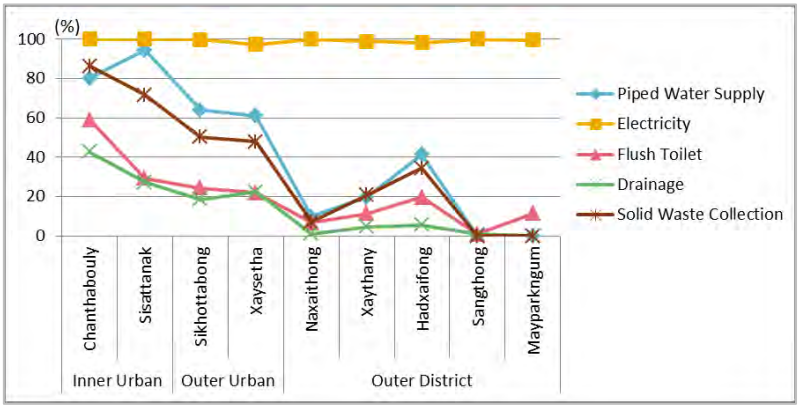


Source: The Project for Urban Development Master Plan Study in Vientiane Capital (JICA, 2010)

3) Public Service Provision

5.13 There are big gaps of public service coverage among the areas. While electric supply covers almost all districts, other public services are provided mainly in the inner urban area. Regarding electric supply, it is not stable in outer district while the service coverage is high. The coverage of drainage is not high in overall city, but the most of household has never experienced a flood even less than 10 cm. However, 32% of resident in Hadxaifong district has experienced a flood. (see Figure 5.1.3)

Figure 5.1.3 Coverage of Public Services



Source: The Project for Urban Development Master Plan Study in Vientiane Capital (JICA, 2010)

5.14 **Power Supply:** There is no hydropower plant in Vientiane Capital. Therefore, Vientiane Capital provides the electric supply from the hydropower plants nearby such as Nam Mang 3 and Nam Lik1/2 in Vientiane Capital. Electrical grid of Vientiane Capital is composed of three kinds of transmission lines (115 kV transmission line, 230kV transmission line and 500kV transmission line) and five substations. In 2010, all villages were electrified by EDL system and 98.4% of household can access to that system.

5.15 The electric consumption of Vientiane Capital was 961 GWh in 2010 which accounts for 43.1% of the national electric consumption of Lao PDR. The energy consumption has been increased rapidly with 16.0% of annual growth rate. The revenue from power supply in Vientiane Capital was LAK558.5 billion in 2010 which accounted for 44.9% of total revenue from power supply. The tariff for electric supply follows the Central Government standard. According to HIS in 2010, household payment for power supply is 88,000 LAK/month in average. The households in urban area tend to pay more than those in suburban and rural areas.

5.16 **Water Supply:** Two type of water supply system are applied in Vientiane Capital; (i) water network system in urbanized area served by Nam Papa Vientiane Capital (NPVC) and (ii) independent wells/bore holes or small scale water networks in rural area served by resident itself or villages. Currently, the service ratios of (i) and (ii) are the same. Vientiane Capital aims to achieve 100% of water supply coverage by 2020.

5.17 Basically main water sources for drinking water in Vientiane Capital are surface water of the Mekong River, Nam Ngum River and underground water except water on the market. According to NPVC, arsenic content and salty water were found at some groundwater in Vientiane Capital. For water treatment purpose, currently, there are four water treatment plants (WTPs) and one borehole station operated by NPVC.

4) Environment Condition

5.18 With the support of DANIDA the Environmental Quality Monitoring Center was created under the Science, Technology and Environment Agency (STEA) to oversee the air quality and noise control. Air quality sampling over 2002 to 2004 for PM10 showed a range of concentrations between 40μg/m to 179μg/m and an average at 87μg/m. Compared to the 2005 WHO 24-hour guideline update (50μg/m) only 4 or 13% of the measurements comply with the standard. In 2006, CAI-Asia concluded that that PM10 may be a problem for Vientiane. Sources of particulate matter emissions include diesel powered vehicles, open fires, cooking, garbage burning, and slash and burn cultivation in the surrounding areas, plus re-suspended road dust. Air pollution is particularly noticeable in the dry season from March to May. There is no comprehensive emissions inventory, so the relative contribution of each source is unknown. Due to the lack of intensive industry mobile sources are likely to be a significant contributor to overall air pollution.

5.19 CAI-Asia also reported that only eight of 29 or 27.6% of the SO2 measurements in Vientiane complied with the WHO 24-hour guideline of 20μg/m. Therefore it was concluded that SO2 was an issue but less than PM. Measurements of NO2 did not indicate a problem.

5.20 However, there is no monitoring data of air quality of Vientiane Capital at the present. Therefore, the air pollutants emitted from vehicles are estimated based on the number of vehicles in Vientiane Capital. As a result, heavy vehicle, 2-wheeler and pick-up trucks are the main causes of air pollution. 3-wheeler is generally focused on as the causes of air pollution. However, the number of 3-wheeler is much less than others, so that the contribution to the air pollution is also less.

Table 5.1.4 Estimation of Air Pollutants from Vehicles in Vientiane Capital (2011)

		Motorcycle		Light vehicles				Heavy vehicles		Total
		2 wheels	3 wheels	Car	Pick-up	Mini van	Jeep	Goods	Passengers	
Quantity (Ton/year)	PM	0	0	0	86	14	29	364	29	522
	NOx	218	2	168	961	158	322	2,190	173	4,192
	CO	7,788	78	1,552	788	129	264	2,865	226	13,689
	THC	4,973	50	207	157	26	53	512	40	6,019
	CO_2	55,509	554	34,596	329,564	54,090	110,310	256,201	20,209	861,033
Share (%)	PM	0.0	0.0	0.0	16.5	2.7	5.5	69.7	5.5	100
	NOx	5.2	0.1	4.0	22.9	3.8	7.7	52.3	4.1	100
	CO	56.9	0.6	11.3	5.8	0.9	1.9	20.9	1.7	100
	THC	82.6	0.8	3.4	2.6	0.4	0.9	8.5	0.7	100
	CO_2	6.4	0.1	4.0	38.3	6.3	12.8	29.8	2.3	100

Source: JICA Study Team

5) Urban Development Condition

5.21 In January 2012, new Vientiane Urban Development Plan up to 2030 was approved by the Prime Minister, which was formulated by JICA Project (2010). The main objective of the master plan is to preserve the old town while building new development in the suburbs. Proposed urban structure concept is multi-core structure which controlling expansion of existing urban center with creating a few sub-centers and urban clusters. The urban center shall be specialized as a commercial and business center and for urban

residence. An urban cluster is a local urban agglomeration to provide public and commercial services to surrounding local villages. Urban development shall be limited in the designated area and other area will be designated either agricultural or conservation area.

5.22 The core urban area, which is designated at the CBD and its surrounding area, is composed of five zones, namely historic conservation zone, inner urban zone, outer urban zone, sub-center zone and outskirts zone.

5.23 The main characteristic of the urban area of Vientiane Capital is very low population density comparing to other cities in south-east Asia. The population density in the overall city is only 2 person/ha. Even that in Chantabouly District which is a center of urban area is only 29 person/ha. Although there are many temples and public land, residential and commercial areas have low-rise building, and there is no compact land use. This is one of the attractiveness of the city, but it has various problems in terms of urban development. Urban master plan of Vientiane Capital says that the future growth of population and urbanization will be immobilized by expansion of the suburban area and establishment of new urban centers (satellite cities). It does not mention to promote compact city. Other problems are as follows;

(i) It is difficult to regulate the land use which promotes urban sprawl;

(ii) The urban structure is the type of depending on the private vehicles uses. Therefore, a good plan is needed to develop public transport system; and,

(iii) Investments in infrastructures are ineffective due to expansion of low dense urban area.

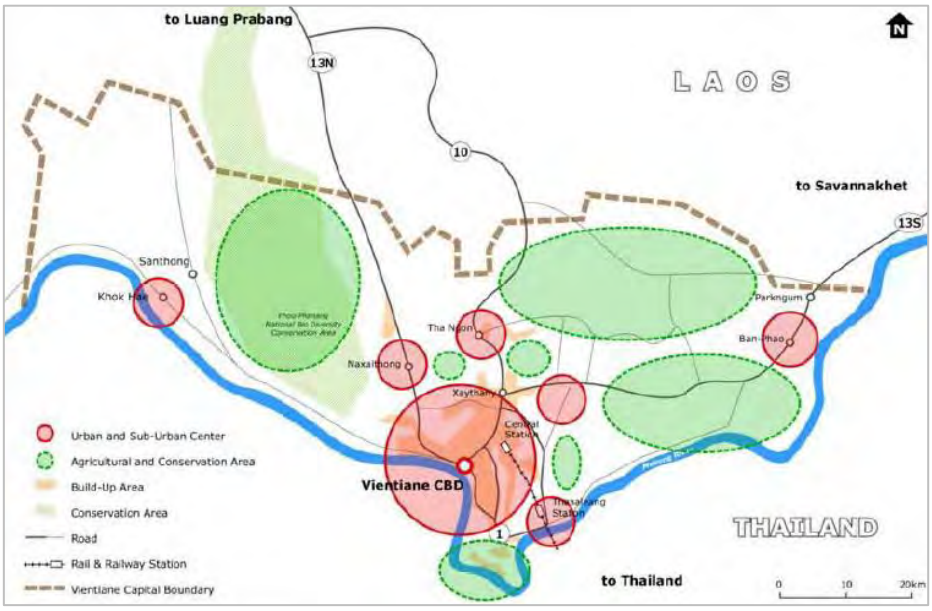
5.24 Considering the above points, it is necessary to develop the city based on the public transport system. However, the urban development should be carried in integration with public transport development. Especially, those integrated development is important in the urban center and the areas along the transport corridors.

Table 5.1.5 Characteristics of Zoning

Zone[1)]	Area (ha)	Actual (2005)		Target (2030)		Characteristics
		Population (000)	Density (pop./ha)	Population (000)	Density (pop./ha)	
Historic Conservation Zone	250	204	38	11	44	Many historical building; Densely constructed with low-rise town house
Inner Urban Zone	5,120			219	43	Newly developed area; Commercial building located along main roads; Sparsely constructed low and middle-rise town houses and villas; Greenery to be protected
Outer Urban Zone	14,540	126,212	-	300	21	Agricultural land; Urbanization rapidly increasing along the main roads; Low-rise villas; Paved main roads and unpaved dirt feeder roads; Environmentally important water surfaces; Greenery to be protected
Outskirts Zone	-		-	50	-	Overwhelmingly dominating agricultural land with typical Lao rural landscapes; Large-scale important greenery to be protected
Sub-Center Zone	10,780	48	4.5	315	29	Agricultural land; Urbanization rapidly increasing along the main roads; Newly large-scale infrastructure; Politically initiated new development; Foreign private investment

Source: The Project of Urban Development Master Plan Study in Vientiane Capital (JICA, 2010)

Figure 5.1.4 Vientiane Urban Master Plan by 2030



Source: The Project of Urban Development Master Plan Study in Vientiane Capital (JICA, 2010)

6) Transport Condition

5.25 **Vehicle Ownership:** The motorization of Vientiane Capital has been dramatically accelerated in accordance with urbanization and economic development. The number of motorcycle has highest share (74%) since 2001due to its affordability. All types of vehicles except three wheelers have increased with very high annual growth rate, which cause many transportation problems such as traffic congestion, traffic accidents, air pollution and so on. Three wheel vehicles have been prohibited to import since 2000 and to move its registration from other provinces to Vientiane Capital since 2001 due to generating high emission gas and unsafe. (see Table 5.1.6)

Table 5.1.6 No. of Vehicles in Vientiane Capital

		No. of Vehicle			Share			AGR (%/year)	
		2001	2005	2010	2001	2005	2010	'01-'05	'05-'10
Motorcycle	Motorcycle	92,475	144,507	309,659	74.0	73.2	73.9	11.8	16.5
	Three wheel	2,480	3,695	3,439	2.0	1.9	0.8	10.5	-1.4
Car	Sedan	7,744	9,437	17,683	6.2	4.8	4.2	5.1	13.4
	Pick-Up	10,204	24,353	51,618	8.2	12.3	12.3	24.3	16.2
	Mini Bus	1,661	3,507	15,955	1.3	1.8	3.8	20.5	35.4
	Jeep	2,327	5,923	8,425	1.9	3.0	2.0	26.3	7.3
Heavy Vehicle	Truck & Trailers	6,966	5,405	11,482	5.6	2.7	2.7	-6.1	16.3
	Buses	1,168	665	906	0.9	0.3	0.2	-13.1	6.4
Total		125,025	197,492	419,167	100	100	100	12.1	16.2

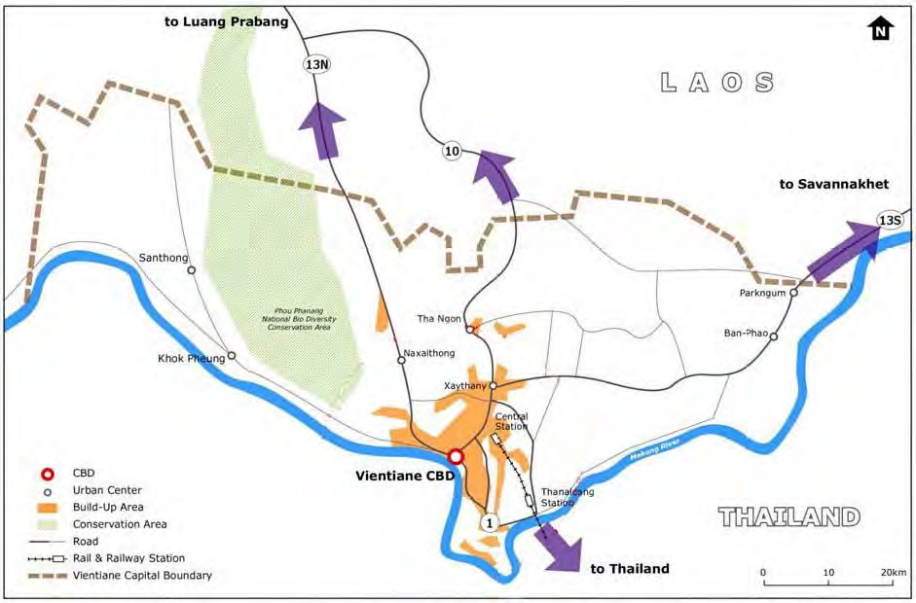
Source: MPWT

5.26 Household ownership rate of motorcycle is around 90% in all districts. While car ownership rate is higher in inner urban area (31.7%), bicycle and farm vehicle ownership rate is higher in outer district (35.5% and 34.4%, respectively). 20-30% of household owning car has more than two cars while 50-60% of household owning motorcycle has more than two motorcycles. In 2010, the average annual household income was 30 – 35 million in Vientiane Capital, and the car ownership reached more than 40% at the income level of 50 – 60 million LAK/year. The rapid economic development will boost the average household income, and much more household can afford to buy cars in near future.

5.27 **Road Network:** Urban road network in Vientiane Capital is developed to form a ring and radius roads. The radius road is formed with NR13N, NR13S, NR10 and Vientiane Road No.1, while the ring road is formed with inner ring road (5km) and outer ring road (15km) (see Figure 5.1.5).Total length of roads in Vientiane is about 2,024 km, and 51.4% of total road length is shared by main roads (national roads, provincial road and urban roads) Pavement rate is still low (only 25%). Even the pavement rate of the main road is only 43.1%. The poor road pavement condition causes difficulty of people to travel during rainy season as well as causing dust as air pollution.

5.28 **Transport Demand:** Traffic volume along some major roads in suburban increased 2 – 5 times in the period of 2007-2010. In urban area, motorcycle was accounted for more than 55% of total traffic volume in each road except Lane Xang Road in 2007. On Lane Xang Road, the total number of cars had highest share with about 42%. The presence of cars occupies more spaces of roads, so that Lane Xane Road is congested more than other roads. Regarding the hourly distribution of traffic volume, two peak hours for commute is notably seen (7 am to 9 am and 4 pm to 6 pm). There is no big difference of vehicle type share in each hour. During the peak hour, the vehicle speed was decreased less than 20 km/h.

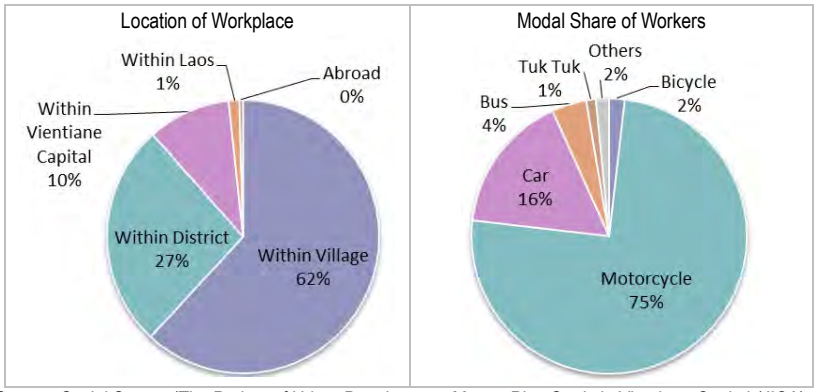
Figure 5.1.5 Main Road Network of Vientiane Capital



Source: The Project of Urban Development Master Plan Study in Vientiane Capital (JICA, 2010)

5.29 According to the Social Survey by JICA in 2010, the most of trip generation and attraction are completed within the village. More than 60% of workers and students have their workplace and school in their village. It is followed by “within district” (about 30% of both workers and students). Thus, about 90% of people do not go out of their district for commuting. The modal share of workers and students is highly shared by motorcycle excluding walking (75% of workers and 82% of students), followed by car (16% of workers and 10% of students). Public transport user is only 5% including tuktuk users. (see Figure 5.1.6) The modal share is slightly different among the districts. While the modal share of motorcycle and car is higher in urban district, public transport shares higher in the outer district.

Figure 5.1.6 Location of Workplace and Modal Share of Workers



Source: Social Survey (The Project of Urban Development Master Plan Study in Vientiane Capital (JICA), 2010)

5.30 Transport Environment was assessed through the Transport Attitude Survey by JICA Study Team. As a result, many people are satisfied with accessibility and fare of their travel condition. On the other hand, its environment and parking condition are recognized as problems. This is because of traffic congestion at peak time, dust and air pollution from the vehicles and roads, reckless driving behavior, illegal parking, etc.

Table 5.1.7 Assessment[1)] on Transport Condition by Travel Mode

	Travel Time	Safety	Environment	Accessibility	Waiting Time	Parking	Fare
Walking	25.0	8.3	66.7	33.3	25.0	25.0	8.3
Bicycle	62.5	50.0	62.5	25.0	37.5	37.5	0.0
Motorcycle	32.2	24.3	65.2	18.4	30.7	27.0	17.6
Car	0.0	33.1	57.3	28.2	51.6	50.8	20.2
Bus	22.4	50.0	50.0	25.0	25.0	75.0	25.0
Paratransit	39.4	14.7	44.1	17.6	38.2	29.4	14.7

Source: Transport Attitude Survey by JICA Study Team (2012)

1) % who answered problem/sever problem

5.31 **Public Transport System:** The public transport system in Vientiane Capital consists of public bus system operated by Vientiane Capital State Bus Enterprise (VCSBE) and paratransit such as private mini bus service, Taxi, tuktuk, Jumbo, and songthaew.

5.32 Public bus system is operated for inner-city, inter-city and international routes. The inner-city bus service is provided mainly from the Central Bus Station (CBS) to within 30km radius with 8 routes. In addition, there are 11 inter-city routes and four international routes to Thailand. In general, the occupancy rate of inner-city bus service is more than 100% when buses leave from the CBS. The fare is fixed by the route, ranging from 2,000 to 5,000 LAK/ride. Electric bus is also operated for two route with 13 electric buses made in China. The service time is relatively shorter, i.e. from 5am to 6pm. The bus service is provided in each 15 minutes to one hour. The operating number of buses is only 74.8% in total. The main causes of breakdown of the buses are older age of fleets and poor road conditions. There are about 60 mechanician in VCSBE, but they do not have desirable working environment and equipment for machines.

Figure 5.1.7 Inner-City Bus Route Network

Source: Outline Design Study Report on the Project for Improvement of Transportation Capacity of Public Bus in Vientiane Capital (JICA, 2011)

5.33 Although the most of buses were provided by grant, the balance of revenue and expenditure of VCSBE has marked low or deficit. VCSBE increased the fare in 2008 and kept the balance in the black. While the more than 95% of the revenue is from fare collection, the fuel cost accounts for more than 40% of expenditure. The fuel price decreased in 2009, so that the revenue was more than expenditure even the number of passenger reduced. However, the fuel price will increase gradually in line with the global trend, which strains the VSBC's finance more.

5.34 The bus users belong to relatively lower income group (average household income is 3 - 3.5 million LAK/year). They use buses as not only passenger transport mode, but also goods transport mode. They are relatively satisfied with the bus service, but more than 50% of bus users are unsatisfied with emission gas and noise from buses.

5.35 Paratransit is operated under each paratransit association. In 2012, there are about 600 tuktuks, about 800 Jumbo, about 500 small songthaews and about 80 Taxi under associations. While songthaew is operated along the fixed routes, tuktuk, Jumbo and taxi does not have any fixed routes. There is a fixed rate for fares, but the passengers usually need to negotiate the price. There is also the meter taxi operated by Chinese company.

5.36 The revenue of paratransit driver is about 50,000 – 100,000 LAK/day, and their spending is 20,000 – 100,000 LAK/day for fuel depending on the types of paratransit. According to the drivers, they work every day, so that they can gain 1.5 million – 3 million LAK/month which is lower than average income of Vientiane. (3 – 3.5 million LAK/month) With this mount of income, it is difficult for them to maintain their vehicles with good conditions or to buy good quality of parts.

Table 5.1.8 Income and Expenditure of Paratransit

	Revenue (LAK/day)	Fuel Cost (LAK/day)	Travel Distance (km/day)	No. of Trip	Price of Vehicle (LAK million)
Tuktuk	100,000	40,000	30 – 40	3	20
Jumbo	50,000	20,000	20	5	10
Taxi	100,000	100,000	30	5	-

Source: Interview with Paratransit Association and Paratransit drivers by JICA Study Team

5.37 **Driving Behavior:** The driving behavior was monitored using the GPS by the Study Team (see ***Appendix 1.3***). The results are as follows;

(i) Mini E-Bus: Top speed was relatively low. It was operated less than 40km/h. Maximum acceleration of electric bus was 0.15g. Total driving distance was 60.2 km/day.

(ii) Songthaew: There are two types of songthaew. One drives around 100km. Another one ran 182.2km. Accelerations of songthaew range from 0.16g to 0.39g.

(iii) Tuktuk and Jumbo: All features such as maximum speed, acceleration, driving distance and top speed were varied by vehicles.

5.38 **Transport related Industries:** The main industrial activities of vehicle related industries include second-hand car assembly plants, motorcycle assembly plants, vehicle dealers, workshop/repair shops, vehicle parts shops, and private inspection center. In 2011, there are 29 goods transport companies, 16 passenger transport companies, 14 packaging and shipping companies and 23 car rental companies in Vientiane Capital.

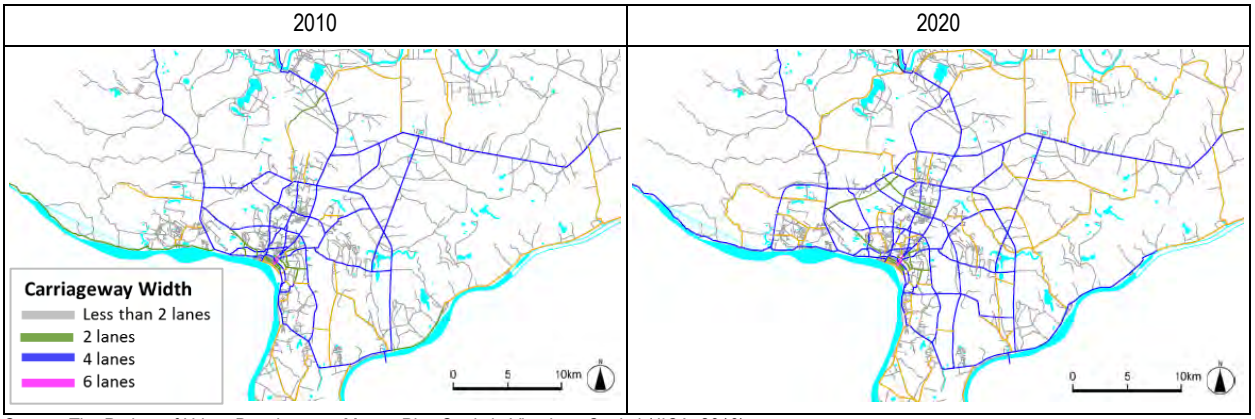
5.39 Gross output values of transport related industries are not stable in the period of 2005 – 2009, and tended to decrease. The gross out value of vehicle industry is about 1/34 of that of vehicle and spare parts commerce. While the vehicle industry accounted for only 1.2% of total industrial gross output, the vehicle and spare parts commerce shared 12.8% of the total commercial gross output. Thus, vehicle dealers, vehicle parts shops, repair shops generated much more value than vehicle assemble factories in terms of total value.

7) Transport Development Plan for Vientiane Capital

5.40 Basic development policy for urban transport is five aspects as follow;

(i) Road Network Development: In order to solve the traffic congestions in the city center, proposed road network is composed of inner and outer ring roads, and a radial road. The proposed road network can accommodate the traffic demand by 2030.

Figure 5.1.8 Future Road Network



Source: The Project of Urban Development Master Plan Study in Vientiane Capital (JICA, 2010)

(ii) Improvement of Public Transport: It is urgently necessary to provide an attractive public transport system to mitigate traffic congestion in urban area. The public transport system should be demand oriented services, high level of services.

(iii) TDM and Parking Policy: Illegal parking is one of the urgent issues in the central area. In order to solve this as well as reduce private car use, it is necessary to specify areas where parking space should be provided and areas where public transport promotion measures are introduced.

(iv) Traffic Safety Improvement: Traffic safety program needs to address traffic education to vehicle drivers, traffic safety facilities and establishment of traffic accidents database.

(v) Environmental Mitigation: Traffic pollution should be minimized through strict enforcement of emission standards of vehicles, promotion of public transport use, and introduction of traffic demand management.

5.41 **ODA Project:** Main on-going or committed transport projects by ODA are as follows.

Table 5.1.9 ODA Projects in Vientiane Capital

	Contents/Objectives
The Project to Enhance the Capacity of Vientiane Capital State Bus Enterprise (JICA)	This project is implemented to improve service quality of urban bus service and to contribute to extend the bus service. In addition, pilot program for public bus transport and experiment of BRT will be implemented during the project.
Clean Air for Smaller Cities in the ASEAN Region (GIZ)	This project aims to empower local governments of smaller cities to develop and implement "Clean Air Action Plans (CAP)" in order to improve living conditions. CAP includes the key issues and challenges facing Vientiane's air quality now and in the future.
Vientiane Sustainable Urban Transport Project (ADB)	The project will focus on three components (i) supporting the establishment and operation of a pilot environmentally sustainable transport agency, (ii) pilot public shuttle bus loops and facilities, and (iii) a demonstration traffic management scheme including a parking structure and facilities.

Source: MPWT, DPWT

8) Summary of Urban Transport Issues

5.42 There are many transport issues in Vientiane, and the transport issue is always interrelated each other. The main issues in Vientiane are as follows;

(i) Traffic congestion in the peak-hour of morning and evening has become serious along the major roads in accordance with increase in the number of vehicles. Especially, the increase in the number of car occupies more space in the roads.

(ii) The lack of road network and poor road conditions lessen the mobility of people. There is only certain number of transport routes to access/through the city center. Therefore, the traffic is concentrated on those routes. The poor road pavement condition causes the difficulty of travel during the rainy seasons.

(iii) The lack of parking facilities makes people to park along the road side and sidewalk which block other vehicle users and pedestrians. The parking along the roadside also deteriorates the streetscape.

(iv) Insufficient public transport system increases the private vehicle users, and the decrease in the public transport users fall the quality of service of public transport service more.

(v) Use of old vehicle, non-maintenance vehicles and low quality of fuel Increases the traffic pollution such as emission gas, noise and vibration which affects to the human health.

(vi) Many traffic accidents are occurred due to vehicle drivers who have poor driving skills, no traffic safety awareness, and so on. Lack of strong traffic enforcement allow to those situation. However, at the same time, the low education level of people creates many undisciplined drivers.

(vii) Lack of traffic enforcement and regulation causes the traffic accidents, traffic pollutions and other traffic problems. Implementation of strong traffic enforcement requires the strong commitment of the governments and understanding of residents.

(viii) Gross output value of vehicle related industries lacks an economic stability. And lack of car assembly factory delay the supply of cars to customers. In order to stabilize this kind of industry, the human resource development is essential as well as issue of the incentives for the investors.

5.43 Transport Needs are also identified by the residents in Vientiane through Traffic Attitude Survey by JICA Study Team. The needs on providing street lighting and incentives for alternative fuel vehicle are high in all travel modes, followed by developing drainage and main roads. Pedestrian concerns more about traffic safety facilities than others. From the view point of high need on incentive for alternative fuel vehicle, people feel the necessity of alternative fuel vehicles for Vientiane. If they have incentive to buy and use for that, it is expected that the alternative fuel vehicle can be propagated.

5.44 Introducing low-emission transport system cannot solve all transport issues, but it can approach above issues directly or indirectly. It is clear that the direct impact of low-emission transport system is to improve the air environment and to save fuel for transport. Indirect impact is that the introduction of low-emission transport system can be a trigger to reorganize the transport system in Vientiane including public transport systems, parking systems, entry regulation and others. People's need of public transport system is still low, because the image of public transport on people is very bad, i.e. unpunctual, poor accessibility, low frequency, poor driver's behavior, etc. However, it is necessary for the society to reduce traffic congestions, to provide equal opportunities to travel for all people, to avoid provision of unnecessary transport facilities such as parking space, and so on. The introduction of low-emission public transport system may attract the people's interest. If the good service can be provided together with low-emission transport system, it is expected that people continue to use public transport system.

5.45 In terms of saving energy, it is good for residents as well as government. Introducing low-emission transport system to government vehicles can save the government budget to use for other purposes. There are many kinds of government vehicles in Vientiane including officer's vehicles, patrol vehicles, ambulance, garbage collection vehicles, etc.

Table 5.1.10 Transport Development Needs

			Walking	Bicycle	Motorcycle	Car	Bus	Paratransit	Truck	Total
Road Facility	1) Main road		58.3	75.0	68.5	73.4	50.0	77.9	100.0	70.9
	2) Minor road		66.7	75.0	61.0	56.5	0.0	57.4	100.0	59.4
	3) Pavement		0.0	37.5	50.2	43.5	50.0	58.8	350.0	49.5
	4) Drainage		75.0	62.5	73.8	75.8	75.0	75.0	100.0	74.4
Traffic Management	5) Traffic signal		41.7	62.5	62.5	67.7	50.0	64.7	100.0	63.7
	6) Safety facility		75.0	50.0	61.0	58.1	50.0	51.5	0.0	58.8
	7) Lane marking		75.0	50.0	53.9	58.9	50.0	55.9	0.0	55.7
	8) Traffic control/enforcement		75.0	87.5	66.7	59.7	50.0	66.2	50.0	65.2
	9) Driving manner		58.3	37.5	61.8	58.1	50.0	42.6	100.0	57.7
Parking	10) Parking space	a. On-road	50.0	100.0	61.4	68.5	50.0	48.5	100.0	61.9
		b. Off-road	58.3	87.5	61.8	63.7	50.0	42.6	100.0	60.0
	11) Parking facilities with fee		41.7	37.5	28.5	35.5	0.0	19.1	50.0	29.3
Public Transport Improvement	12) Tuktuk/Jumbo		58.3	75.0	52.8	62.9	25.0	42.6	100.0	54.4
	13) Songthaew		58.3	75.0	47.6	48.4	50.0	35.3	50.0	46.8
	14) Taxi		33.3	50.0	33.0	34.7	75.0	27.9	0.0	33.2
	15) Bus	a. Small	41.7	62.5	54.3	57.3	50.0	27.9	50.0	51.1
		b. Large	16.7	50.0	53.9	50.8	50.0	30.9	50.0	48.9
NMT Condition	16) Walking	a. More sidewalk	58.3	37.5	56.2	50.8	75.0	41.2	0.0	52.4
		b. Walking condition	75.0	50.0	43.8	37.1	75.0	35.3	0.0	41.9
		c. Street lighting	83.3	87.5	79.8	75.0	75.0	89.7	50.0	80.0
		d. Trees/Shade	33.3	62.5	61.8	67.7	75.0	72.1	100.0	64.3
	17) Bicycle	a. Bicycle lane	50.0	37.5	44.2	41.1	75.0	32.4	0.0	41.9
		b. Safe parking	66.7	75.0	53.6	59.7	75.0	57.4	0.0	56.3
Improvement of Vehicle Condition	18) Vehicle inspection		58.3	62.5	68.5	62.9	75.0	66.2	50.0	66.4
	19) Registration control		66.7	75.0	67.4	62.9	75.0	60.3	50.0	65.4
	20) Incentive for alternative fuel vehicle		83.3	87.5	82.0	86.3	100.0	86.8	100.0	84.1

Source: Transport Attitude Survey by JICA Study Team (2012)

9) EV Introduction Opportunities

5.46 Introducing EVs means that vehicles are electrified. So while EVs can improve the environmental conditions such as air pollution and noise, EV introduction cannot reduce the traffic congestion and improve traffic safety. However, EVs can bring the benefit at national level including saving import of gasoline, reducing GHG, and so on. It is important to consider EV introduction opportunities together with other measures.

5.47 The opportunities to improve transport and urban environment of Vientiane Capital by EV introduction are as follows. The model project will be formulated considering those points.

(i) Improve urban environment by introducing EVs: EVs will be introduced as a countermeasure for traffic pollution in the urban center. The urban center will be designed as E-mobility center which restricts the entry of ICE vehicles, so that EV introduction can also work on the reduction of traffic congestions.

(ii) Introduce bus priority lane which focuses on e-buses in the future: As an incentive to use EVs and public transport system, priority/exclusive lane for public transport and EVs will be installed to the main roads.

(iii) Improve people's awareness on transport environment by introducing EVs: The people's awareness on transport environment will be improved through the introduction of EVs, which can encourage people to use public transport system and/or EVs which are good for environment.

(iv) Increase attractiveness of public transport system by introducing e-paratransit: Introducing EVs to public transport system can be a trigger to improve the service level of public transport. Renewing the public transport vehicles and improving the service level can attract more people to use public transport system.

5.48 Improve commercial transport service by introducing EVs: Introducing EVs to commercial vehicles can reduce the transport expenses of enterprises as well as aiming to improve a green and clean image of enterprises.

5.2 Luang Prabang City

1) Overview

5.49 Luang Prabang City locates in the north central Lao PDR which is far from 425 km north of Vientiane Capital. The city is the capital of Luang Prabang Province, and it used to be a capital of the first Lao kingdom (Lan Xang kingdom) from 1353 onwards. There are still rich culture and unspoiled traditional architecture, so that the city was place on the UNESCO World Heritage List in 1995. Moreover, the city is a part of the ASEAN Environmentally Sustainable Cities (ESC) Network and was rewarded and ESC award in 2008 to promote its environmentally sustainable practices. The city aims to be green, clean and beautiful, and ensure safe and prosperous living environment with the world heritage in the core.

5.50 Luang Prabang features a tropical wet and dry climate under the Koppen climate classification. The wet season is from March until September, and the dry season is during the remaining five months. While the city is generally very warm throughout the year, it is noticeably cooler during December and January. The city receives approximately 1,400 mm of precipitation annually.

5.51 The city has a land area of 818 km^2, and about 2/3 of land area are rugged mountains. The city has an elevation above sea level between 240 -1,425 m. The water level of two main rivers flowing through the city (the Mekong River and the Nam Kan River) varies by the season. These rivers play very important roles for the city and the province as main water supply resources. The city also has large forest area including one district conservation forest (5,000 ha), three national protection forest (16,140 ha), five district protection forest (3,057 ha) and one regeneration forest (1,940 ha). Those natural resources are important both for residents and tourism sectors.

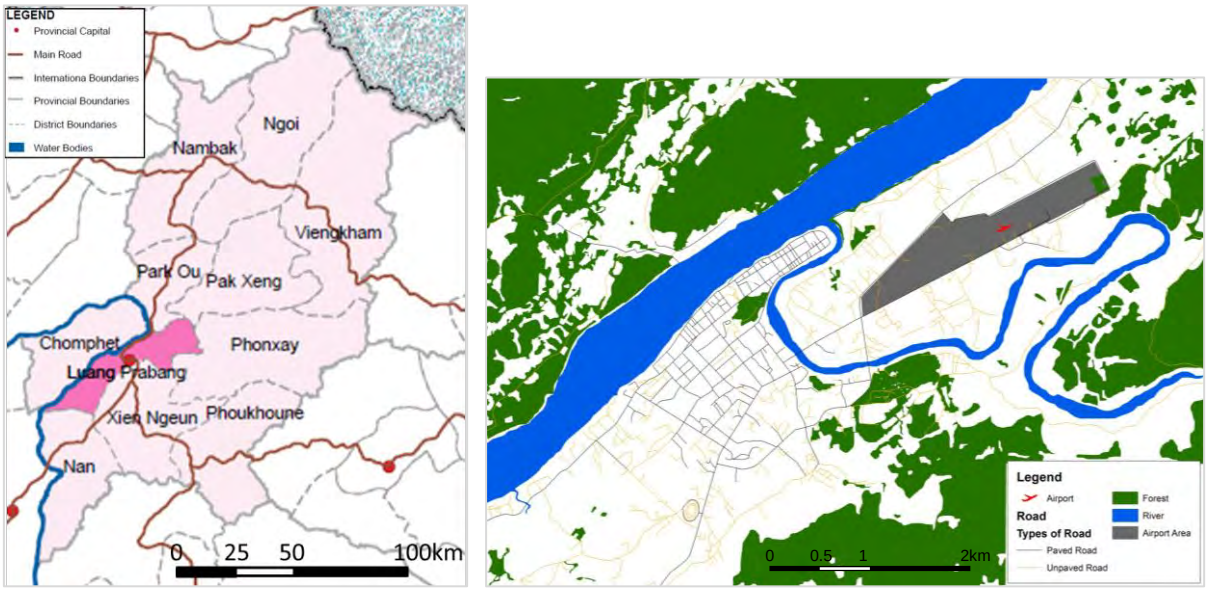
Table 5.2.1 Basic Urban Indicator of Luang Prabang City

Indicators				2005	2010
Area (km^2)				852	818
Population	000			78.5	82.0
	Annual Growth Rate (%/year)			1.05	0.9
Economy	GRDP (LAK billion @ 2005 price)			519.5	760.5[1)]
	Sector Share (%)	Primary		25.6	23.6[1)]
		Secondary		15.5	17.1[1)]
		Tertiary		58.9	59.2[1)]
	Per Capita (LAK million @ 2005 price)			6.6	9.3[1)]
	Main Industry			Tourism	Tourism
Socio	Poor Household Rate (%)			-	2.1
	Unemployment Rate (%)			-	0
Infrastructure	Water Supply	Household coverage (%)		70.0	65.8
	Electricity	Household coverage (%)		50.0	97.7
	Public Service	Village with Primary Healthcare (%)		-	83.8
		Village with Primary School (%)		43.1	88.9
	Transport	Urban Road (km)		-	64.8
		Vehicle Ownership	MC	3,348	8,963
			Car	134	4,300
		Public Transport	No. of bus fleet	-	532
			No. of bus route	-	25
			No. of paratransit	-	283

Indicators			2005	2010
Governance	Revenue and Expenditure[3)]	Revenue (LAK million)	4,229	7,079
		Expenditure (LAK million)	3,262	2,821
	Organization	No. of village	116	114
Consumer Price	Gasoline (LAK/l)		-	9,285
	Electric Tariff (LAK/kWh)		-	559
	Bus Fare (LAK/km)		-	255

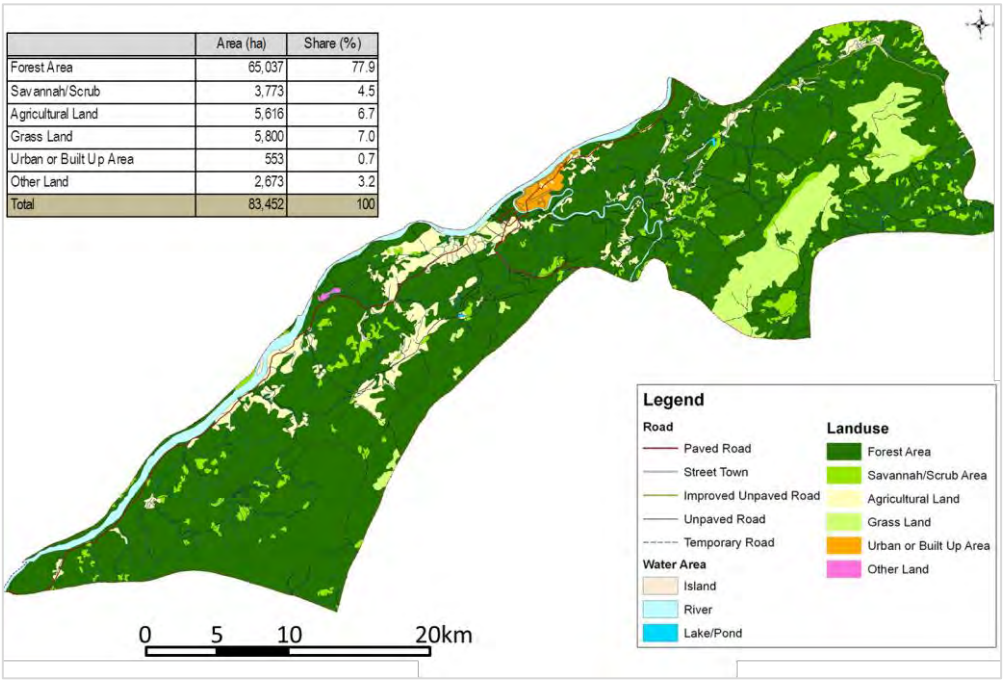
Source: Statistical Yearbook 2010 of Luang Prabang, Decide Info, information from relevant agencies
1) data on 2008, 2) data on 2004, 3) data of province

Figure 5.2.1 Location of Luang Prabang City



Source: JICA Study Team worked out based on data from DOT of MPWT and ATLAS of Laos (2005)
Note: District boundary of Luang Prabang in 2009 is not available. Phonthong District is not included in the map.

Figure 5.2.2 Land Use Condition of Luang Prabang, 2003



Source: National Geographic Department

2) Socio-economic Condition

5.52 **Population:** The population increased from 78,516 people in 2005 to 82,056 people in 2010 with 0.9% of annual growth rate. It accounted for 19.6% of the total provincial population. The main factor of population increase is in-migration from the Northern provinces. They are seeking to get better living condition. The population density was the highest in the province, which marks 100 person/km^2. However, it is still much lower than Vientiane City (830.1 person/km^2). In 2005, the size of urban area is smaller than those in rural area, but about 56% of the total population was concentrated on the urban area. In 2005, more than 32% of the total population in the city was indigenous group people. The main indigenous group in the city is Hmong, Yao and Khamu.

5.53 **Economic Condition:** In the fiscal year 2008-2009, the economic growth of Luang Prabang City marked 14.1% per year while the city GRDP achieved LAK 888 billion which accounted for 35.4% of the provincial GRDP. The sector share of the city GRDP was 24% in the primary sector, 17% in the secondary sector and 59% in the tertiary sector, respectively. Tertiary sector is the dominant sector for the city economy while the primary sector is the main economic sector for the province. Therefore, the GRDP per capita of the city (LAK 11 million) is almost double of that of the province (LAK 5.9 million).

5.54 Regarding the estimated labor share in the city, 50% of the people in the city are engaged to the tertiary sector including tourism related business, retail shops and so on. The remaining 30% is engaged to the secondary sector such as Tabaco factory and cement factory and other 20% is farmers.

5.55 **Tourism:** Since Luang Prabang city was listed as one of the World Heritage Sites, the tourism sector is the important economic activities for the city. The number of tourist arrivals at Luang Prabang Airport increased dramatically from 33,000 people to 78,000 people in the period of 2005 – 2010. The main tourism sites in Luang Prabang City are the ancient town of Luang Prabang, Tad Kuang Si Waterfall, Tham Ting Caves and other natural and historical sites. Regarding the tourism facilities, there are 41 hotels and over 202 guesthouses while 44 hotels and 209 guesthouses in the province. Thus, most hotels and guesthouses locate in the city. The room occupancy rates were relatively stable at about 65-70% in the period of 2003 – 2010.

5.56 **Private Investment:** The service sector received about 59% of the private investment (USD58.8 million) for the province in 2008. This is because the tourism sector in Luang Prabang City has been raised as one of the key private investment sectors.

5.57 **Poverty Condition:** The poor household rate in the city was 2.1% with 300 household in 2010. Of which, the poor household rate in the urban area was 0.4% while that in the rural area was 5.7%. The poor household rate varied by the village group also, which mainly belong to Hmong people. Their housing condition is very poor, and they are usually engaged to agricultural sector or cleaners of hotels, etc. While they have sewing skill of traditional craft, they can earn only 3,000 LAK from small product which takes one day to make.

5.58 **Education:** In general, all residents can easily access to the education services. However, the quality of education varies by the area, and 11 villages with 497 households do not have the primary school in the village. The urban area has better education quality,

so that many people who live in the suburban go to school in the urban area. The literacy rate is generally low in the village with higher population rate of ethnic minority groups. For the higher education, there are two universities (public and private) and 16 vocational schools. Souphanouvong University (national university) has four faculties composed of education, agriculture and forestry, economy and tourism and engineering. The vocation schools have courses for mechanic and technic, agriculture, finance, nurse, etc.

5.59 **Healthcare:** The accessibility to the healthcare service is quite different among the area. There are three hospitals and nine clinics, but generally these hospitals and clinics locate in the urban area. In order that all people can access to the primary healthcare, in general, village has a service of medical box or pharmacy at least. However, 19 villages with 6,758 people still cannot access to even those service. Furthermore, the residents in the remote area are hard to access to those services due to lack of road network to hospitals or clinics.

5.60 **Water Supply:** Population coverage of water supply in 2009 was 65.8% which decreased from 70.0% in 2005. This is also still lower than the national target of water supply by 2020 (80%). Water supply is provided from two main water treatment plants (Phou Phueng water and Pahnum water treatment plant). Phou Phueng water treatment plant has 9,000 m^3/day of capacity from spring water during rainy season. Pahnum water treatment plant has 6,000 m^3/day of capacity from the Khan River. This plant is under expansion to add 7,000 m^3/day to its capacity by loan from local bank. Although the city has two water treatment plants for water supply, the city faces on the water supply problems such as the water supply capacity reduction during the dry seasons. In addition, there is a remarkable increase in demands of water due to increasing population in the city famous for tourism, so that it is expected that serious lack of water will occur in near future.

5.61 **Power Supply:** Power supply for Luang Prabang Province is generated at four dams. In 2012, the power supply coverage of the city is 100% which was dramatically increased from 50% in 2005. However, the capacity of power supply is not enough. Power failure is occurred 2 – 5 times in a month due to some accidents such as tree falling on the transmission line. In order to increase capacity, there are three hydropower projects have already started in Luang Prabang Province. In addition to these hydropower plants, Luang Prabang Province will be able to get power supply from the coal power plant in Xayabouly Province in the future which is on-going project.

5.62 **Drainage and Sewerage:** The current system of sewerage and drainage rely on the onsite septic facilities only. There is no wastewater collection system or wastewater treatment plant currently. The situation is worsening during the rainy seasons, especially in lower areas where the underground water level is high or the absorption capacity of the ground cannot cope with discharged rate of wastewater. Without a proper wastewater treatment plant and sewerage and drainage system, the environmental conditions of the city are threat for tourist as well as citizens. This is very concerned situation as a World Heritage City. However, Master Plan will be prepared with financial support of AFD.

5.63 **Solid Waste Management:** Urban Development and Administrative Authority (UDAA) is in charge of solid waste management. The solid waste collection service by UDAA covers 56 villages (47.9% of the total village) with 2 solid waste collection trucks. The solid waste is transported to the final disposal site at km 8 after collection. UDAA

partially subcontracts with two private companies for solid waste collection, namely Luang Prabang Sa Ad Co. (2 solid waste collection trucks) and SaynamKhan Sa Ad Co (2 solid waste collection trucks). The solid waste is collected once to twice a week. The estimated waste disposal amount is 45 tons/day. The main budget source of the solid waste collection service is service tariff paid by households. However, it is not enough to provide a service in actual condition.

5.64 Besides solid waste collection services, recycling shops collect recyclable material such plastic bottles, metals and so on. The primary markets for those recyclables are China and Vietnam. Market for compose and organic material is not yet developed.

5.65 **Environmental Pollutions:** The main environmental pollutions in the city are air pollution and noise. Air pollution is caused due to slash-and-burn farming during the dry season. Noise comes from the entertainment and restaurant along NR 13.

5.66 **Natural Disasters:** The city has not faced on any serious natural disaster, but the water level of the Mekong River and the Nam Khan River becomes high and water flow into the city which causes flood in the area along the rivers. Another factor of flood is disposed garbage or waste wood stuck in the drainage pipe which causes inflow of waste water to the some roads and houses during the rainy season.

5.67 Regarding the inundation flood in the peninsular area due to the storm, roadside drains and road surface convey storm water to the rivers. The gratings along the riverbank road can drain the flooding water smoothly to the rivers with short duration of inundation. On the other hand, in the hinterland along the road with flat area in the western areas, the storm water has been frequently stagnant and flooding due to poor water drainage capacity.

5.68 **Living Condition:** In general, people are satisfied with their living condition, because most of them can access to the public services and facilities. However, the issues on the living environment depends on the area, which is summarized as follows;

Table 5.2.2 Issues on Living Environment

	Issues
Urban Core	- Lack of sewerage due to reforming many houses to guesthouse - Crowded city center due to the higher demand on limited land - Insufficient wastewater treatment and solid waste management. - Noise pollution, dust and odor from canals.
Urban Area	- Some problems as urban core (wastewater, solid waste, noise, dust, etc.) - Traffic congestion along the national road and around market - Decrease in green space/pond/marsh by converting to construction land - Poor condition of drainage due to disturbance by construction. - Unpaved roads due to lack of fund - Poor coverage of clean toilet
Fringe	- Similar to urban area - Construction without permission. - Conversion of rice fields to construction areas. - Poor road condition (unpaved, lack of drainage)
Rural area	- Inappropriate compensation for the construction - Lack of solid waste management and wastewater - Lack of appropriate toilet facilities

Source: DPWT

3) Urban Development Condition

5.69 Luang Prabang City is composed of a compact urban center and low density development area of fridge and rural areas. While the urban center including the protected area is well managed, the disordered development has been started in the fringe area due to internal and external development pressures. The residents also concern about the disparity of living condition between urban and rural areas, harmonization between traditional life style and modern life style, lack of information on the direction of urban development, and so on.

5.70 It is expected that the number of tourists and investment will increase, but its sustainability is threatened. In this situation, formulating the urban development strategy of Luang Prabang City is the important policy issue. The basic direction of urban development will be to increase the capacity of accommodating tourists together with preserving the environment of urban center, and to build the foundation to sustain the growth of the city together with improving the living conditions. The carrying capacity of the city can increase by integration of protection area, buffer zone which surrounding the core zone and neighboring tourism areas.

5.71 The main concern of residents on the living conditions are as follows;

(i) Urban center: Traffic congestions, noise, air pollution odor from the drainage due to the concentration of the various activities in the urban center. Lack of solid waste management and wastewater treatment due to renovations of accommodations such as guest houses;

(ii) Other urban area: In addition to the problem in the urban center, traffic congestions, reduction of green areas due to development activities, deterioration of road conditions, and lack of sanitary toilet;

(iii) Suburban area: illegal development activities, development of paddy fields, and poor condition of roads; and,

(iv) Rural area: In appropriate compensation for the development, lack of waste management and toilet.

4) Transport Condition

5.72 The transport system in the city is composed of road transport, inland water transport and aviation. The road network of the city includes NR 13, several provincial roads and other local roads. Inland waterway is composed of the Mekong River and the Khan River. The Luang Prabang airport located in the north of the city.

5.73 **Land Transport:** The road network of the city is composed of NR 13, provincial roads, urban roads, rural roads and special roads. In the urban area, the road network was improved, especially in 2011 for the national sports. Many roads are already paved. On other hand, 6 villages in the rural area have a difficulty to access to main road during the rainy seasons.

5.74 As public transport modes, many kinds of vehicles are available for inner-city transport, inter-district, inter-province and international transport. Paratransit such as three-wheel and four-wheel tuktuk is the main public transport mode for the inner city,

which costs 5,000 – 10,000 LAK/person/ride. The residents usually have their own travel mode such as motorcycle and car. However, they also use paratransit for goods transport. Inter-district, inter-province and international buses are operated from/to northern bus terminal and southern bus terminals. Large buses are not allowed to enter the city center. Therefore, the visitors using buses need to change to other modes at the bus terminals to enter the city center. Besides those public transport modes, bicycle and motorcycle rental are common for the tourist. In general, the transport condition and public transport condition in the city are good. However, the city is crowed and more public transport mode is needed during the high-season of tourist.

Table 5.2.3 Public Transport in the City

	No. of Bus Route	No. of Vehicles	Fare
Inner-city	-	283 (paratransit)	LAK5,000 within Zone I LAK 10,000 within Zone II&III
Inter-district	12	427 (bus)	250 LAK/km
Inter-province	9 (to the north) + 1 (to Vientiane)	91 (bus)	280 LAK/km
International	4 (Vinh, Hanoi, Kunming, Chain Mai)	14 (bus)	

Source: DPWT of Luang Prabang

5.75 There is no data on the number of vehicle at the district level in Lao PDR. Table 5.2.4 shows the number of vehicle in Luang Prabang Province. According to DPWT, the number of car in the city is estimated 60% of the total number of car in the province, i.e. the total amount of sedan, pick-up, mini bus and Jeep/SUV is about 4,300 vehicles. As a result of the transport attitude survey by JICA Study Team, each household has more than one motorcycle regardless of household income level. The household with more than LAK2 million of monthly household income has more than two motorcycles. The household monthly income to afford the car is more than LAK4 million (see Table 5.2.5).

Table 5.2.4 No. of Vehicles in Luang Prabang Province by Vehicle Type, 2011

	Motorcycle		Vehicles				Heavy Vehicles		Total
	Motorcycle	Tuktuk	Sedan	Pick-Up	Mini Bus	SUV	Truck	Buses	
Luang Prabang	52,689	740	739	6,044	1,484	456	530	263	62,945

Source: DOT of MPWT

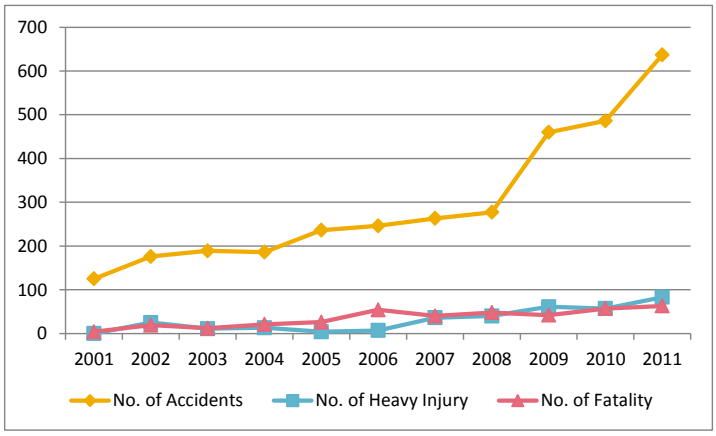
Table 5.2.5 Vehicle Ownership by Monthly Household Income Level (vehicle/household)

000 LAK/month	< 600	600 – 1,000	1,000 – 2,000	2,000 – 3,000	3,000 – 4,000	4,000 – 6,000	6,000 – 10,000	10,000<=	Total
Bicycle	0.5	0.7	0.7	0.7	0.6	0.9	0.6	0.6	0.7
Motorcycle	1.1	1.7	1.7	2.3	2.6	2.5	2.3	2.2	2.0
Car	0.1	0.2	0.2	0.4	0.6	1.0	1.0	0.4	0.4

Source: Transport Attitude Survey by JICA Study Team

5.76 The increase in the number of vehicles has increased the number of accidents from 125 in 2001 to 637 in 2011 dramatically. At the same time, the number of heavy injury and fatality has also increased.

Figure 5.2.3 Traffic Accident in Luang Prabang City



Source: LPP Environmental Management Component

5.77 In order to avoid the traffic congestion and mixed traffic in the city center, there is entrance restriction based on the size of vehicles. There are three zones as follows. As other traffic management measure, one way roads, parking control and regulation on three-wheeler (not allow to operate more than 10kms) are carried out.

Figure 5.2.4 Entrance Restriction Zone by Vehicle Size

	Zone 1	Zone 2	Zone 3
MC	< 150 cc	-	-
Bus	< 15 seats	< 25 seats	< 45 seats
Truck	< 2 T	< 5 T	< 8 T

Source: DPWT of Luang Prabang

5.78 **Inland Waterway Transport (IWT):** Inland waterway is used not only for transport mode of local people, but also for one of the tourism attractions. Especially, there is no bridge on the Mekong River, so that people needs to use slow boat to across this river. The boat can take people, motorcycles and cars.

5.79 **Aviation:** The Luang Prabang International Airport locates 4km far from the city center, which serves international and domestic flights. The airport can accommodate only 72- and 60-seat ATR aircraft with its 2,200 m long runway. The airport is under expansion by Chinese loan (more than USD86 million) which includes a new concrete runway measuring 2,900 by 45 meters and a new 9,800-square-metre terminal. The construction is planned to complete within 2013. The upgraded airport will be able to accommodate Boeing 737s and Airbus 320s.

5.80 The available flights from Luang Prabang International Airport are from/to Bangkok, Chiang May, Hanoi, Jinghong and Siem Reap as international destination, and Vientiane and Pakse as domestic destination.

5.81 In 2010, 77,978 foreigner tourists arrived at the Luang Prabang International Airport which increased rapidly from 35,257 in 2006. Of which, 15.1% was Thai people, followed by French (9.4) and UK (8.6%).

5.82 **People's Assessment on Transport:** The most of residents in Luang Prabang use a motorcycle for their commuting mode (63%), followed by walking (17%). Usually their workplace or school is in the same village or area, so that commuting time is very short. There are some congested spots at some intersections or along the NR13, but the traffic congestion does not influence on commuting time so much. (see Table 5.2.6)

Table 5.2.6 Commuting Condition of the Residents

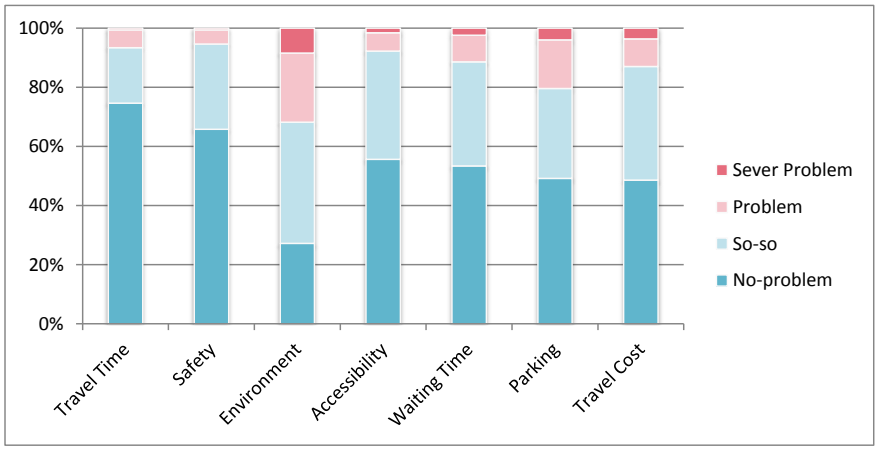
		Area			Total
		Zone 1	Zone 2	Other Village	
Commuting Mode (%)	Walking	31.8	28.3	9.6	17.1
	Bicycle	0.9	3.8	2.2	2.0
	Motorcycle	51.4	64.2	66.2	63.0
	Car	5.6	1.9	4.1	4.0
	Minibus	0.9	0	0	0.2
	Paratransit	6.6	1.9	16.6	12.3
	Truck	2.8	0	1.3	1.4
	Sub-total	100	100	100	100
Commuting Time	Normal (min)	10.9	9.6	10.2	10.4
	Congested (min)	16.6	14.6	15.2	15.5

Source: Traffic Attitude Survey by JICA Study Team (2012)

5.83 People are relatively satisfied with their travel condition including travel time, safety, accessibility, and so on, except environment. More than 20% of people assessed the travel environment as problem. Environment may include road condition, transport infrastructures such as street light, street trees, etc. (see Figure 5.2.5)

5.84 The transport development needs of the local people were identified by the transport attitude survey. The needs to install street lights and to provide incentives for alternative fuel vehicles are higher than other development measures. They are followed by improving main roads, installing street trees and shades and controlling vehicle registration. People usually have private vehicles to travel, so that the improvement and development needs for the public transport is relatively lower. Furthermore, people do not consider the importance of public transport. However, the people who do not have motorcycle or car think that it is necessary to develop or improve public transport system, especially tuktuk and small bus. (see Table 5.2.7)

Figure 5.2.5 Assessment on Travel Condition by the Residents



Source: Traffic Attitude Survey by JICA Study Team (2012)

Table 5.2.7 Transport Development Needs

Measures			Necessity (%)				Most Important Aspect (%)
			Low	Fair	High	Total	
Road Facility	1) Main road		2.8	24.8	72.4	100	48.2
	2) Minor road		6.2	32.2	61.6	100	17.6
	3) Pavement		5.8	36.6	57.6	100	16.6
	4) Drainage		12.0	18.6	69.4	100	39.2
Traffic Management	5) Traffic signal		9.2	25.4	65.4	100	35.8
	6) Safety facility		8.0	35.8	56.2	100	17
	7) Lane marking		9.0	39.8	51.2	100	13.6
	8) Traffic control/enforcement		4.0	26.4	69.6	100	32.6
	9) Driving manner		4.8	43.4	51.8	100	10
Parking	10) Parking space	a. On-road	30.4	24.4	45.2	100	16.2
		b. Off-road	25.6	38.0	36.4	100	7.6
	11) Parking facilities with fee		17.0	55.6	27.4	100	5
Public Transport Improvement	12) Tuktuk/Jumbo		14.8	45.8	39.4	100	6.4
	13) Songthaew		19.2	49.8	31.0	100	1.8
	14) Taxi		32.0	33.4	34.6	100	4
	15) Bus	a. Small	15.2	42.4	42.4	100	11
		b. Large	20.8	44.0	35.2	100	4.4
NMT Condition	16) Walking	a. More sidewalk	12.6	33.4	54.0	100	13.6
		b. Walking condition	13.6	42.6	43.8	100	4
		c. Street lighting	2.6	11.2	86.2	100	57.6
		d. Trees/Shade	5.2	20.4	74.4	100	31.4
	17) Bicycle	a. Bicycle lane	24.2	43.6	32.2	100	4
		b. Safe parking	16.8	29.8	53.4	100	9.6
Improvement of Vehicle Condition	18) Vehicle inspection		4.8	26.2	69.0	100	14.2
	19) Registration control		3.2	24.2	72.6	100	17.6
	20) Incentive for alternative fuel vehicle		83.3	7.6	91.6	100	61

Source: Transport Attitude Survey by JICA Study Team (2012)

5) Summary of Urban Transport Issues

5.85 As a result of transport attitude survey by the Study Team, the average commuting time is 10 minutes without congestion, or 15 minutes with congestions. Therefore, it can say that there is no congestion problem. So the main concerns of residents are traffic environment and parking problems. Road, drainage, traffic lights, traffic management, street lights and roadside trees have high development needs.

5.86 Considering the above and the opinion of city authorities, the transport problems of Luang Prabang City is summarized as follows;

(i) Traffic congestions along NR 13 at the peak-time in the morning and the evening;

(ii) Disordered parking in the urban center and deterioration of street scape;

(iii) Increase in the traffic accidents;

(iv) Low service coverage and service level of public transport system; and,

(v) Deterioration of pedestrian and NMT spaces and environment.

6) EV Introduction Opportunities

5.87 Luang Prabang City has small population and a small urban center, which envisions to become an environment sustainable city. The citizens also support this vision of the city. The historical heritage in the abundant nature and various traditional culture including the indigenous group and their lifestyle create the space integrated the socio-economic condition of the citizens. That space also provides the tourism sites with good quality. However, the development pressure by internal and external investment influences on the carrying capacity of Luang Prabang City. The acceleration of motorization has deteriorated no only the traffic in the core zone but also the overall living conditions. The basic development directions to approach those problems are as follows;

(1) Carrying capacity will be increased by strategic integrated development of fringe area of core zone and buffer zone, which can lessen the pressure to the core zone. Furthermore, the tourism sites in the suburban area will be developed to strength the urban and tourism network;

(2) In accordance with the above spatial development, the transport development will be advanced by EV introduction. The concrete actions are the follows;

  (i) Basically, all transport system in the city will be replaced to EVs to realize the zero emission transport system;

  (ii) The core zone will be designed as EV zone to remove the air pollution and noise. At the same time, the vehicle design will be considered to match with the street scape;

  (iii) Public transport network based on EVs will be introduced in the buffer zone to connect the core zone and the whole urban area.

  (iv) EV public transport route will be developed to connect among the communities in the suburban areas and tourism sites.

5.88 Moreover, EV services will be developed to satisfy the travel demand of users, as well as EV infrastructures and regulations will be developed to support EV services.

5.3 Kaysone Phomvihane City

1) Overview

5.89 Savannakhet or Kaysone Phomvihane is the capital of the Savannakhet Province. The city's proximity to Thailand's economy and a bridge construction has brought about new commercial development in the northern part of the city. The second Thai-Lao Friendship Bridge over the Mekong River connected to Mukdahan Province in Thailand opened in 2007. Kaysone Phomvihane has a mixed population of Lao, Thai, Vietnamese and Chinese, as well as ethnic groups from inner lands of the provinces.

5.90 Its name originally comes from Savanh Nakhone, meaning 'City of Paradise.' Fossilized remains prove dinosaurs once roamed what is now Kaysone Phomvihane, and archaeological findings suggest humans lived in the area at least 4,000 years ago.

5.91 **Topography and Hydrology:** It is situated in Khanthaboury, Kaysone Phomvihane, its geographical coordinates are 16° 33' 0" North, 104° 45' 0" East.

5.92 **Climate:** Kaysone Phomvihane features a tropical wet and dry climate, with generally very warm weather throughout the year. The city does feature warmer and cooler periods of the year, with average temperatures ranging from 22 °C in January, to 29 °C in March. Kaysone Phomvihane has discernible wet and dry seasons, with the wet season covering April through October and the dry season covering the remaining five months. The city sees on average roughly 1,500 mm of precipitation per year.

2) Socio-economic Condition

5.93 **Population:** A population of Kaysone Phomvihane in 2005 is 112,915 and 122,220 in 2011, and population density in 2011 is 1.6 person/ha. In 2005, the number of household is 19,133, and its size is about 5.8 persons per household. About 5% of the population is categorized as ethnic group in the province. In 2010, the province recorded four districts as poor, and in 2012, the number of poor district is increased to 6, encompassing 360 villages with 28,808 households. Poor villages are found along national border with Vietnam, villages with poor accessibility, damaged from the war and villages with ethnic groups.

5.94 Savannakhet province has 15 districts, 1,015 villages and 144,754 households. Estimated population in 2010 is 906,440, and the province's population density is 42 persons/km^2.[1]

5.95 **Economic Condition:** According to the SEDP Savannakhet province, GRDP in 2010 was estimated LAK6,918.55 billion, increased 10.52% per annum which exceeds the 6th five year SEDP (2006-2010) by 0.5%, in which agriculture sector increased by 7.3%, manufacturing 15.7% and service by 13.1%. The economic growth was accounted for continuous agricultural production expansion, political and social stability and domestic and foreign investment inflow.

[1] Statistical Yearbook 2010. Lao Department of Statistics. June 2011.
[2] Pakse Urban Environmental Improvement Project. ADB TA 7567-LAO. GHK International. September 2011

Table 5.3.1 GRDP per Capita in Savannakhet Province

Fiscal Year	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010
GRDP per Capita (USD/person/year)	525	587	653	801	897*

Source: The 7th Five Year SEDP (2011-2015) of Savannakhet Province. Savannakhet Province Administration. 2012.

5.96 In the past years, the provincial economy was constructively transformed to the province's economic directions, i.e., more industrialized and modernized economic structure, contracting agriculture-forestry sector and expanding manufacturing, handicraft and service sectors. The value of the agriculture-forestry sector was 49.0% reduced by 7.9%, the manufacture sector was 24.5% increased by 5.1% and service sector was 26.4% increased by 2.89%. (see Table 5.3.2).

Table 5.3.2 Economic Composition by Sector (%)

Sector	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10
Agriculture-forestry	56.98	55.54	53.97	52.38	50.73	49.04
Manufacture	19.49	20.35	21.34	22.36	23.43	24.54
Service	23.53	24.12	24.70	25.27	25.84	26.42

Source: The 7th Five Year Socioeconomic Development Plan (2011-2015) of Savannakhet Province

5.97 Savan-Seno Special Economic Zone (SEZ) is set by the Decrees of the Prime Minister on Savan-Seno Special Economic Zone (Ref. No. 148/PM, dated 29th September 2003), in order to promote economic development by use of the East-West Economic Corridor (EWEC). According to Savan-Seno SEZ, 5km of both sides of NR9 shall be designated as SEZ.

5.98 The development progress is summarized as following. Zone A: TAGS Company from Thailand is the developer for the trade and service zone. A plan was made, however, no action is yet been taken. Zone B: transportation area cleared by using public investment. 650 m earth road, electricity and water supply system and single entry service office were constructed. Zone C: industry and commerce area was developed by Pacifica Streams Development from Malaysia. The company completed 96% of site clearance, 70 ha of land leveling and 1,721 m concrete road. Zone D: the resettlement area planned to accommodate the affected people from Zone A is designated to this area. The site clearance of 80 ha was completed, equivalent to 67% of the total area, 74 houses are being constructed (222 houses in total) together with the earth road construction, install medium voltage transmission line to the area. The public investment was capitalized to the infrastructure development and land acquisition. 25 foreign companies were authorized with the investment value of 106 million US dollars and the province will continue to promote the investment.

5.99 **Labor Market:** Job creation shows a steady increase in past five years due mainly to sound domestic and foreign investment inflow to the province. Around 15,000 jobs were created in the past years. Total labor force in the province is 512,909 persons, in which 435,385 persons in agriculture-forestry sector, sharing about 84.88%, reduced by 0.12%, 20,772 persons in industry, 4.05%, increased by 1.05%, while 56,752 persons for service sector, 11.07%, increased by 1.07%. Labor force in agriculture-forestry sector is still high, while industry and service sectors have been slightly increased, which implying the trend towards industrialization. In the city, most people in service sector work at Casino or retail

shops. Large industries are located in Saybury and Vilabury districts, while medium industries, such as garment and assemble factories, are located in the city.

5.100 Skilled Development and Employment Division of the DLSW estimates around 16,000 workers in primary, 35,000 in secondary and 16,000 in tertiary sectors in the Kaysone Phomvihane. Although a provincial unemployment is recorded 0.2% in the statistical yearbook of the province, it reveals the unemployment rate in the city is unknown since the definition of unemployment is unclear to them.

5.101 In the district, there is one public technical vocational education and training (TVET) school and 7 private vocational schools. While the public schools provide wide range of course, private schools mainly focus on administrative skills to work at private companies. Demand of lobar force is more than supply in the district, so foreign investors inevitably hire foreigners to fill the labor force gap.

5.102 **Public Investment and FDI:** The past five year plan has outlined the demand of LAK11,238 billion for financing economic development, in which, LAK479.2 billion from public investment, LAK1,961 billion from official development assistance, and LAK6,297.9 billion from domestic and foreign investment, and LAK2,500 billion, respectively. The province achieved the implementation of 702 projects amounting LAK320.6 billion (including the investment along the border), with domestic fund of LAK226.1 billion, around 70.5 %.

5.103 The past five years, there were 65 projects from foreign direct investment with the value of USD691.4 million, which increased by 2.8 times in comparison with 2005. USD544.28 million for agriculture (78.7%), 55.93 million US dollars (8.1%), USD48.6 million (7.0%), and USD42.6 million for (6.2%) for energy and mines, were invested from 16 countries, mainly China, Thailand and Vietnam. The investments from local investors are growing, which represented by the issuance of investment certificate of 47 projects with the total amount of LAK350.7 billion, increased by 94% including 20 projects (30.6%) for industry, 3 projects (25.6%) for energy and mines, 10 projects (6.0%) for agriculture and forestry, 14 projects (37.8%) for service.

5.104 **Development Targets:** Overall targets towards 2020, based on the SEDP Savannakhet province, are 1) to ensure firm political stability, social security and integrated rural development, 2) to ensure economic growth, better livelihood, and foster human resource development in accordance with SME development, and 3) to enhance economic ties with bilateral and international partners. General directions set in the plan are 1) to seek strong economic growth focusing on commercial production, 2) to focus on rural development and poverty eradication and reduce gaps between rural and urban areas, 3) to emphasize sociocultural development and 4) to promote natural resource utilization as economic development driving force of the province.

5.105 The province envisages GRDP will increase by 11-12% per year. Agriculture sector will grow by 7-8%, accounting for 39.3%, manufacturing by 17-18%, accounting for 31.2% and the service by 14-15% and accounting for 29.5%. It is estimated that the provincial population will reach to 0.98 million by 2015 with average income of USD1,705, which is almost doubling annual income compared to that of 2010. By 2015, it is also expected that the province will be attract investments, accounting for 48% of GRDP, and achieve annual revenue collection around 10-13% of GRDP.

5.106 **SWOT identified in SEDP Savannakhet Province:** The SEDP identified the province's development advantages, challenges, constraints, opportunities and potentials for the seventh five-year development plan from 2011 to 2015. Table 5.3.3 summarizes SWOT identified in the SEDP.

Table 5.3.3 SWOT identified in the SEDP Savannakhet Province

Strength	Weakness
・ The east-west economic corridor and Lao PDR–Cambodia economic corridor will facilitate socioeconomic development in the next five years ・ Agriculture-forestry: abundant land resources with biodiversity ・ Industry: abundant natural resources with diverse mineral resources which can be exploited to promote processing and export.	・ Scare water resources in different areas which are a constraint for two season's cultivation, especially during dry season. Flood and drought are occurred annually. ・ The infrastructure development investment cannot response to the development needs ・ The technological application in public and private sectors is limited.
Opportunity	**Threat**
・ Transit service: the regional route, Savanh-Seno special economic zone and Dansavanh border trade area, natural tourism sites, historical and cultural value, will provide opportunities for future development.	・ Global warming and climate change will affect the livelihood of all ethnic group and threat to natural disasters. ・ Limited infrastructure development investment could slow down further economic development. ・ Reform in public administration is slow which will delay the provincial industrialization and modernization ・ Resource mobilization for human resource development is limited, and low skilled labor and low payment will discourage Lao labors to work in Lao PDR, but migrate abroad.

Source: The 7th Five Year Socioeconomic Development Plan (2011-2015) of Savannakhet Province

3) Urban Utilities

(a) Power Supply

5.107 Electric power is supplied to all 15 districts in the province, and average electric supply volume is 30w or less in rural areas. The electricity supply coverage ratio in 2011 is 90%. The remaining 10% is a new residential area, where infrastructure is not fully installed yet. A small hydropower station is under construction by Taylang Power Company from Thailand with total investment of THB200,000 million; yet, it has been delayed due to natural disaster, flood last year. Although the province has enough electric sources to supply electricity to the district, at present, electricity is imported from Thailand, Vietnam and Cambodia to meet high peak demand. In 2011, Japanese ODA was provided to extend transmission lines from the north of the province.

5.108 Regarding to renewable energy, a study was conducted by Finland. The study reveals Kaysone Phomvihane has a potential to develop wind power plant. Monitoring equipment for wind power was installed in Seno and Palawan, and will be installed in Nong district.

(b) Water Supply and Drainage System

5.109 In urban area, water supply coverage in 2000 is 70% and 79% in 2010. The status of water supply is summarized in Table 5.3.4. Waste water is directly discharged to rivers without any treatment. It was pointed out that a drainage system should be developed and improved in sub-urban and industrial areas.

Table 5.3.4 Water Supply in Kaysone Phomvihane

A Water quality	Water quality is good. Water is taken from the Mekong River.
B Water volume	In 1976, water company was established by France. - Capacity 15,000 – 70,000 m^3/day In 2003, a water supply improvement project was implemented to upgrade existing facilities. In 2011, the water supply capacity become 25,000 – 30,000 m^3/day
C Frequency of Water shortage	No water shortage in urban area in general, but electricity shortage causes water shortage sometimes. In sub-urban area, piped water is not supplied. Residents in sub-urban area get water directly from water company or fire fighters support providing water sometimes.
D Water tariff	Depending on the purpose of the usage, water tariff differs from 1,700 to 5,500 LAK/m^3.

Source: DPWT Savannakhet

4) Urban Development Condition

5.110 There is only one urban development master plan up to 2010, which was approved in 1999. JICA Study in 2010 was only a development strategy level plan, which indicates urban core development, and it was not formally endorsed by the provincial government. Table 5.3.5 shows the land-use composition of the urban area in 2009.

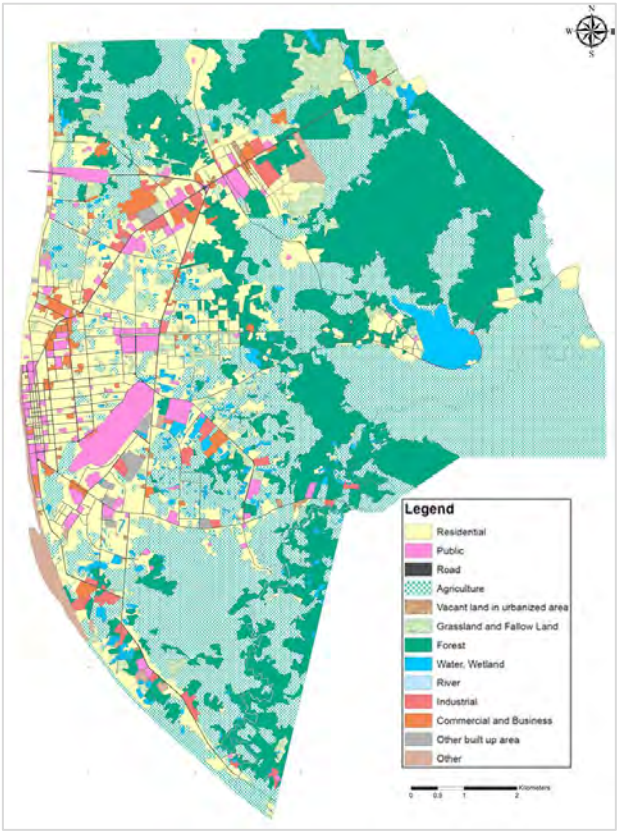
5.111 The left figure in Figure 5.3.2 illustrates a proposed urban structure of the urban area. There are two traffic axis, NR9 running through the north of the urban area to NR13 and Vietnam, and the other is NR9A which runs through the south of the urban area to NR13. Kaysone Phomvihane Road running north to south at the eastern part of the urban area should be developed as a new traffic axis connecting the two established axes. Besides traffic axes, old city center, commercial center, industrial center, administration center, transport center, education center, and park and green recreational/tourism center were identified and land-use concept was designed accordingly. The right figure in Figure 5.3.2 shows the land-use concept plan in the JICA report.

Table 5.3.5 Land-use Composition in 2009

	Area (ha)	Share *1 (%)	Share *2 (%)
Residential	1,695	20.7	64.4
Commercial and Business	162	2.0	6.2
Industrial	141	1.7	5.4
Public Facility	358	4.4	13.6
Road	143	1.7	5.4
Others	133	1.6	1.6
(Built-up area)	(2,632)	(32.1)	100
Agriculture	2,792	34.1	
Forest	2,155	26.3	
Grassland, abandonment and fallow land	337	4.1	
River and water surface	279	3.4	
Total	8,197	100	

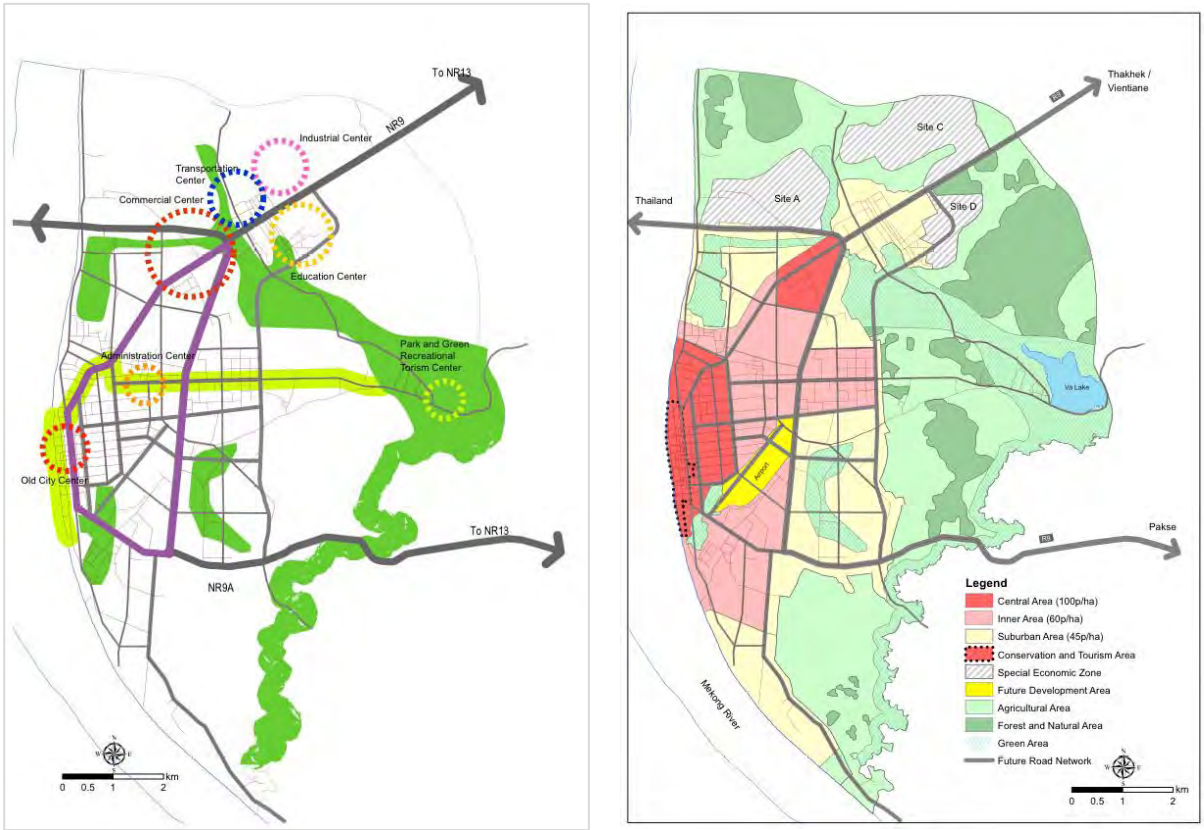
Source: Preparatory Survey on Formulation of Basic Strategies for Regional Core Cities Development in Lao People's Democratic Republic. Final Report Appendix. JICA. January 2010.

Figure 5.3.1 Land-use Map in Kaysone Phomvihane



Source: Preparatory Survey on Formulation of Basic Strategies for Regional Core Cities Development in Lao PDR (JICA. 2010)

Figure 5.3.2 Proposed Urban Structure and Land Use Concept Plan



Source: Preparatory Survey on Formulation of Basic Strategies for Regional Core Cities Development in Lao PDR (JICA. 2010)

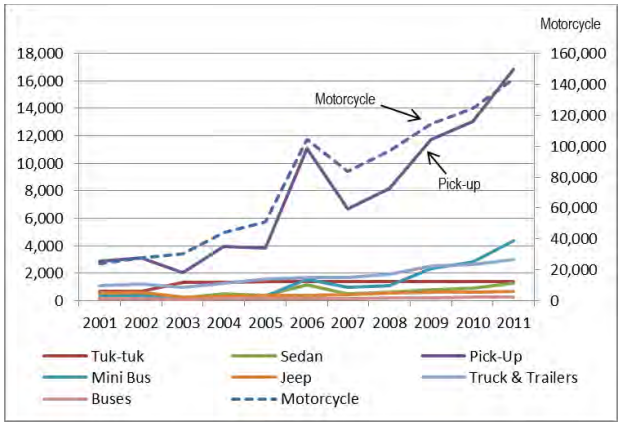
5.112 Development vision of the province is Clean, Attractive and Green City. Housing, Urban Planning and Environment division of DPWT in Savannakhet identified developing sewerage is the highest priority because it closely related to residents' health, followed by drainage and road. It also pointed out that living environment in the urban area is not satisfactory to accommodate predicted population growth in the future. It suggested the city should be compact and dense to provide urban infrastructure effectively and efficiently. At present, population density is not high, which is good from living condition perspective, but it will be one of difficulties to promote public transport in the urban area.

5) Transport Condition

5.113 **Vehicle Ownership:** Registered vehicle number in the province from 2001 to 2011 is about 0.99 million, including motorcycles, which accounts for 85% to the total vehicles. Among cars, the number of pick-up truck exceeds tenfold of sedan type. (see Figure 5.3.3). Based on the hearing to the DPWT, an average number of motorcycles in a household in Kaysone Phomvihane is one motorcycle per person.

5.114 In the province, the number of passenger cars has been increased significantly due to the availability of a down payment system introduced by KOLAO Company. KOLAO is the only service provider for vehicle inspection. According to a regulation, scrapped cars need to be informed to vehicle management section; yet, in practice, people sell their cars to recycles shops, so virtually there is no car scrapped as practice. Only one private repair shop is permitted by the government.

Figure 5.3.3 Registered Vehicles in Savannakhet Province



Source: JICA Study Team based on the data from DOT of MPWT

5.115 **Road Network:** Urban Road network in Kaysone Phomvihane is summarized in Table 5.3.6. Around 63% of roads out of 172.2 km are already paved. Arterial roads in the city are all paved, while collector roads, neighborhood roads are still unpaved or earth roads.

Table 5.3.6 Status of Transportation Infrastructure in Kaysone Phomvihane

	Description
Total Road Length (km)	172.2 km
Pavement Rate (%)	Concrete road: 6.7%, Asphalt road: 56.4%
Number of Traffic Signal	5 locations (only 1 traffic signal is working)
Number of Public Parking Space	None

Source: DWOT Savannakhet Province

5.116 **Public Transport System:** In Kaysone Phomvihane, there is no public route bus transport service. Public transport services are provided for inter-district, inter-province and international routes. The DPWT suggests a bus loop service, with 20 seats bus, in route of Latsavongseuk – NR9B – Kaysone Phomvihane – University – Phokadouath, is high prospective with feeder service, with 9 seats bus, in the urban center.

Table 5.3.7 Public Transport Service in Savannakhet City

	No. of Bus Route	No. of Bus
Inner-city	0	-
Inter-district	15	227 (Songthaew)
Inter-province	5	34
International	4	23

Source: DPWT Savannakhet

6) Summary of Urban Transport Issues

5.117 The DWPT deems that there is no serious mobility problem in the city, while traffic congestion at some locations is observed during peak hours, in morning and evening hours. One serious issues pointed out by the DWPT is parking problem both for motorcycles and passenger cars, in particular along Latsavongseuk road. Traffic accidents have increased, especially caused by motorcycles, while there is no record of traffic accident by paratransit, like tuktuk, Skylab and Jumbo.

5.118 Table 5.3.8 summarizes the SWOT analysis identified by the DPWT.

Table 5.3.8 SWOT Analysis on Transport Development

Strength	Weakness
- Improvement of road infrastructure (street light and center line) - Good mobility	- Lack of parking all day long. - Lack of infrastructure for NMT
Opportunity	**Threat**
- Being the second urban city in Lao PDR	- Local people have less cooperation to the government. - Lack of transport related budget - Direct impact of transport on health conditions

Source: DPWT Savannakhet

5.119 Transport attitude survey, a sample survey to randomly selected 100 respondents, was conducted in May 2012 by the JICA Study Team. It reveals that more than 80% of the respondents own motorcycle. One third of the respondents own two motorcycles and 40% of them own more than three motorcycles, while around 10% of the respondents own a passenger car, but the ownership of van and pick-up car jumps to nearly 20% each. Around two third of respondents use their motorcycle as commuting mode and around 15% of them paratransit. Many people are already used to use private vehicles for traveling, so that they do not think that public transport system is important for the city.

7) EV Introduction Opportunities

5.120 Many people know about electric motorcycle (e-motorcycle) because many Chinese e-motorcycles were imported. However, user used to face on the difficulty to exchange the batteries, shorter batteries life than expectations, and no appropriate measures to dispose used batteries. Therefore, people's impression of e-motorcycles is

not good. On the other hand, the government officers in Kaysone Phomvihane understand the importance of utilizing public transport system and EVs to reduce the private vehicles and also reduce fossil fuel use. They also expect that introduction of public transport system can reduce the traffic accidents because main cause of traffic accidents is motorcycle use.

5.121 In order to develop low-emission public transport system in Kaysone Phomvihane, promoting people's understanding is the key successes factors. People do not have the custom to use public transport system. So the government needs to start to make a habit of using public transport to residents. Introducing EVs in Kaysone Phomvihane is also effective to appeal the neighboring countries because many Thai and Vietnamese people come to Kaysone Phomvihane through NR9.

5.4 Pakse City

1) Overview

5.122 Pakse city is the capital and most populous city in the southern province of Champasak. It has a population of about 86,000 (second largest city in Lao PDR), with the area of 12,507 km^2 situated at the confluence of Xe Don Mekong Rivers. Pakse city share a border with Thailand, and the province border with Thailand and Cambodia.

5.123 The city was founded by the French as an administrative outpost in 1905, and was formerly the capital of the Lao Kingdom of Champasak until its abolishment in 1946 when the Kingdom of Laos was formed. After the Kingdom collapsed the city become an economic driving force and of regional importance within the region

5.124 **Topography and Hydrology:** The Pakse city located at 15°07'00" N latitude and 105°10' 00" longitude with 2km^2 land area. It is endowed with natural surroundings, the Mekong River to its east and Xe Don River from north to south flowing into the Mekong River, and the expansive jungles and mountains of Pakse, especially to the northeast in the Bolaven Plateau, an upland region where temperatures could sometimes go down to freezing point in the winter months.

5.125 **Climate:** Pakse is characterized as tropical according to the Koppen climate classification and divided by two seasons, wet and dry seasons. Its inland and southernmost location makes it Lao PDR's hottest city all throughout the year. Even during the winter months of December to February, the daytime maximum temperatures still over in the 30 °C range. The months of May to October is the wet season, as characterized by persistent rains brought about by the monsoons, with June and August as the wettest.

2) Socio-economic Condition

5.126 **Population:** A population of Pakse has been growing from 78,669 in 2005 to 86,432 in 2010. The expansion of Pakse urban area has impacted and drawn population from neighboring five districts. Population growth is more notable in the period of 2009 – 2010, which increased with 6%/year. According to the ADB project, forecasted population is 148,800 by 2030. However, at the growing rate by 6%, the population will double in 10 years, to around 173,000. Based on the data collected in 2011, the average household size is 6.3 persons, which is larger than an average in Lao PDR (5.9), and in urban (5.7).

5.127 There were 67 villages in Pakse in 2005, but now there are 42 villages. Many villages were merged into, so that the total number of village decreased, while a few villages located to northern part of the city were added and being a part of Pakse.

Table 5.4.1 Population in Pakse District and Surrounding 5 Districts

District	2005	2010[1)]	Forecast			AGR (%/year)		
			2015	2020	2030	'05 - '10	'10 - '20	'20 - '30
Pakse	78,669	86,432	100,200	116,200	148,800	1.9	3.0	5.1
Xanasomboun	62,238	68,380	77,000	86,700	107,800	1.9	2.4	4.5
Bachiang	49,338	53,553	60,300	67,900	84,500	1.7	2.4	4.5
Pathoumphone	51,370	56,439	63,600	71,700	89,200	1.9	2.4	4.5
Phonthong	85,188	93,594	105,400	118,700	147,600	1.9	2.4	4.5
Total	326,803	358,398	406,500	461,200	577,900	1.9	2.6	4.6

Source: Pakse Urban Environmental Improvement Project (ADB, 2011)
1) estimated figure

5.128 **Economic Condition:** Champasak province locates at a strategic position in the country, taken into account that the province has valuable natural resources and bordering to exporting markets. On the other hand, natural resources may not be fully utilized. A shortage of skilled and qualified labor force has been a long-term constraint. Service sector infrastructure is also an impediment to economic development.

5.129 GRDP growth rate of the province is high (9.9 %/year) even compared to new industrializing countries. While secondary and tertiary sectors show annual increase of 15% and 16%, primary sector has the highest share (40%) in total GRDP. Composition of GRDP by sector in Pakse differs from that of the province. Tertiary sector accounts for more than a half followed by secondary sector, 33%. Pakse embraces around 250 wholesalers, 2,200 retail shops, 450 transport-related service providers and 110 hotels and restaurants. GRDP per capita in 2011 is USD1,429, while it is USD1,281 nationwide.

5.130 According to the ADB project (2011), in 2010, approximately 71.5% of the active labor force is involved in the agriculture, 22.2% in the services and only 3.5% in the manufacturing. The data indicates that 3/4 of labor force contribute merely 12% of the GRDP in Pakse district, while 1/4 of them contribute more than a half of the GRDP.

Table 5.4.2 GRDP of Pakse City

		2011	%
GRDP by Sector	Primary	106.3	12.0
	Secondary	296.3	33.4
	Tertiary	483.5	54.6
GRDP (LAK billion, current price)		886.1	100
GRDP per Capita (USD, current price)		1,429	-

Source: Pakse District Statistical Report 2011. Pakse District. 2012

5.131 **Household Income and Poverty:** Another survey from the Cities Development Initiative for Asia (CDIA) revealed that 35% of the households, spending less than LAK1,200,000 per month in Pakse district were among the poorer strata (but not the very poorest). The poor live in both urban and sub-urban villages, and in the urban villages, they are concentrated in the low lying areas with poor drainage and litter problems.

5.132 **Social Services:** Following tables show the status of social infrastructure in Pakse. Pakse also has one public technical vocational education and training (TVET) school and within the province, there are five private TVET schools. A national university, Champasak University locates in neighboring district, Bachiang district.

Table 5.4.3 Educational Facilities in Pakse District

	Kindergarten & Nursery	Primary School	Secondary School	
			Lower + Upper	Lower
No. of school	19	44	4	12
No. of teacher	143	426	259	194
No. of student	2030	8,206	4,421	2,566

Source: Pakse District Statistic Report 2011. Pakse District. 2012

Table 5.4.4 Healthcare Facilities in Pakse District

Description	Unit	Data
No. of clinic/clinic	no.	55
No. of district hospital	no.	1
No. of pharmacy	no.	45

Source: Pakse District Statistic Report 2011. Pakse District. 2012.

5.133 **Provision of Urban Utilities:** Considering Pakse district encompasses provincial capital and the third largest urban city in the country, public service delivery is in decent level. Electricity supply coverage is 100% in 2010 (one village with 34 household access to off-grid system), water supply by Nam Papa Champasak is 81% in 20010, sanitation facility, household with a toilet, is 100% in 2011, and solid waste collection is estimated about 23%[2]. Solid waste is collected from 28 out of 42 villages and transported to the landfill site located 17km northwest of the city center. The uncollected waste remains in the urban and suburban areas where it is burned, dumped indiscriminately or buried. Apart from the Pakse Urban Development Administration Authority (UDAA), several private waste contractors and individual businesses collect and transport solid waste from markets, shops and offices for disposal at the landfill.

5.134 **Power Supply:** There are two electric network systems from small dams (5MW) in Champasak and Salavan provinces. Grid systems contain 0.4kV, 22kV and 115kV. During dry season, electricity is imported from Thailand, so that there is no electric shortage in dry season; yet, due mainly to heavy rain, there are electric blackout about less than five times per day, for 10 minutes to one hour, in rainy season.

5.135 The DEM of Champasak province deems electricity power plants have enough capacity to supply electricity to the city in future, yet the construction of electric supply infrastructure for expanded area of the city shows slow progress because of a lack of financial resources. A bauxite factory might be opening within two to three years, which may affect to electric supply. Biomass using rice husk and agricultural wastes in the city is under study based on the Renewable Development Strategy of Ministry of Energy and Mines.

5.136 **Water Supply:** Water supply coverage rate in Pakse district is 55% in 2005 and 81% in 2010. According to the JICA Study (2010), water demand in the future is 28,500m^3/day in 2015 and 43,000m^3/day in 2025, so it recommended to build new water supply plants in a capacity of 15,000m^3/day by 2015, and 14,500m3/day by 2025.

Table 5.4.5 Water Supply in Pakse District

E Water quality	Good: PH= 7.8; Density= 12.7; Chlorine remain=0.36
F Water volume	Enough: 3,787,440m^3/ year
G Frequency of Water shortage	None - sometimes
H Water tariff	It's 1/3 of electric tariff for daily use. average 3,300 LAK/m^3

Source: Water Company Champasack

5.137 **Drainage System:** While more than 85% of households have septic tank toilet, grey water is directly discharge to rivers without any treatment. The ADB report points out most of septic tanks are not dredged more than three years, so many households

[2] Pakse Urban Environmental Improvement Project. ADB TA 7567-LAO. GHK International. September 2011

complained about smell from their toilet. The district government is expecting an ADB project to be implemented to build drainage systems along Xe Dong River.

5.138 **Solid Waste Collection:** According to the ADB study, the waste projects assume a per capita waste generation growth rate of 1% per annum throughout the projection period, to reflect urbanization and industrialization. Total waste generation will be 93.6 tons/day in 2015, 115.1 tons/day in 2020 and 137.2 tons/day in 2030, which is 5.5 times more than that of 24.8 tons/day in 2011.

5.139 **SWOT Analysis on Pakse City Development:** The ADB Study (2011) identified the strengths, weaknesses, opportunities and threats for the development of Pakse City. Table 5.4.6 summarizes SWOT identified in the ADB Study (2011).

Table 5.4.6 SWOT Analysis on Pakse City

Strength	Weakness
・ Location connecting to Vietnam, Cambodia and Thailand ・ Favorable location having rivers and mountains ・ Presence of International airport ・ Center for trading and transport center for southern Lao PDR ・ Presence of many tourism sites ・ UDAA has mandate for development of future municipality ・ Strong private sector development interest and support ・ Population growing can provide large human resource pool.	・ No clear urban planning and no revision of old master plan ・ No clear transport plan ・ Limited budget and capacity for urban development ・ Poor solid waste management ・ Disparity between developed area and undeveloped area ・ No strict protection of conservation areas and river banks ・ Shortage of development land ・ Flooding and no consideration on drainage ・ Too close to the airport
Opportunity	**Threat**
・ Development of tourism sector ・ Expansion of trading, services sector and tourism support ・ Development of transport hub ・ Possible railway plan ・ Development of business hub ・ Coordination between districts in future development ・ Development of natural attractions such as hills and rivers	・ Lack of human resource development ・ Inadequate education facilities to support professional development ・ Continues disordered development ・ Low land – difficulties for construction ・ Uncontrolled in-migration from different places ・ Continue environmental degradation

Source: Pakse Urban Environmental Improvement Project (ADB, 2011)

3) Urban Development Condition[3]

5.140 The existing master plan for Pakse urban area was approved in 1997. In 2010, JICA formulated a land use concept for the main urban area. Utilizing the land used plan and a framework for the initial expansion of the urban area as a starting point for an urban development strategy for Greater Pakse, the ADB project formulated development targets and concepts in 2011. The project suggested three phase development steps. Targets for phases of the urban development strategy are summarized below. (see Table 5.4.7).

Table 5.4.7 Targets for Phases of the Urban Development Strategy

	Target
Phase 1: 2011-2015 Improve Urban Environment	To be planned and well managed To be as well known as Luang Prabang – as a tourist destination and hub for the attractions of southern Lao PDR To be the major market for agriculture products In southern provinces and a center for agricultural processing
Phase 2: 2016-2020 Green City	To be established as a city being developed sustainably To be a self-governing city

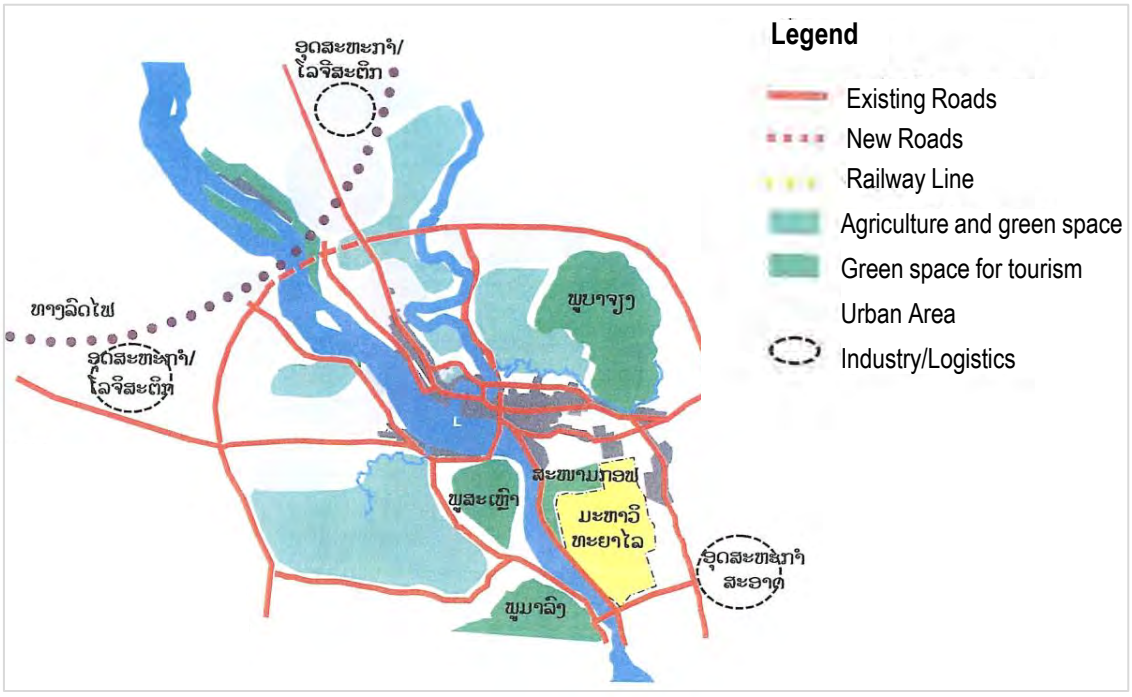
[3] Source: Pakse Urban Environmental Improvement Project. ADB TA 7567-LAO. GHK International. September 2011

	Target
	No residents living in poverty or without full urban services
Phase 3: 2021-2030 Major Regional Commercial and Cultural Center	To be the greenest and most livable city in the southern part of Lao PDR and the region. To be a major center in Mekong region for commerce, tourism green industry and other services. To be a center of excellence for sustainable development

Source: Pakse Urban Environmental Improvement Project (ADB, 2011)

5.141 In recent years, the urban area has extended to the east and to the south, out of Pakse district. Expansion was encouraged by infrastructure development, in particular the Mekong Bridge, and the availability of land at elevations above those liable to flood. The JICA study also suggested in its master plan to extend the development to the east of the city.

Figure 5.4.1 Future Development Plan of Greater Pakse City



Source: Pakse Urban Environmental Improvement Project (ADB, 2011)

5.142 Pakse has been developed as a center of southern Lao PDR. Champasack Province shares a boarder with Vietnam, Cambodia and Thailand, so that there is a lot of traffic from/to neighboring countries. There is also an international airport which accommodates the tourists attracted to the abundant nature and many tourism sites. It is expected that the city will continue to grow as the growth center in this area, so that the future urban development strategies are required. However, there is no clear urban development vision in the city, and there is no updated urban plan and transport plan. In this context, the main urban development problems include followings;

(i) Lack of protection of preservation area and embankment;

(ii) Progress of disordered development and deterioration of environment;

(iii) Disparity of infrastructure development between urban and suburban areas;

(iv) Lack of drainage system and flood;

(v) Lack of solid waste management system;

(vi) Lack of capacity (human resources and budget) for urban planning and development management; and,

(vii) Location of airport which is too near to the urban area.

4) Transport Condition

5.143 **Vehicle Ownership:** Registered vehicle number in the province in 2011 is about 0.1 million, including motorcycles, which accounts for 85% to the total vehicles. Among cars, the number of pick-up truck exceeds tenfold of sedan type. (see Table 5.4.8). Based on the registered vehicles in the province, DPWT estimated ownership of car in Pakse. It estimates around 46.2% of the registered vehicles are in the city and a household owns two motorcycles, which results in the fact that estimated car ownership of Pakse district is about 70%.

Table 5.4.8 Registered Vehicles in Champasak Province from 2001-2011

Motorcycle		Cars				Heave Vehicle		Total
2 wheels	3 wheels	Sedan	Pick up	Van	SUV	Truck	Bus	
84,548	1,094	987	9,087	1,401	697	1,845	382	100,041

Source: DOT of MPWT

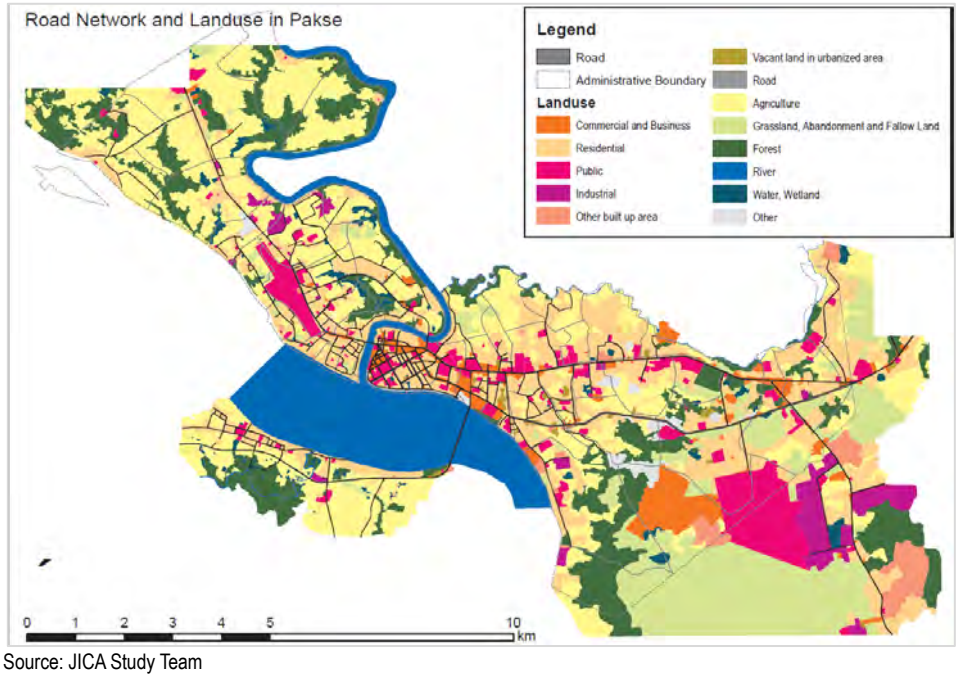
Table 5.4.9 Estimated Ownership of Motorcycle and Passenger Car

% of city's share in the total No. of vehicle in Province	46.2% (about 45,222 vehicle)
Average No. of motorcycle in a household	About 2 motorcycle/HH (city)
Estimated ownership of car (%)	About 70%

Source: DPWT Champasack

5.144 **Road Network:** Urban road transport infrastructure in Pakse is summarized in Table 5.4.10. Around 60% of roads out of 147 km are already paved. Arterial roads in the city are all paved, while collector roads and neighborhood roads are still unpaved or earth roads.

Figure 5.4.2 Main Road Network of Pakse



Source: JICA Study Team

Table 5.4.10 Status of Transportation Infrastructure in Pakse District

	Description
Total Road Length (km)	132 routes with 147.2 km
Pavement Rate (%)	Concrete road: 8.0%, Asphalt road: 42.3%
Number of Traffic Signal	7 locations
Number of Public Parking Space	• 12 public parking lots at station and market • 4 private company parking lots

Source: DPWT Champasack

5.145 **Traffic Demand:** The ADB project conducted a small scale OD and traffic count survey in 2010. Traffic volume by direction and each type of vehicle was recorded for 12 hours from 06:00 to 18:00. Table 5.4.11 shows the summary of the survey. At all locations, motorcycle dominates the road traffic, an average of about 70% followed by pick-up truck and paratransit, tuktuk and Jumbo (Sam Lor).

Table 5.4.11 Summary of Traffic Count Survey Result (December 2010)

Station	Road Name/Location	Incl. Motorcycle	Excl. Motorcycle
1	National Road.13s, Russian Bridge	8,582	5,268
2	National Road 13s, French Bridge	17,690	12,446
3	National Road 13s, KM2	26,846	17,291
4	Salakheow Road	22,608	15,848
5	National Road 16, Mekong Bridge	7,216	4,848

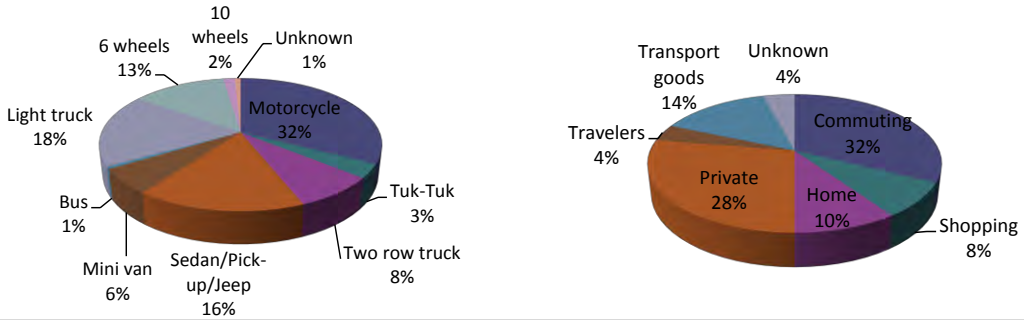
Source: Pakse Urban Environmental Improvement Project (ADB, 2011)

Figure 5.4.3 Traffic Count Survey Locations

Source: Pakse Urban Environmental Improvement Project. (ADB, 2011)

5.146 According to the OD Survey by the ADB Study (2010), 32% of people use motorcycle as their travel mode, followed by cars (16%). Public transport users share only 4%. Main trip purpose is commuting and other private purpose. Since 34% of people use truck or trailers and 14% of trip purpose is travel goods, freight transport also has high traffic demand in the city. The main road from Thailand and NR 13 passes through the city, so that it is also important to consider those freight transports to develop transport system in Pakse.

Figure 5.4.4 Travel Modes and Trip Purpose of People (December, 2010)



Source: Pakse Urban Environmental Improvement Project (ADB, 2011)

5.147 **Public Transport System:** In Pakse district, Sam Lor[4] (3-wheel) is more popular than tuktuk as paratransit. (see Table 5.4.12). Likewise in Vientiane, songthaew is used for route and cross border public transport (father than10km), while Sam Lor (within 5km) and tuktuk (approximately 5 – 10km) are mostly found and used for intra-city transport. The number of public transport is decreasing in past years, which the public transportation association also raised as a major problem.

5.148 In 2008, 15 mini buses with 12 seats from Vientiane were provided to the drivers as loan and operated in the city. However, it stopped after 3 months. DOT recommended to the investors to conduct some kinds of survey before operation, but they didn't do any survey. After implementation, the drivers didn't operate on a determined route, and it disturbed other transport activities. Therefore, DOT prohibited the project after 3 months. There was no good management system to operate the public buses then. Pilot project of e-tuktuk was also conducted some years ago with 2 e-tuktuks from Thailand. However, it's failed due to many slopes, poor condition of road surface, and slow speed. Vietnamese investor also approached to the province to start taxi service in the city. The investor only sent a document to the province even they need to send it to the Central Government. There is no progress until now.

5.149 Major public transport within city is paratransit, while inter-district routes are served mostly by songthaew. As for inter-province and international routes, various buses are operated from three main bus terminals located around the urban area. Passengers from/to bus terminals must rely on paratransit since there is no route public service, feeder service from/to the bus terminals.

Table 5.4.12 Number of Public Transport in 3 Years (2009-2011)

No.	Vehicle Type	No. of Vehicle			No. of Seat	No. of Annual Passenger	Fare (LAK/ride)	No. of Route
		2009	2010	2011				
1	Songthaew (pick-up)	28	18	8	18	1,049,760	15,000	10 districts
2	Van (VIP)	-	10	35	12	1,166,400	20,000	-
3	Taxi	14	8	2	-	-	-	-
4	Tuktuk	81	50	35	9	3,277,040	5,000	-
5	Sam Lor (3-wheel)	170	150	120	2	9,504,000	5,000	-
6	Inter-provincial bus	-	-	149	-	-	35,000-150,000	6 (3-5 service/day)
7	International bus	-	-	37	-	-	More than 150,000	13 (Vietnam Thailand)

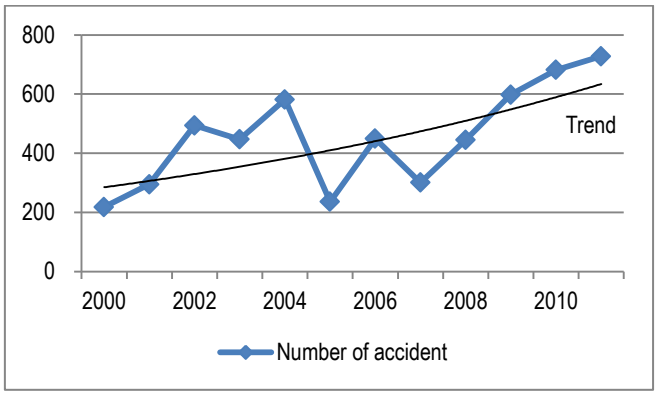
Source: Report of Public Transport Capacity in 3 years (2009 - 2011). Pakse Public Transport Association, Champasak. Document# 032 dated 4 April 2012, DPWT

[4] Sam-lor is a common public transport in Champasak province, which is a motorcycle with a sidecar.

5) Summary of Urban Transport Issues

5.150 The DOT identifies several transportation related issues, which many urban cities have encountered in accordance with recent rapid motorization. One of notorious issues is swelling number of traffic accidents. (see Figure 5.4.5).

Figure 5.4.5 Number of Traffic Accidents and its Trend (2000 – 2011)



Source: DPWT Champasak

5.151 Another issue is chronic congestion at old and new Xe Done bridges, in front of the evening market Km2 and inter-junction at Phonesay School.

5.152 Table 5.4.13 summarizes the SWOT analysis identified by the DPWT.

Table 5.4.13 SWOT Analysis on Transport Development

Strength	Weakness
- Many east-west corridors linked to Pakse - Locating along NR 13 - Connecting to the Southern provinces, Vietnam, Cambodia and Thailand. - Being the center of commerce and goods transport in the Southern Lao PDR - Many tourist sites - Improvement of public transport	- One-way goods transport (only import). - High goods transport cost - Limited volume of goods transport - No organized system for goods transport - No specific transport system plan - Limited development budget
Opportunity	**Threat**
- Continue to develop and enhance the commerce, service and tourism related sectors - Develop transport sector to be the center of transport in the Southern Lao PDR (e.g. logistics center) - Infrastructures are under developed	- Lack of private investment on the transport sector - No awareness of the private investors on the importance of transport sector - Poor condition of trading company due to having only contractual workers

Source: DPWT Champasack

6) EV Introduction Opportunities

5.153 In order to solve the several traffic problems such as traffic congestions, introducing low-emission public transport is effective. However, the city has experiences of failure of introducing public transport system in the past, so that the government officers are relatively negative to introduce public transport system. On the other hand, if the public transport system is introduced, it should be introduced more for low income people and to connect suburban area and urban center. In addition, before start the operation, the project should be conducted at the pilot project level and the demand should be carefully studied.

5.5 Transport Corridor

1) Overview

5.154 National and provincial roads network provide backbone for regional development of the country. Total length of transport corridors is 39,585km which is composed of 7,235km of national roads and 7,961km of provincial roads. NR13 (about 1,600km) is the north-south axis of Lao PDR which is assigned as Central Corridor in the GMS corridor concept. Main east-west corridor is NH9 (less than 200km) which is also called East-West Corridor (EWEC) in GMS corridors. NR13 plays important role to connect Vientiane Capital with secondary town such as Luang Prabang City, Kayson Phomvihane City, and Pakse City. NH9 is important for the logistics among Thailand, Lao PDR and Vientiane.

5.155 The pavement rate is still very low. It is only 15.4% for the whole road network. The pavement rate for national road is relatively higher than other types of roads (61.3%), but not yet 100%. That of provincial road is only 8.8%. Thus, the road conditions are unsatisfactory even road traffic has been increasing, and better services are demanded (see Table 5.5.1). The unsatisfactory road condition is also constraints for rural development along the transport corridors.

5.156 Besides road surface conditions, the parking or resting areas along the transport corridors are also not developed yet. There are many gas stations along the transport corridors even the internal of each gas station is not constant. So the drivers usually take rest at the gas station, or just road side. There are a few rest areas called Michi-no-Eki, but it provides only parking spaces for users.

Table 5.5.1 Road Length and Pavement Condition

Road	Length (km)	Paved (%)
National	7,235	61.3
Provincial	7,961	8.8
Others	24,389	4.0
Total	39,585	15.4

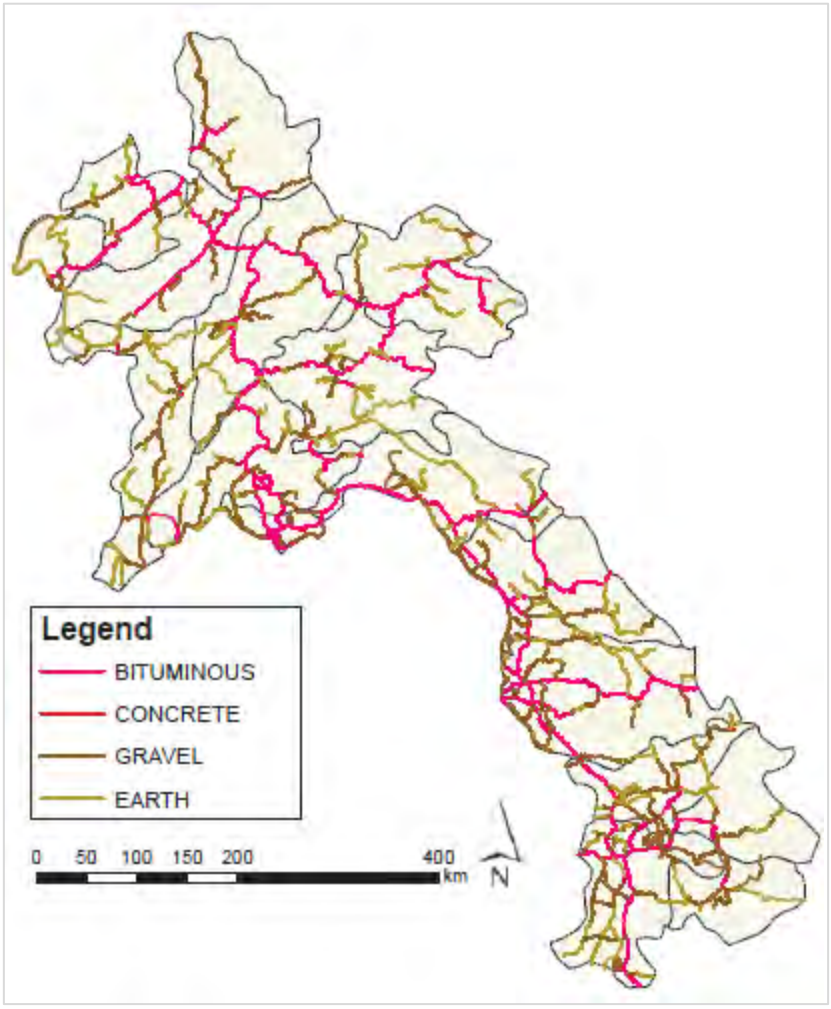
Source: MPWT

2) Opportunities to Introduce EV Infrastructures

5.157 Main EV infrastructures along the transport corridor will be charging stations at rest areas. Rest areas can provide the place for drivers to take rest including food, toilet, etc. This kind of facilities can make people to travel long distance easier. EV charging stations can also help EV users to drive along the transport corridors. Since land transport is major travel mode for Lao PDR, the government should expand and improve transport corridor more strategically.

5.158 Fortunately, the condition of road network in Lao PDR is still under development. The construction cost of rest areas would be cheaper when it is constructed together with road construction or improvement projects.

Figure 5.5.1 National and Provincial Road Network by Pavement Conditions



Source: MPWT

5.6 Rural Areas

5.159 The village types in Lao PDR are classified into three, namely urban village, rural village with access roads and rural village without access roads. The village having more than three of the following defined as urban villages. Others are rural village.

(i) Locate at the capital of district or province;

(ii) Provide electric supply for more than 70% of the total household;

(iii) Provide water supply for more than 70% of the total household;

(iv) Have road access for cars to the village in the whole year (less than 200m far from the main road); and,

(v) Active market in the whole day.

5.160 In 2009, there were 8,725 villages in Lao PDR. Of which, about 85% of villages were defined as rural villages. Rural villages are relatively concentrated on the northern provinces. Although Luang Prabang Province has higher urbanization rate, it has highest number of rural villages without access roads. (see Table 5.6.1) The population in the rural villages had reduced in the period of 2005 – 2009, but still more than 70% of population live in the rural villages. However, road development has made progress. Population in rural village without access road dramatically reduced. (see Table 5.6.2)

Table 5.6.1 No. of Village by Categories

Province		No. of Village				Urban Village (%)	Share (%)		
		Urban	Rural with Access Road	Rural without Access Road	Total		Urban	Rural with Access Road	Rural without Access Road
North	Phongsaly	52	347	143	542	9.6	4	6	11
	Luangnamtha	37	271	47	355	10.4	3	4	4
	Oudomxay	49	303	120	472	10.4	4	5	9
	Bokeo	42	212	37	291	14.4	3	3	3
	Luang Prabang	160	413	221	794	20.2	12	7	17
	Huaphan	28	646	53	727	3.9	2	11	4
	Xayabouly	97	315	35	447	21.7	7	5	3
	Sub-total	465	2,507	656	3,628	12.8	34	41	52
Central	Vientiane Capital	264	224	3	491	53.8	19	4	0
	Xiengkhouang	69	394	46	509	13.6	5	6	4
	Vientiane	87	408	22	519	16.8	6	7	2
	Borlikhamxay	56	251	19	326	17.2	4	4	2
	Khammouan	114	368	108	590	19.3	8	6	9
	Savannakhet	146	753	129	1,028	14.2	11	12	10
	Sub-total	736	2,398	327	3,463	21.3	53	39	26
South	Saravanh	32	551	29	612	5.2	2	9	2
	Xekong	20	138	77	235	8.5	1	2	6
	Champasack	101	387	151	639	15.8	7	6	12
	Attapue	22	102	25	149	14.8	2	2	2
	Sub-total	175	1,178	282	1,635	10.7	13	19	22
Total		1,376	6,083	1,265	8,725	15.8	100	100	100

Source: LSB

Table 5.6.2 Population by Village Types

Province		2005				2009				AGR: '05-'09 (%/year)			
		Urban	Rural with Access Road	Rural without Access Road	Total	Urban	Rural with Access Road	Rural without Access Road	Total	Urban	Rural with Access Road	Rural without Access Road	Total
North	Phongsaly	21	48	97	166	24	105	37	166	3.5	21.5	-21.6	-0.1
	Luangnamtha	32	81	32	145	34	112	14	159	1.7	8.2	-19.5	2.3
	Oudomxay	40	121	103	265	53	180	49	281	6.8	10.4	-17.2	1.5
	Bokeo	20	78	47	145	30	116	12	159	10.8	10.4	-28.4	2.2
	Luang Prabang	77	202	128	407	143	194	77	413	16.8	-1.1	-12.0	0.4
	Huaphan	33	143	105	281	34	239	15	288	0.5	13.7	-38.2	0.6
	Xayabouly	77	228	34	339	104	239	16	359	7.9	1.2	-17.4	1.4
	Sub-total	300	902	546	1,748	421	1,185	219	1,825	8.9	7.0	-20.4	1.1
Central	Vientiane Capital	570	121	1	692	503	225	1	729	-3.1	16.7	-0.6	1.3
	Xiengkhouang	48	140	41	230	67	178	13	258	8.5	6.2	-24.8	3.0
	Vientiane	92	266	31	389	120	324	9	453	7.1	5.0	-26.6	3.9
	Borlikhamxay	59	130	36	225	75	167	6	248	5.9	6.4	-35.8	2.4
	Khammouan	72	171	95	337	96	217	41	354	7.4	6.2	-18.9	1.2
	Savannakhet	185	501	140	826	220	614	54	887	4.4	5.2	-21.3	1.8
	Sub-total	1,026	1,329	344	2,699	1,081	1,724	124	2,928	1.3	6.7	-22.6	2.1
South	Saravanh	28	246	51	324	34	316	9	358	5.1	6.5	-36.0	2.5
	Xekong	18	46	20	85	22	58	19	98	4.6	5.7	-2.1	3.8
	Champasack	124	310	173	607	184	334	113	631	10.2	1.9	-10.1	1.0
	Attapue	19	43	50	112	32	76	16	123	13.6	15.1	-25.4	2.3
	Sub-total	190	645	294	1,129	271	784	156	1,211	9.4	5.0	-14.7	1.8
Total		1,773	3,693	498	5,964	1,773	3,693	498	5,964	4.0	6.5	-19.5	1.7

Source: LSB

5.161 The common characteristics of rural villages are poor electric supply coverage, less accessibility to the primary education, high poverty rate and relatively big size of household. The accessibility to the dispensary is not so much difference between urban and rural villages compared to other disparity. (see Table 5.6.3) In general, the people living in unelectrified villages use small/pico hydropower generation, diesel generation and solar photovoltaic. The operation cost for those alternative power generations is varied by the types of generation. According to the Master Plan Study on Small Hydropower in Northern Lao PDR (JICA, 2004), the pico hydropower generation needs only initial cost with 20 – 50 USD. The initial cost and operation cost of diesel generation are 300 – 600 USD and 10 – 20 USD/month, respectively. The initial cost and the operation cost for solar photovoltaic are about 16 USD and 1 USD/month. The above figures are prices in 2004. Therefore, those prices must have increased and burden on people, especially on diesel generation users.

Table 5.6.3 Comparison among the Village Categories

	Urban	Rural with Access Road	Rural without Access Road
Coverage of Electric Supply (%)	95.4	49.0	10.9
Village with Primary School (%)	73.5	59.3	46.5
Village with Dispensary (%)	13.3	11.6	5.5
Share of Poor Village (%)	4.1	26.3	67.8
Household Size (person/HH)	5.6	5.8	6.0

Source: LSB

5.162 In order to know the actual condition of rural villages, two villages were visited by JICA Study Team as follows.

1) Muanglong village, Hom District, Vientiane Province

5.163 **Overall:** Muanglong Village is designed as rural village with access road. The distance from Vientiane Capital to Hom District is about 140 km (2.5 hours by car), and it takes 36 km from Hom District capital to Muanglong Village (about one hour by car). The village locates the boundary to a special district of the province. Since a copper mining company locates further away from the village and passing the village is the only way to reach there, there was an agreement between the government and the company that the company would pave a road and provide necessary basic infrastructure to the village. Because of that, the condition of village road is relatively good and all households are connected to electricity and piped water: yet, not from water supply plant, but upstream surface water.

5.164 The number of population in 2012 is 681 with 87 households. The average household size is relatively larger with more than 7 persons. 90% of population is engaged in agriculture and the remaining 10% in husbandry and in mining. The main economic activity is paddy agriculture. This village is defined as poor village, and 5 – 6 households live in poverty.

5.165 The public utilities are well provided. Coverage of electricity and piped water are both 100%. Road to the village is paved and well maintained, the villagers have clean and sufficient piped water, septic tank and piped drainage, so odor from drainage and/or black waste is not noticed at all and messy water puddle and dirty water channel were not observed at all. The village seems to have necessary infrastructure already. Electricity was already installed 5 years ago and the interviewee considers the life at the village is getting better.

5.166 Regarding the public service, there are two primary schools (one is under construction and the other one is broken down), but not secondary school. So students must go to the next village for lower-secondary school which is about 30 km away from Muanglong Village, and to the district capital for the upper secondary school. Since there are primary schools in the village, about 70% of population completed primary education. The village has no healthcare facility, so that people have to go to a clinic in the next village, which has two nurses.

5.167 **Living Conditions:** According to the interview to the residents, cash income in 100,000 LAK/month on average. The main source of cash is by selling rice and animals that they hunted to other villages. The main expense is for transport. The fuel cost for motorcycle and a small tractor is about 40,000 LAK/month and 50,000 LAK/month. It is followed by electric cost with about 20,000 LAK/month. Water cost is only 3,000 LAK/month. In case of using public transport, residents have to pay 20,000 LAK/trip to the most nearest neighboring village and 45,000 LAK/trip to the district capital (four times per a day in total for both ways). However, each household has one motorcycle in general in this village. So people use motorcycle to go to work, to neighboring villages and for daily uses. More than a third is spent for motorcycles' fuel, in spite of using them only for urgent matters, not for daily uses. Since there is no gas station in the village, it is understood that

the villagers need to buy fuel at the district capital, where it has a few gas stations.

5.168 Besides motorcycle, some household also have TV, electric light and refrigerator as their property.

5.169 As mentioned in the above, there is no secondary school in the village. So students who go to a lower-secondary school usually stay at a boarding house/dormitory close to the school. Students from wealthy family stays weekdays at the dormitory and return to their houses every weekend or once in two weeks, while other students return to their houses once in a month. Students who want to continue their education to higher-secondary school or higher must go to the district capital or other places.

5.170 **Development Needs of Infrastructure and Environment:** Since one of primary school is falling down, as the president of village council, he said he would like to request the local government to build a new primary school building. According to him, one school is not enough to accommodate all students. (one new school building is under construction).

5.171 Road conditions are considered good and easy to transport, but due to heavy traffic of heavy trucks, environment has been worsen, such as air and noise pollution. Village head has pleaded many times to the local government regarding air and noise pollutions from heavy trucks passing from/to the copper mining site, but no improvement is observed so far. Trucks pass the village 24 hours, so noise in night time is a critical problem for the villagers.

5.172 Traffic accidents are observed once or twice per year, but mostly light injured ones, and no measures have been taken so far to prevent a traffic accident.

2) Kheang Hin Soung Village, Savannakhet City, Savannakhet Province

5.173 **Overall:** This village locates at the north-east of Savannakhet City. It takes 20 km far from the city center. The village has 436 people with 81 household in 2012. In general, one household has 3 – 11 persons. All household is engaged with agriculture, especially rice cultivation.

5.174 The public utilities provision is very poor. Kheang Hin Soung Village is not yet electrified with national grid. People use diesel generators, vehicle batteries and oil lamps for their daily use of electricity. Some households also have solar photovoltaic panels and the village has four electric poles with solar photovoltaic panels which were donated by Laotian in the neighboring village nearby. Water well is available in the village, but it is not drinkable for human being. The drinking water from the deep well is available in the other village which is 2 – 3 km far from Kheang Hin Soung Village. However, water volume has been reduced due to deforestation.

5.175 The access to the public service is also poor. The village has the primary school, but the number of teacher is only three. So different grade students study in the same class (e.g. students of 4 grades and 5 grades). There is no secondary school. The first year of lower secondary school is 6 km far from the village. The second and third year of that is 8 km far from the village. It takes 10 km far from the village to upper secondary school. Usually students in the lower and upper secondary school stay in the relatives' house to go to schools. There is also no dispensary in the village. Nearest dispensary and

hospital are 8 km and 24 km far from the village, respectively. Regarding the market to buy groceries and commodities, there are three small shops and open market (once a week). The permanent market is 24 km far from the city center. When people go to market, they usually go by share riding.

5.176 **Living Condition:** People earn their income from selling rice and other agricultural products. They cultivate rice in one cycle mainly for their food, and selling their remaining to get their income. The main expenditure is for food, transport and healthcare.

5.177 The main transport modes for the people are motorcycles and agricultural tractors. In 2012, there are about 55 motorcycles and 57 agricultural tractors. The most of motorcycle are made in China, and agricultural tractors are made in Thailand. There are only two cars in the village. The gas station is available in another village which is 10-15 km far farm Kheang Hin Soung.

5.178 The living condition including economic activity, provision of public utilities and others seems to be poor. However, Kheang Hin Soung Village is not defined as poor village.

5.179 **Development Needs:** According to the interview to villagers, the development priority for this village is drinking water, street light and transport. Improving accessibility to the information is also one of the needs of people. They lack to get the information, so they are doubt what the ideal situation for them is.

3) Summary of Opportunities for Introduction of Low Emission Transport

5.180 EV introduction opportunities in the rural areas are not studied enough, but the following will be opportunities;

(i) EV will be introduced where cannot access to the national grid system, which is connected to individual small scale power plants. EV used with small scale power plant can save the long distance travel to get fuels. Moreover, EVs can be utilized as power sources for houses;

(ii) Vehicle operating cost of EVs is cheaper than that of ICE, so that EVs should be introduced to the low income areas to improve their mobility together with a proper government policy; and,

5.181 Increase in the fuel cost has been burden to farmers. Therefore, introducing electric agricultural machines can reduce the production cost of agricultural products as well as improve the environment in the rural areas.

6. IDENTIFICATION OF MODEL PROJECTS

6.1 Approach

1) Rationale

6.1 Model projects are meant to be test beds of the economic and financial viability of selected interventions for wider EV adoption. As such, they serve to pilot-test institutional arrangement, identify human resource needs, and probe public acceptance. EV manufacturers have tested the big auto markets in many industrialized countries, but have yet to do so in Laos, which is a very small market compared to the more mature markets in Europe, USA and G-20 countries.

6.2 Aside from the lack of commercial heft, Laos does not yet have the legal and policy environment for EVs to flourish naturally. Therefore, for EV to gain any significant foothold in the Lao PDR, the government has to take the lead, manage the promotion via model projects, and clear doubts and wrong perceptions about EVs.

2) Approach

6.3 As a result of analysis in Chapter 4 and 5, it is clear that Lao PDR can gain the significant benefits from EV introduction and there are various opportunities to introduce EVs. However, the EV technology is not yet fully established, and the available models in the market are still limited. It is expected that the development of EV technologies and the expansion of EV market will be accelerated from 2015 to 2020. In order that Lao PDR benefit effectively from the expected EV development situation in near future, it is advisable that Lao PDR should design the appropriate model project and implement it. Through implementing the model project, the introduction opportunities of EVs shall be clarified further, and the EV promotion mechanism including regulations and human resources needs to be developed to promote EVs in the whole country.

6.4 The model project was selected considering the following;

(i) The model project will cover EV related issues comprehensively (technology, social, economy, and regulations/organization).

(ii) EV users will be invited from the various groups in the society.

(iii) The role of stakeholders to promote EVs will be identified (especially, role-sharing between public and private sectors).

(1) Participants for Model Project

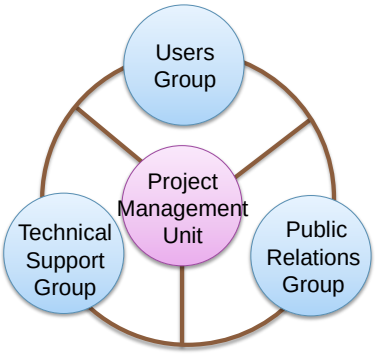
6.5 It is necessary to invite the participants for Model Project from the various groups of people. The participants for Model Project will be composed of EV users, technical support group and project management group of the government.

(i) EV users group: This group includes ordinary people (individual, household), business group (transport operators, tourism business, logistics, etc.), public transport associations, the local government/public service providers, and others (NGO, community).

(ii) Technical support group: This group will conduct maintenance and conversion of EVs during the project, which will promote the technical support system of EVs at the local level.

(iii) Public relations group: This group will publish the process and the results of Model Project to the society to make society to recognize and understand properly EVs.

Figure 6.1.1 Participants for Model Project



Source: JICA Study Team

(2) EV Type for Model Project

6.6 The types of EVs will be selected from the various models. So the advantage and disadvantage of each EV and suitability to Lao PDR will be evaluated. The types of vehicles are supposed to be motorcycles, passenger cars, taxi/commercial utility vehicles, paratransit vehicles (tuktuks, songthaews, and equivalent vehicles of them), mini-buses and small trucks.

Figure 6.1.2 Examples of Available EVs for Model Project

SEED60 (Terra Motors) 	EC-03 (YAMAHA) 	EV-neo (HONDA) 
B-com Basic (TOYOTA) 	Pecolo (Prozza) )	E-trike(Terra Motors; under development) 
LEAF (NISSAN) 	Minicab MiEV (MITSUBISHI) 	e-NV200 (NISSAN) 
Minicab MiEV Truck (MITSUBISHI) 	TU(Takeoka Motor Craft) 	WEB-03(Waseda University) 

Source: Web-site of each company

6.7 Regarding the specification of EVs, the vehicle operating condition in Vientiane Capital was studied using GPS and thermometer to clarify the required specification of EVs to introduce in Lao PDR, (see ***Appendix 1.3***). As a result, the following specification was identified as required specification of EVs for Lao PDR. EVs of OEM already have a similar or better specification, so that the introduced EVs in the model project were selected from OEM products. In terms of motorcycles and passenger cars, based on the person trip survey by JICA (2010), the average daily travel distance is 40km for motorcycles and 50km for cars. The average parking time at school or workplace is about eight hours for both motorcycles and cars. The range of OEM e-motorcycle and e-car is about 40km and 100 km. Therefore, OEM EV can satisfy the travel demand of users. In addition, eight hours of parking time is enough to charge those EVs.

Table 6.1.1 Required Specification of EVs for Lao PDR

			JUMBO Alternative	Tuktuk Alternative	Songthaew	Microbus	Minibus
Dimension	Curb Weight (kg)		300	650	1,100	1,170	4,710
	Passenger Capacity (no.)		4	6	6	12	31
	Gross Vehicle Weight (kg)		580	1,040	1,450	1,950	6,725
	Drag Coefficient (Cd)		0.65	0.65	0.4	0.4	0.4
	Acceleration (g)		1.88	1.88	1.97	2.09	3.79
	Coefficient of Friction (μ)		0.015	0.015	0.01	0.01	0.01
Motor and Controller	Manufacture		Curtis	Curtis	Meiden	Curtis	Yasukawa
	Controller Type		1238-5601	1238-6501	-	1238-6501	QMET-II
	Voltage (V)		48	72	330	72	300
	Power at peak (kW)		19	28	25	28	122
	Maximum Torque (Nm)		85	137	196	137	200
	Max (rpm)		7,500	6,500	10,000	6,500	12,000
	Efficiency (%)		89	89	90	89	90
Battery	Type		Li-ion	Li-ion	Li-ion	Li-ion	Li-ion
	Voltage (V)		48	72	330	72	240
	Capacity (kWh)		10	10	16	15	30
Performance	Acceleration (second)	0-20km/h	1.8	1.6	1.5	1.8	2.3
		0-40km/h	3.9	3.7	4.6	4.9	4.8
		0-100m	8.7	8.8	9.6	9.8	9.8
		Max gravity (G)	0.29	0.33	0.36	0.30	0.25
	Max. Speed (km/h)	0% Grade	87.4	87.5	94.7	66.2	91.7
		4% Grade	68.5	66.0	54.7	55.0	71.1
	Max Grade (%)		31	34	37	31	25

Source: JICA Study Team

3) Screening Potential Projects and Evaluation Criteria

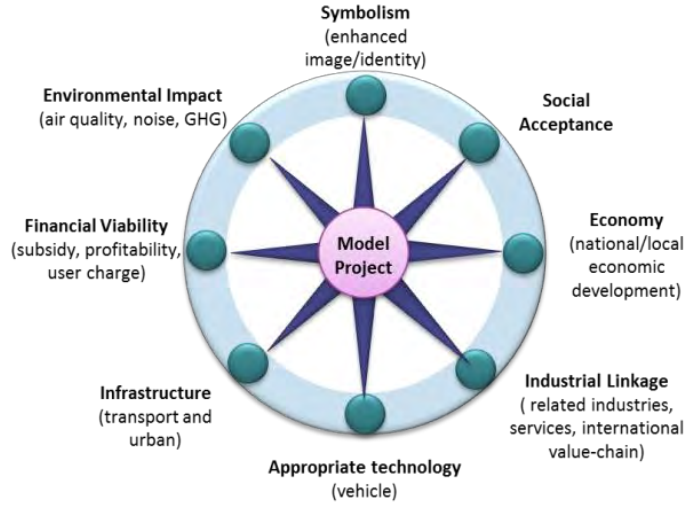
6.8 From the strategies in Chapter 4 and situation analysis of main cities in Chapter 5, it is possible to identify a long list of candidate projects for EV adaption in Lao PDR. From this long list, a short list can be culled to constitute the model EV projects based on key evaluation criteria. The final selection can then be made based on studies and consultations with stakeholders in 2–3 selected cities - including central and local government, communities, and the private sector.

6.9 By design, model projects are small in scale, but have the potentials of being scaled up and replicated in other cities/areas of the country - after some fine-tuning and

lessons learned during model implementation.

6.10 In the selection of model projects, eight (8) criteria or factors were chosen, as shown on Figure 6.1.3.

Figure 6.1.3 Factors for Selection of Model Projects



Source: The Study Team

(i) **Symbolism:** EVs are the visible manifestations of an environmentally, socially, and economically sustainable country. The project should symbolize the country's vision of a sustainable country, aside from enhancing its global identity in the international community.

(ii) **Social Acceptance:** Ultimately, it is the public who will judge whether the EV is acceptable or not through the exercise of their market power. They will either buy or use EVs to fulfill an economic or social need. For private vehicle owners, what matters are price, fuel efficiency, convenience, and reliability. For public transport users, frequency, fare, accessibility, and convenience would rank high in importance.

(iii) **Economic Benefit:** The EV projects should produce real economic benefits to the country and to its users. Reduced dependence on foreign oil is a national benefit. Reliance on domestic sources of energy improves the security of the country's transport system as it becomes less vulnerable to international oil supply chains. Lower energy cost per kilometer adds consumer surplus, and reduces overall Lao transport cost.

(iv) **Industrial Linkage:** The introduction of a particular form of EVs changes the support industries. Instead of mechanics for repair and maintenance of ICE engines, the EVs will require technicians for electrical motors and electronic controls. Some of the parts industry, such as battery manufacturing might emerged in the country. Less-complicated EVs can be supported domestically without major adjustments, but the more sophisticated ones would rely on international supply chain to be sustainable. Hence, an EV project that can be supported locally is preferable.

(v) **Appropriate Technology:** Somewhat related to industrial linkage is the appropriateness of the EV technology. There are many kinds of EVs in the world; some are mature, sold commercially and competitively-priced, others are still under development. Lao PDR cannot afford unproven technologies, much less introduce

EVs not needed or demanded by local conditions. Hence, projects that rely on proven technologies and meet already existing needs should be given priority over those projects more suited to developed countries.

(vi) **Infrastructure:** For EVs to become dominant, a national network of charging stations (much like petrol stations for ICE vehicles) has to be established. There is a chicken-and-egg situation here, as the charging station is not viable unless there is a sufficient base or number of EVs; on the other hand, few would buy EVs without assurance of availability of re-charging facility. A model project that is not dependent on extensive infrastructure, such as self-charging EVs, deserves higher priority.

(vii) **Financial Viability:** At present, prices of EVs are higher than those of conventional vehicles. Hence, without financial incentives such as subsidies and tax deductions, buyers will avoid EVs. However, the government cannot justify incentives beneficial only to a few, nor can it sustain such a scheme without undermining its fiscal base in the long run. The savings in energy cost, however, if sufficiently large, could tilt the balance. A project whose viability is not dependent on subsidies deserves higher priority over those that require them.

(viii) **Environmental Impact:** One of the main benefits of EVs is an improvement in the environmental footprints. Projects that generate bigger reductions in GHG emissions are preferable to those that have only minor impacts.

6.2 Concepts of Candidate Projects

6.11 Considering that Model Project is an opportunity to promote EVs to all over the country and to evaluate the applicability, candidate projects were created for the following regional classification.

(i) Vientiane Capita: a capital of Lao PDR, largest city

(ii) Luang Prabang City: tourism city with the world heritage site

(iii) Kayson Phomvihane and Pakse: local core cities in the southern part of Lao PDR

(iv) Transport corridor

(v) Rural area

1) 100 EV Pioneer project

6.12 While the next project is aimed at public transport users, the target for this project is private users. It is similar to the market testing done by EV car manufacturers in other countries. A number of electric cars are assigned to individuals who are willing to participate in the study. These individuals or families use the vehicle in their regular activities and report back performance data over an experimental period (1 – 2 years). After the period of testing, the vehicle is either returned to the sponsors or purchased by the user at discounted prices.

6.13 This project will enable ordinary households and private entities to experience EVs, and for manufacturers to collect operational data in different situations. Analyzing collected data and information will be useful to identify the most possible EV introduction system for next stage after 2016 (diffusion stage). While the number of EVs is small (at 100 units), the impact should extend beyond them, especially if they are known in the community and their personal experiences inspire future users of EVs.

6.14 The pioneering 100 will be chosen by types of vehicles and travel purpose, from among volunteers or applicants. Various types of EVs will be introduced such as e-motorcycles, e-passenger cars, and e-light trucks. A tentative grouping is shown in Table 6.2.1. Selected volunteers are examined if their travel mode and purpose can be replaced by EVs in terms of technology. The volunteers who pass the screening will discuss with the project implementation unit (PIU) on cost sharing of EV introduction and maintenance.

Table 6.2.1 Target Segments for 100 EV Pioneer Project

	No. of EVs		
	Motorcycle	Passenger Car	Light Truck
Private use: Commuting	20	10	-
Private use: at business and other private purpose	20	10	-
Public transport (including taxi)	-	10	-
Public services and other public purpose	10	10	10

Source: JICA Study Team

Figure 6.2.1 Example of EV in Commercial Production

Source: Web-site of auto manufacturers

6.15 Part of the model project is the installation of charging stations. Although the 100 EVs can be equipped with self-charging device, it is necessary to provide charging stations at key sites in the city where the 100 units would generally operate.

6.16 The users shall record their daily driving experiences (distance, time, area), re-charging situation (amount of charging, charging time, charging location), expenditure (monthly electric tariff, maintenance cost), and user's impression (advantage, disadvantage, concern, improvement points). In addition, the users will be interviewed by PIU to extract more valuable information about EV use and performance.

6.17 PIU will provide technical support to volunteers and create opportunities to share information among participants. After two years, the PIU will analyze the data collected and recommend measures for medium- and long-term diffusion of EVs in Lao PDR.

6.18 The users are expected to contribute to the cost of the project (see Table 6.2.2). The indicative project cost is USD7.2 million, which covers vehicle cost and charging infrastructure. For the 100 pioneer project, it is proposed that taxes be waived by the government.

Table 6.2.2 Project Cost for 100 EV Pioneer Program[1]

Item	Quantity	Base Cost (USD 000)	Alternative (USD 000)		
			Tax Exemption on EVs	(1) + Sharing EVs cost1)	(2) + Sharing charger cost2)
		(0)	(1)	(2)	(3)
Motorcycle	50	608	403	367	367
Passenger car	40	4,477	3,030	2,526	2,526
Light truck	10	521	299	262	262
Charging Station	205	134	134	134	82
Total	-	5,740	3,866	3,289	3,237

Source: JICA Study Team
1) Volunteers pay equivalent cost of ICE vehicles.
2) Volunteers pay charging infrastructure for garage/origin side.

[1] Special tax incentive on electric cars by the government was applied for calculation, i.e., import tax is 1 % only. In addition, new excise tax on electric motorcycle was applied for calculation, which is 20 percent lower than that charged for fuel powered motorbikes. The same tax rate was also applied for other projects.

2) E-Transit for Vientiane Capital

6.19 New registration of tuktuk and Jumbo is prohibited in Vientiane Capital (3,439 three-wheelers in Vientiane Capital, 2010) ostensibly because of their substandard conditions (emissions, noise, unsafe). Songthaew is still allowed to newly register, but the vehicle condition is similar to tuktuk. However, banning them is not a solution, since they fulfill a need and are essential elements of the public transport system.

6.20 Instead of a ban, what is envisaged is the expansion of the public transport system by introducing EVs to replace tuktuk and songthaew as the modern and safer modes of paratransit. This can take two forms: replacement or retrofit. Replacing existing paratransit vehicle to new electric units utilize vehicle designs more suited to electric energy, while retrofitting replaces the motive power of existing vehicles into electric motors. The model project can examine the viability of the two tracks - replacement and conversion. As was discussed in Chapter 5, Vientiane needs to expand its public transport coverage, before dependence on private cars become endemic. As the center of administrative and economic activities of Lao PDR, it has to show the way for other urban centers to follow.

6.21 The most obvious project is to introduce e-Trike (to replace the improvised tuktuks) operating as a shared taxi within defined zones of the city feeding into e-Paratransit operating in a fixed route. The model project is conceptualized to comprise 100 e-Trikes (6-seat capacity) and 10 e-songthaews (12-seat capacity).

6.22 The specific area and route have to be delineated, followed by selection, procurement and deployment of the desired EVs. Estimated project cost is shown on Table 6.2.3.

Figure 6.2.2 Existing and Proposed E-paratransit

	Jumbo	Tuktuk	Songthaew (small)
Existing			
Possible Replacements	E-Trike (Philippines, ADB) 	E-Trike (India) 	e-6 (GEM) 
	E-microbus (China) 	E-Minibus (Spain) 	E-microbus (Bremen) 

Source: ADB, MITSUBISHI, GEM, JICA Study Team

Table 6.2.3 Estimated Cost for e-Paratransit Project

Vehicle Type		Quantity	Base Cost (USD)	Alternative Costing (USD)		
				Tax Exemption on EVs	(1) + Sharing EVs cost1)	(2) + Sharing charger cost2)
			(0)	(1)	(2)	(3)
Three-wheeler	Conversion	10	180,800	165,000	127,944	127,944
	Replacement	90	3,842,640	3,443,040	3,109,534	3,109,534
Songthaew	Conversion	5	179,040	161,990	118,855	118,855
	Replacement	5	193,140	130,015	86,880	86,880
Charging Station		220	339,700	339,700	339,700	241,100
Total		-	4,735,320	4,239,745	3,782,912	3,684,312

Source: JICA Study Team
1) Volunteers pay equivalent cost of ICE vehicles.
2) Volunteers pay charging infrastructure for garage/origin side.

6.23 It is anticipated that existing owners of paratransit vehicles (tuktuk and songthaew) will have financial difficulty in buying EVs to replace their fleet. Hence, it may be necessary to provide a soft-loan financing facility that includes partial subsidy through paratransit associations. Through this project, the different paratransit associations will be reorganized and provided with capacity for coordinated scheduling. This project can access ODA, which would in turn require the establishment of a PIU to manage the project in closed coordination with the associations as well as with Vientiane Capital State Bus Enterprise (VCSBE). Expected project duration is 1.5 years (2014 - 2015).

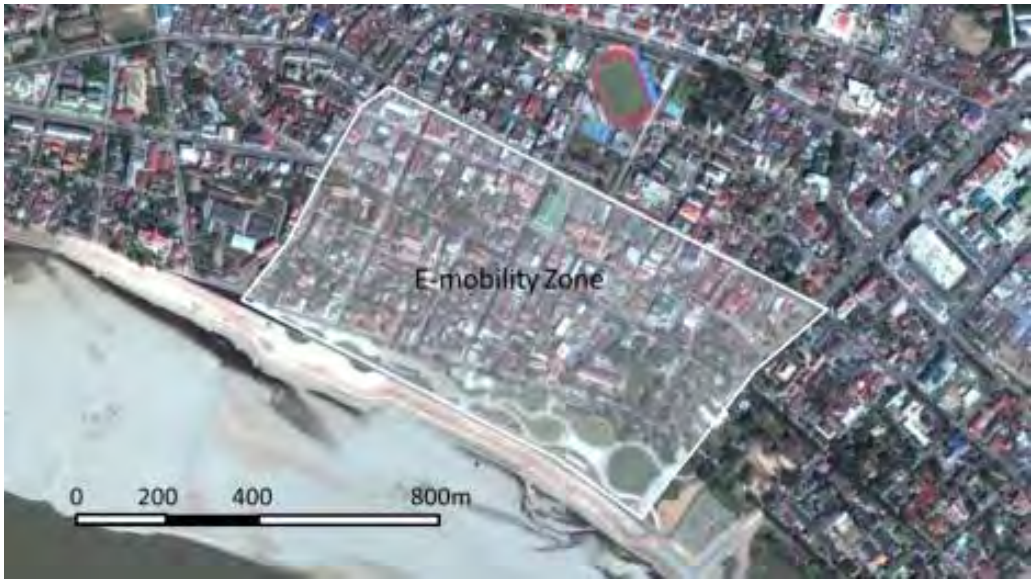
6.24 After the model project, the MPWT, in conjunction with MOF, should consider new regulations governing the franchising of E-paratransit with the following features:

1) Close the door for new applications for paratransit business permit unless they are EVs;
2) Phase out old paratransit in 5 years, beginning with those 10 years or older, to be progressively lowered by 2 years every year after the date of enactment;
3) Impose a new minimum service standard (MSS) that specifies seat space, noise level and other safety requirements for vehicles.

3) E-mobility Zone project

6.25 This project is a second-stage project, after the successful piloting of EV use in selected cities. Under this project, E-mobility zone will be designated in the city center where only green transport will be allowed and corollary traffic management schemes are introduced.

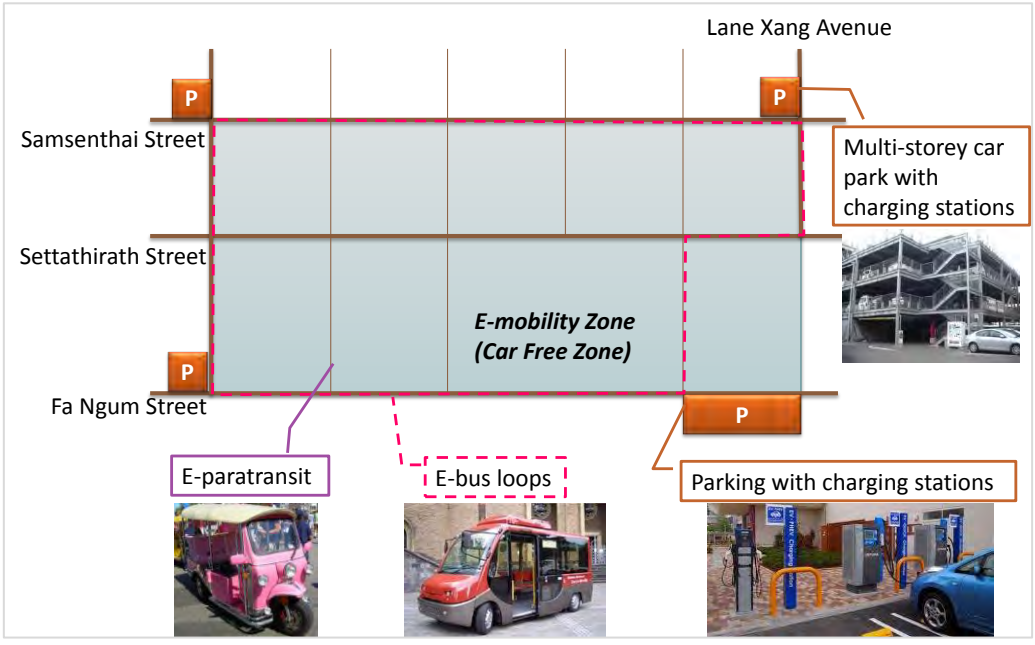
Figure 6.2.3 Proposed E-mobility Zone in Vientiane Capital



Source: JICA Study Team

6.26 The project concept is to use the EV only as a trigger to improve the overall transport and living environment of the city center through an integrated approach of urban development. Traffic management, parking management, creation of urban landscape and other actions will be conducted in conjunction with EV deployment. This is illustrated in Figure 6.2.4.

Figure 6.2.4 Schematic of E-mobility Zone



Source: JICA Study Team

4) EST Lane Project

6.27 This can be considered as a follow up to the E-transit project, or implemented together to promote public transit patronage. The rationale is to reduce travel times of users on the lane in a situation of traffic congestion. Obviously, this can only be introduced

when there is already sufficient number of EVs on the road, and only on wide streets of 4 or more lanes. Premature delineation of roads exclusively for EVs could backfire, as empty road space would create resentments from motorists caught in traffic on the remaining lanes.

6.28 The basic model in a bus priority lane. In other countries, shared use vans and other high occupancy vehicles are allowed to use this lane. To promote EV propagation, the priority lane can be opened to EVs on the road. It loses its efficacy when there are more EV cars on the road. In short, EST lane can only be an interim arrangement.

6.29 As the largest urban center, Vientiane capital is the logical target for examining the effectiveness of priority public transport lane in conjunction with promotion of EVs along main transport corridors. However, only Lane Xang Avenue (1.5 km) has enough road width that can accommodate a priority lane. But this road also does not have the extra lane at intersections. With very few public transport vehicles, allocating such a lane would be counter-productive. Considering the above condition, this project could focus on a short section of the road for demonstration purposes. The first task, therefore, is to identify the most suitable road section where it can be introduced.

5) EVs in Tourism Area (Luang Prabang)

6.30 Luang Prabang is a core of tourism in Lao PDR. The number of visitors increased from 133,569 in 2005 to 210,783 in 2010. The increase in the number of tourist brings more investors to the city too. Tourism sector is one of the key economic drivers in the development of the city. However, its downside is the increase in vehicular traffic. During peak season for tourists, this traffic balloons at the city center which causes traffic congestion and honky-tonk atmosphere.

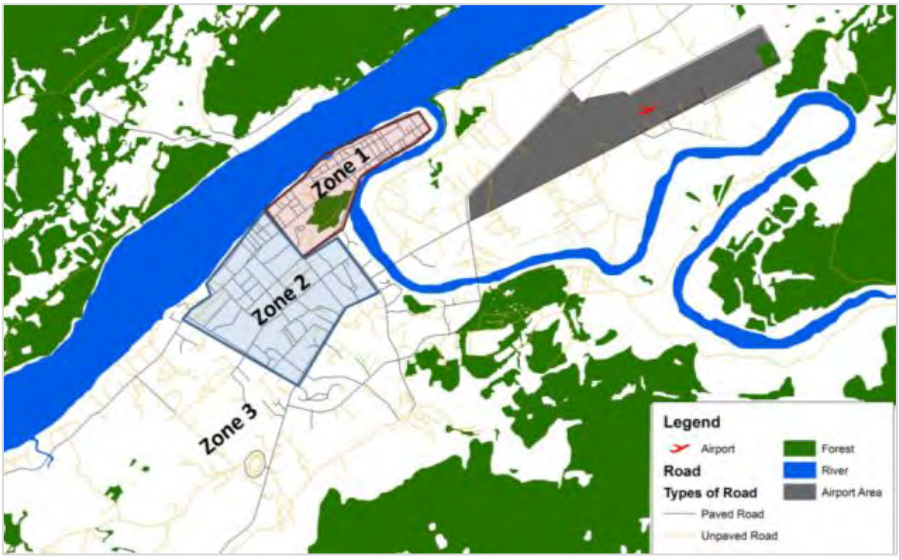
6.31 Urban sprawl is also occurring in the city. People with properties in the city center rent out their building/land to others who want to set up tourism-related businesses, while they relocate to the quieter suburbs.

6.32 Introducing EVs in Luang Prabang will mitigate the negative impact of tourism as well as enhance its international appeal as a world heritage site. The project is meant to address various demands of tourists - such as access to the airport, movement into the city core, and travels to other tourism sites. The EVs should therefore be designed to cater to this market niche, and must have the appropriate range per charge, highly comfortable, and allows panoramic viewing.

6.33 The main tourism zone is defined by Si Savangvong Road and Sakkaline Road. As part of the activities of the model project, this zone will be studied in order to characterize its unique features and delineate the transport corridor and pedestrian-only areas. Many temples, the national museum (old palace), and Phu Si Hill are located along the Si Savangvong Road and the Sakkaline Road. At night, many tourists also converge on the night market along Si Savangvong Road. During the night market (5 PM – 10 PM), vehicles are prohibited to enter the Si Savangvong Road.

6.34 Si Savangvong Road and the Sakkaline Road are two lane roads 12 to 16 m wide. However, they have narrow loading/unloading lane, so that vehicles stopping for passengers disrupt the smooth flow of traffic. The presence of lodging houses, restaurants and shops along these roads create additional roadside friction, compounded by lack of parking spaces and street vendors occupying sidewalks.

Figure 6.2.5 Area of Entrance Restriction



Source: JICA Study Team worked out based on Information from DPWT

6.35 The project entails the deployment of 90 EVs of various categories to be owned and operated by selected residents and entities. As shown in Table 6.2.4, 10 of each type of EVs are to be introduced. The estimated cost is shown in Table 6.2.5.

Table 6.2.4 Target Users for EVs in Tourism Project

Area	Users	Motorcycle	Passenger Car	Paratransit
World Heritage Site	Resident	10	-	-
	Public Transport (including Taxi)	-	10	10
	Public Service, Other services	10	-	-
Other Area	Commuter to the World Heritage Site	10	-	-
	Residents	10	-	-
	Public Transport (including Taxi)	-	10	10
	Public Service, Other services	-	10	-
Total		40	30	20

Source: JICA Study Team

Table 6.2.5 Project Cost for Tourism EV Project

Vehicle Type	Quantity	Base Cost (USD 000)	Alternative (USD 000)		
			Tax Exemption on EVs	Tax Exemption on EVs[1)]	Tax Exemption on EVs[2)]
		(0)	(1)	(2)	(3)
E-Motorcycle	40	117	97	68	68
E-paratransit	10	427	383	339	339
EV airport taxi	10	1,600	1,128	1,002	1,002
EV Hotel guest car	10	386	260	174	174
EV personal mobility vehicle	10	260	186	179	179
Charging Station	74	84	84	84	49
Total	-	2,757	2,040	1,778	1,744

Source: JICA Study Team
1) Volunteers pay equivalent cost of ICE vehicles, 2) Volunteers pay charging infrastructure for garage/origin side.

6) E-Paratransit for Secondary Towns (Kayson Phomvihane City and Pakse City)

6.36 The secondary urban centers are not yet as congested as Vientiane Capital.

However, without early interventions to improve their public transport, they could be overtaken by rapid motorization and become dependent on private modes of transport. To forestall this eventuality, EV paratransit can be introduced. Also, since the growth in motorization will be dominated by motorcycles, it is ideal to channel this growth into EV motorbikes.

6.37 The proposed model project shall involve the deployment of 20 units of EV equivalents for public transport use, in the cities of Kayson Phomvihane and Pakse (see Table 6.2.6). It is envisaged that 5 E-Trikes and 5 E-micro Bus shall be piloted in each of the two cities.

Table 6.2.6 Estimated Cost for E-transit Program

Vehicle category	No.	Cost excluding tax (USD)	Cost including tax (USD)
E-Trike (equivalent to Tuktuk)	10	308,750	508,750
E-mini bus (equivalent to songthaew)	10	219,110	445,610
E-charging & maintenance facility	-	50,000	85,000
Technical assistance	-	100,000	100,000
Total	20	627,860	1,139,360

Source: JICA Study Team

6.38 The project is likely to fail if it is limited to the simple acquisition and deployment of E-vehicles. Establishing a modern public transport system is the objective. Accordingly, the following tasks shall also be performed:

(i) Review of the existing urban structure and major origins and destinations;

(ii) Design of an appropriate and responsive route networks;

(iii) Survey and analysis of current operations of tuktuks and songthaews;

(iv) Review, evaluation and selection of suitable E-vehicles (e-tuktuk and e-mini bus);

(v) Seek donor assistance (and/or supplier's sponsorship) in the acquisition of 10 e-Trikes and 10 e-mini buses

(vi) Selection, training, and organization of drivers and technical support staff;

(vii) Distribution of EVs to trained participants;

(viii) Deploy the units into designated routes, monitor performance, make adjustments as maybe necessary;

(ix) Document lessons learned, and recommend scaling-up of the paratransit program.

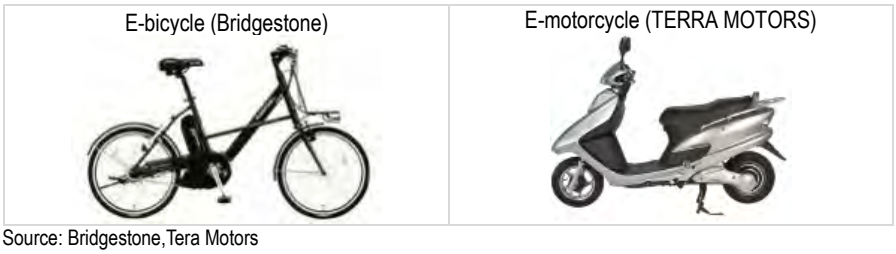
6.39 As a pilot project, the project can tap ODA funding as well as supplier support and be given tax exemptions. The operators/drivers of the EVs shall also contribute some amounts, as ownership of the units shall devolve to them at the end of the pilot test. Expected project duration is three years (2013 – 2015). A soft loan (e.g., lease-to-own financing) can be introduced by the local governments sweetened by trade-in mechanism for old units.

7) E-Bike project

6.40 The rapid increase in motorization is expected to be dominated by motorcycles – for reasons of income. This project is similar to the 100 Pioneer Project proposed for Vientiane capital and Luang Prabang City, except that it will be limited to E-motorbikes and to other urban centers of Lao PDR. The candidate site is Kayson Phomvihane and Pakse

as well as rural areas. In the former, a survey revealed that more than 80% of the respondents own a motorcycle, and more than 50% have one or more bicycles at their household. Since E-bikes are financially and economically viable for Lao PDR, the model project is really intended as a promotion towards phase-in of E-motorcycles in lieu of the noisy and gas-fed ICE motorcycles.

Figure 6.2.6 Example of E-bicycle and E-motorcycle



Source: Bridgestone,Tera Motors

6.41 As in the 100 Pioneer Project, the initial units of E-bikes is proposed to be granted exemption from import taxes. Individuals and entities will be selected based on eligibility criteria and ability to share part of the cost of the units that will theirs at the end of the project. To obviate the need for a charging facility, these units should have built-in chargers, so that they can be re-charged at home. However, for demonstration purposes a public charging facility in a convenient and publicly-visible place (like a market) should be installed. Figure 6.2.7 and Figure 6.2.8 show suggested locations of charging stations in Kayson Phomvihane and Pakse.

Figure 6.2.7 Potential Sites for Public Charging Stations in Kayson Phomvihane

Source: The Study Team

Figure 6.2.8 Potential Site for Charging Stations in Pakse District

Source: The Study Team

6.42 In the course of the model project, the participants are expected to participate in publicity events, users' forum and other promotional activities. In addition, they will be asked to provide periodic reports.

8) EV Remodeling Center Program

6.43 The benefits to replace ICE vehicles to EVs are very clear, and many people expressed willingness to use EVs in Lao PDR. However, the price of EVs is still high while the running cost is lower than that of ICEs. Furthermore, the disposal of ICE vehicles will be a problem if they are replaced with EVs. Japan has faced the same issue, such that conversion became a practical option. Converted EVs are EVs which are retrofitted but utilizing basic ICE vehicles. Thus, the bodies of ICE vehicles are retained, but its motive power is replaced. In general, the converted EVs have lower performance than OEM EVs because of heavier body mass. However, they are usable for urban use or short distance trips. Moreover, the initial cost may turn out to be lower than OEM EVs.

6.44 This project aims to establish EV remodeling center – where conversion of existing ICE vehicles into EVs are performed. In so doing, practical EV technologies can be accumulated, aside from promoting skills development. In the future, it could spawn new local industries and employment opportunities.

6.45 The preparation of the model project includes establishing regulations and guidelines for vehicle standards for converted EVs, particularly on body design and configuration, power-to-weight ratio, emission levels, and other safety parameters. For safety and efficiency, it is necessary to set technical and safety standards and provide initial guidance to retrofitting shops.

6.46 Accordingly, it is advisable to conduct the model project in cooperation with trade and vocational schools that have related know-how in mechanical and electrical works. Estimated project cost including conversion kits for 100EVs are shown below.

1) Installation cost

USD19,660 x 100 paratransit vehicles = USD1,966,000

2) Training materials compilation and training automobile mechanics

USD20,000

3) Promotion	USD100,000
4) PIU Administrative costs	USD100,000
	TOTAL USD2,186,000

6.47 MPWT and MOF will be leading agencies at national level, and DPWT will be an executing agency in cooperation with Department of Energy, and traffic police for the education of safe-driving practices.

9) E-Transport Corridor

6.48 National and provincial roads provide the arteries for regional development of the countryside. Their current conditions are generally poor. Of the 15,200 km of national and provincial roads, only 34% are paved. It is expected that the government will continue to improve and upgrade these roads. The proposal is to incorporate EV charging stations as a component of roadside stations to be developed with broader functions along these roads in conjunction with road upgrading.

6.49 The roadside station (known as Michi-no-Eki in Japan) is a rest area along roads and highways. In addition to providing places for travelers to rest, they also provide a convenient market outlet for local products, a hub for information sharing, and a center for extending public services (e.g., health and postal services). Charging facility for EVs shall be set up in these stations. This will address the concern about short cruising range of EVs.

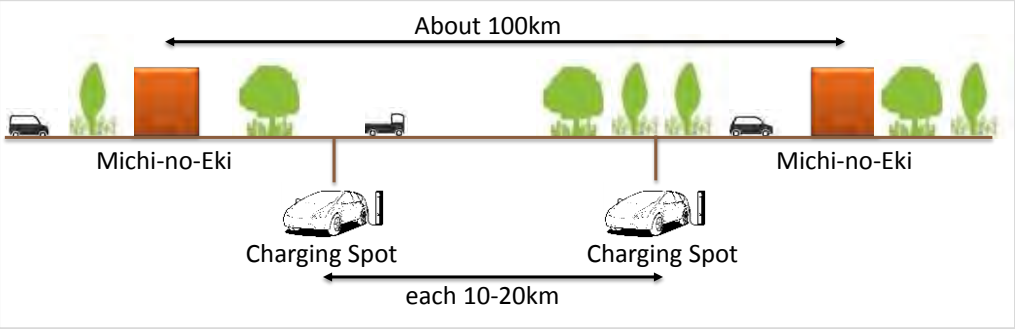
6.50 At present, only Savannakhet Province has Michi-no-Eki along the major roads. None of them have EV charging facilities. While there are gas stations along major roads, their intervals are irregular. The objective of this project is to set up prototype Michi-no-Eki with charging stations and repair shops for EVs.

6.51 This project shall encompass the formulation of EV Michi-no-Eki plans to be implemented via PPP scheme along the Vientiane – Luang Prabang corridor (≈ 400 km). The EV Michi-no-Eki shall be operated and managed by the private sector and its community. The basic infrastructure and facilities should be constructed as a part of road projects by government.

6.52 Components of EV Michi-no-Eki can vary by locations. Not all EV Michi-no-Eki needs to have the full range of services. For example, full-service Michi-no-Eki cum EV support station shall be established every 100 km, but semi-furnished ones at 50 km interval. The function of EV Michi-no-Eki includes rest area (toilet, parking), information center (local information including tourism sports and traffic information), community cooperation facilities (restaurants, souvenir shops, local products shops, etc.), and EV supporting facilities (charging stations, repairing shops).

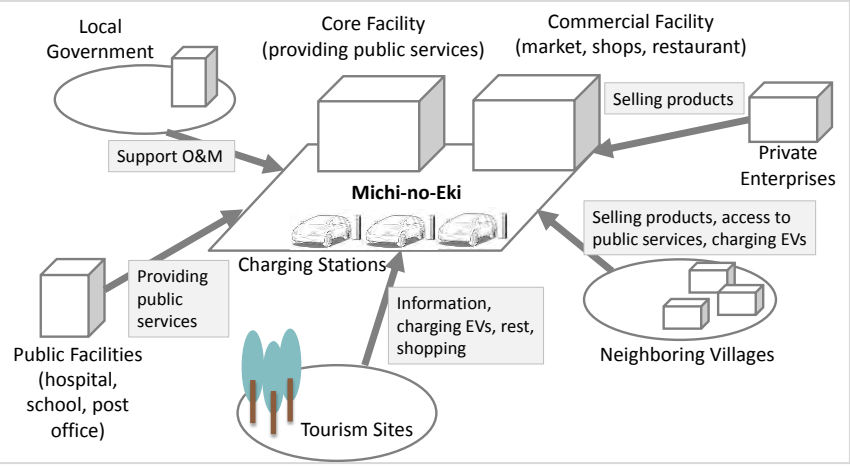
6.53 To be viable, the EV Michi-no-Eki needs to be located strategically, with sufficiently large catchment area. Its customer base is not limited to travelers, but also residents in the surrounding region. The design of the EV Michi-no-Eki has to consider its target market. Road development plan and development needs of localities should be carefully studied to identify the location and service scope of EV Michi-no-Eki.

Figure 6.2.9 Spacing of EV Michi-no-Eki on Major Roads



Source: JICA Study Team

Figure 6.2.10 Conceptual Plan for EV Michi-no-Eki



Source: JICA Study Team

Figure 6.2.11 Michi-no-Eki in Japan

Appearance

Charging Station

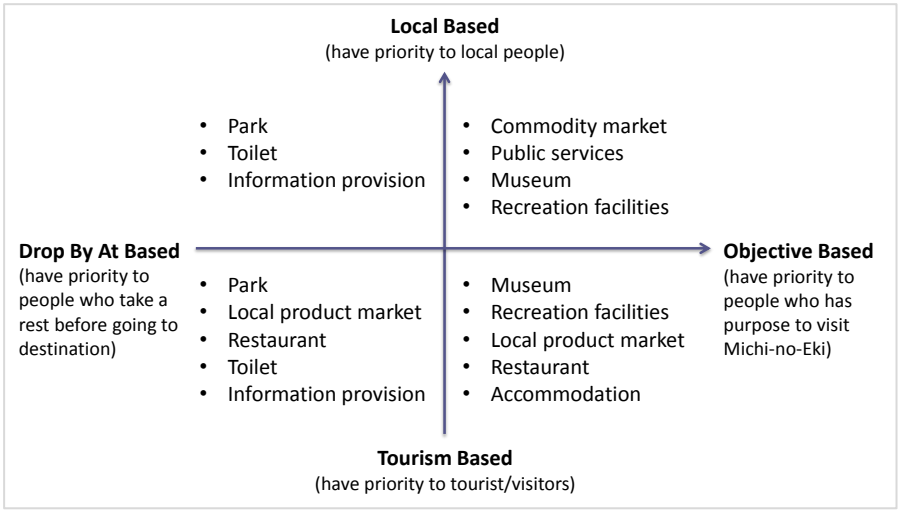
Market

Source: Michi-no-Eki web site

6.54 Construction cost of EV Michi-no-Eki depends on the site and range of functions. For budgetary purposes, the cost range is USD375,000 – 625,000 for one EV Michi-no-Eki. The cost of charging stations is USD3,500 per standard charger and USD25,000 per rapid charger.

6.55 It will be cheaper to install EV charging equipment together with Michi-no-Eki or parking area rather than afterward. Lao PDR still needs a lot of investment for road infrastructure development. Once Lao PDR decides to introduce and promote EVs. EV related infrastructure should be considered together with other infrastructure development, so that Lao PDR can develop EV infrastructures more effectively and efficiently.

Figure 6.2.12 Types of Michi-no-Eki and its Functions

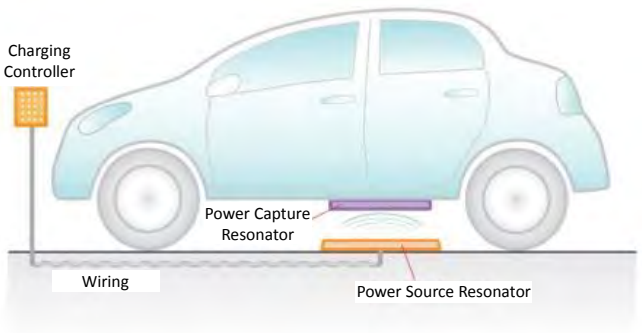


Source: Tajimi city (Gifu prefecture, Japan)

6.56 EV Michi-no-Eki Master Plan will be formulated under MPWT in cooperation with DPWT in the provinces. Investment program for EV Michi-no-Eki will be considered in the coordination with MPI. While pilot project may be possible to be assisted by ODA, it is essential to establish PPP scheme to expand project nation-wide and to sustain the operation and management of EV Michi-no-Eki. The proposed schedule for this project is as follows.

6.57 A safer option for chargers at roadside stations is to install wireless charging facilities. EVs can be charged without physical wires. EVs in need of re-charging can do so while parked, or by passing through a charging lane equipped with contactless charging equipment underneath of road surface. At the moment, this technology is still expensive and still under development in such countries as Japan, Korea, and Italy. They can be viable only in few selected stations with high demand or concentration of public transport.

Figure 6.2.13 Chart of a Wireless Charging Facility



Source: Electronic Bus Magazine

10) E-road Project

6.58 At present, standard charger and rapid charger are the mainstreams for charging equipment, which is the way to charge EVs through inlet plug of charger. However, it is expected that wireless charging facilities will become economical in the future. EVs can be charged without the need for physical cables or wires. For example, EVs can be charged while at the parking lot with wireless charging equipment, or when they pass through a

charging lane equipped with wireless charging equipment underneath the pavement.

6.59 This technology of wireless charging is still under development. Their biggest potential is for public transport network, because the vehicles (especially public buses) operate along fix routes. Therefore, only some parts of public transport route need to have wireless charging facilities. The demonstrations of wireless charging e-buses are being conducted in several countries including Japan, Korea, and Italy. The installation cost of wireless charging equipment can be reduced if done together with road construction.

Figure 6.2.14 Image of E-Road in the City

Source: WiTricity Corporation

Figure 6.2.15 Contactless Charging Facilities in the World

Contactless Hybrid Electric Bus (Tokyo)

Contactless Electric Bus (China)

Electric Bus with Wireless Charger (Italy)

Source: car watch, autobloggreen, wampfler

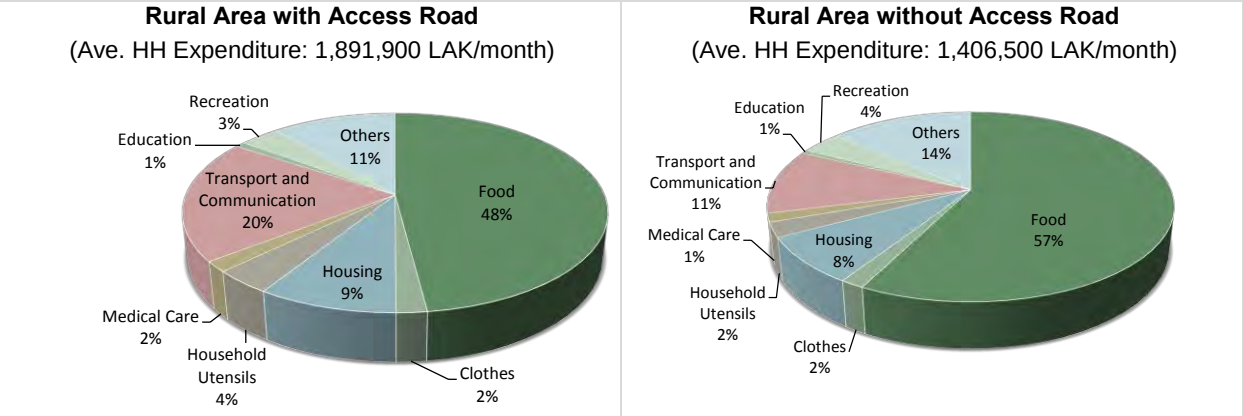
11) EV in Rural Areas Project

6.60 Rural areas are often lacking in basic infrastructure – especially in transport and power. Pockets of small villages spread thinly over large agricultural lands make such infrastructure uneconomical. Of the estimated 8,725 villages in 2009, 14% (1,265 villages) did not have access roads, while 36% (3,232 villages) are not connected to the power grid.

6.61 To compensate for these disadvantages, EV motorbikes can be provided as a shared resource as well as agricultural machines that can be powered from stand-alone solar cells. When not in use for transport, the EVs can also be used at nighttime to provide power supply to households. Such a technology is known as V2H. In contrast, ICE vehicles and machineries would need petrol trucked from afar and therefore expensive. In this manner, EVs assume dual purpose.

6.62 Justification for EVs in rural areas can be found in the Household Expenditure and Consumption Surveys of 2007/2008, which found that 10 to 20 % of the household budget is spent for transport and communication. In rural areas with limited access, the transport expenditure shoots up to 19.8%.

Figure 6.2.16 Expenditure Structure of Household in Rural Area (2007/2008)



Source: Survey Results on Expenditure and Consumption of Household 2007/2008 (LECS4)

6.63 Another feature of rural areas is the use of farm machinery (e.g. cultivators) also for traveling (see Figure 6.2.17). To insulate them from the galloping price of petrol, this farm equipment can be electric-powered. The electricity can come from renewable sources, such as mini-hydro and solar cells.

Figure 6.2.17 Farm Machinery in Savannakhet Province and Vientiane Province

Source: JICA Study Team

6.64 The objective of this model project is to determine the viability of EVs in rural areas, especially farm machinery that is also used for transport. Pilot villages can be selected under certain criteria, such as:

- Presence of other agricultural projects: Collaboration with existing project will get the cooperation of local people easily.
- Poverty rate: E-farm machinery provides financial savings as to supplement family incomes.
- Distance to nearest gas stations: Remote villages with no access to gas stations can benefit more from E-machinery.
- Accessibility to electricity: E-agricultural machine must need electricity, so that village should have access to either on-grid electric system or off-grid one.
- Commitment of local people: Without commitment of stakeholders, it is difficult for the project to succeed.

6.65 Aside from model village selection, there is a need to evaluate and select the appropriate type of farm machinery. Figure 6.2.18 shows some of these battery-powered machineries.

Figure 6.2.18 Example of Electric Far Machineries

Agricultural Tractor (ISEKI, Japan) (under development)	**Small Cultivator (ISEKI, Japan)**	**Agricultural Tractor (aike, Italy)**
		

Source: ISEKI, aike

6.66 At this stage, it is not possible to estimate the cost of the project. As in EV cars, those available in the market are still expensive, costing as much as twice the conventional ones. Accordingly, testing these machines on a pilot basis, combined with support charging infrastructure, should be funded by government and ODA support.

6.67 As in other model projects, there would be evaluation of results. The evaluation process may need a comparison with base case villages that use conventional farm machineries, as well as those villages without any.

6.3 Selection of Model Projects

1) Assessment on Candidate Projects by Stakeholders

6.68 Based on the opinions of stakeholders, introducing EVs for various uses in the urban areas and transport corridors is of higher importance than in rural areas. Moreover, one of the objectives of model project is to examine and promote social acceptability. For this reason, projects for public use (pioneer programs, E-mobility zone programs, etc.) are more suitable as model projects. This project can also respond the high interests of ordinary people in two cities (see Table 6.3.2). In terms of location, Luang Prabang City ranks high because of its eco-tourism character and the need to protect it from negative impacts such as transport pollution.

6.69 In terms of projects for the secondary cities, i.e., Kayson Phomvihane and Pakse cities, while E-transit program and EV remodeling center program have relatively high importance, e-bike comes in lower in priority. This may be attributed to the bad experience of early users of Chinese made e-bike of poor quality. They discovered that life expectance of its battery, cruising distance, and charging times were far below the promised performance. Users had trouble in re-selling these vehicles, for obvious reason. Thus, introducing an e-bike program into this environment would be a hard sell.

6.70 Regarding the projects for rural areas, opinion surveys are divided: 60 – 70% of people who answered the item (see ***Chapter 4***) gave priority to rural areas, while 50 – 60% of respondents who ignored this question did not give priority to projects for rural areas.

6.71 Some large projects such as EST lane and E-road project have high importance. However, survey respondents believed that it is too early to develop in Lao PDR.

Table 6.3.1 Assessment on Candidate Projects (% of respondents)

Proposed Model Projects		Importance		
		Low	Middle	High
Vientiane Capital	100 EV pioneer program	6.8	6.8	86.4
	E-paratransit program	8.9	13.3	77.8
	E-commercial program	9.1	20.5	70.5
	E-mobility zone program	6.8	9.1	84.1
	EST lane program	9.1	6.8	84.1
Luang Prabang	100 EV pioneer program	2.4	19.5	78.0
	Tourism EV program	7.0	7.0	86.0
	E-mobility zone program for core zone	7.1	4.8	88.1
Secondary Cities	E-transit program	2.6	25.6	71.8
	E-bike program	7.3	36.6	56.1
	EV remodeling center program	7.3	19.5	73.2
Transport Corridor	Develop model EV Michi-no-Eki	2.2	20.0	77.8
	E-road project	7.1	14.3	78.6
Rural Area	Program on introduction of EV for bike, multi-purpose vehicle	15.9	18.2	65.9
	E-paratransit program.	11.6	25.6	62.8
	E-agricultural machine program	26.7	20.0	53.3

Source: JICA Study Team

Table 6.3.2 People's Awareness on EVs

		Experience of EVs (%)	Interests on EV (%)	Support of EV Policy (%)
Vientiane	Citizen	42	82	95
	Enterprise	24	88	95
	EV users	100	100	100
Luang Prabang	Citizen	19	96	100
	Enterprise	21	78	93
	EV users	100	100	98

Source: Survey on Capacity to Introduce and Promote EVs (JICA, 2012),

2) Ranking of Candidate Projects

6.72 Based on the assessment by the stakeholders and considering the criteria laid out in Figure 6.1.3, the candidate projects were evaluated. 100 pioneer programs in Vientiane Capital and Luang Prabang, E-paratransit program in Vientiane Capital, Tourism EV Program and E-bike Program got relatively higher score. (see Table 6.3.3).

Table 6.3.3 Evaluation of EV Projects for Lao PDR

		Symbolism	Social Acceptance	Economic Benefits	Industrial Linkage	Appropriate Technology	Infrastructure	Financial Viability	Environmental Impact	Overall Score
Vientiane Capital	1. 100 EV pioneer program	5	5	5	2	5	3	3	5	4.1
	2. E-paratransit program	4	4	4	4	3	4	4	5	4.0
	3. E-commercial program	3	3	4	2	5	3	3	4	3.4
	4. E-mobility zone program	5	4	3	1	3	3	4	4	3.4
	5. EST lane program	4	4	1	1	1	1	1	3	2.0
Luang Prabang	1. 100 EV pioneer program	5	4	5	2	5	3	3	5	4.0
	2. Tourism EV program	5	5	4	2	5	3	3	4	3.9
	3. E-mobility zone program for core zone	5	5	3	1	3	3	4	4	3.5
Secondary Cities	1. E-transit program	3	4	4	2	3	4	4	5	3.6
	2. E-bike program	2	3	3	4	5	5	5	4	3.9
	3. EV remodeling center program	5	4	2	5	3	2	3	2	3.3
Transport Corridor	1. Develop model EV Michi-no-Eki	4	5	2	1	2	2	2	1	2.4
	2. E-road project	1	4	1	1	1	1	1	1	1.4
Rural Area	1. Program on introduction of EV for bike, multi-purpose vehicle	2	3	3	4	5	4	4	4	3.6
	2. E-paratransit program.	3	3	3	4	3	4	4	5	3.6
	3. E-agricultural machine program	3	1	3	2	2	2	2	2	2.1

Source: JICA Study Team
Notes: Score of 1 = Poor/Low; 2=Fair; 3= Good/Medium; 4= Relatively Good; 5=High/Excellent

6.73 In order to complement each other, selected Model Project is proposed as package programs of candidate projects considering the above result. The components of selected Model Project is as follows;

(i) **Component 1 100 EV Pioneer Program for Vientiane Capital:** This program is a 100 EV pioneer program which focuses more on commercial use. This includes the contents of 100 EV pioneer program, e-commercial vehicle program and e-mobility

zone program.

(ii) **Component 2 Tourism EV Program for Luang Prabang:** This program is a 100 EV pioneer program which focuses more on tourism use. This includes the contents of 100 EV pioneer program, tourism EV program and e-mobility zone program for core zone.

(iii) **Component 3 EV Introduction Support Program:** This includes the contents of EV remodeling center program, e-paratransit program and institutional development.

3) Potential EV Users in Model Project

6.74 In order to clarify the potential EV users in 100 EV Pioneer Program both in Vientiane Capital and Luang Prabang, the questionnaire survey was conducted by the Study Team. As a result, 80 – 90% of private enterprises and residents are interested in using EVs. Regarding the private enterprises, tourism related business has more interests than others, because EVs can be a good appeal to attract tourists and visitors. The main reasons of people who are not interested in using EVs are high prices of EVs and its spare parts, short cruising distance, and slow speed of EVs. Non-experience of using EVs and its poor design are also reasons of some people (see Table 6.3.4).

Table 6.3.4 Willingness to Use EVs in Vientiane Capital and Luang Prabang

		Vientiane Capital (%)			Luang Prabang (%)		
		Yes	No	Total	Yes	No	Total
Private Enterprises	Accommodation	95.7	4.3	100	87.5	12.5	100
	Delivery	81.4	18.6	100	59.3	40.7	100
	Service	90.3	9.7	100	93.1	6.9	100
	Tourism agent	100.0	0.0	100	85.0	15.0	100
	Vehicle Rental	100.0	0.0	100	68.8	31.3	100
	Sub-total	88.0	12.0	100	78.0	22.0	100
Residents		82.0	18.0	100	96.0	4.0	100

Source: Survey on Capacity to Introduction and Promote EVs by JICA Study Team (2012), Urban Transport Condition Survey in Priority Cities by JICA Study Team (2012)

6.75 By vehicle types, while private enterprises are interested in using e-motorcycles and relatively larger e-cars, residents chose e-cars ranged from small to big rather than e-motorcycles. The purposes of use are varied by the companies and residents. However, the private enterprises tend to choose motorcycles or smaller cars if they just want to use for goods delivery. The purpose of use EV by residents is daily use including commuting, sending somebody, shopping, etc. (see Table 6.3.5).

6.76 Considering the driving distance of people who are interested in EV use, more than 90% people use less than 40km in motorcycles and less than 100km in cars. Thus, the existing EVs can satisfy their curing distance already. On the other hand, people raise the price of vehicle as the most important condition for the use of EVs, which followed by the electricity fee.

6.77 In terms of installing charging stations, about 80% of private enterprises and residents have their own parking space. Therefore, it is possible for them to access to chargers at their home or office at least. The government only needs to consider the locations of charging station for their destinations.

Table 6.3.5 EV Vehicle Types of Willingness to Use

	Private Enterprise		Residents	
	Vientiane Capital	Luang Prabang	Vientiane Capital	Luang Prabang
MC	12.5	35.9	14.6	13.5
Tuktuk	1.1	1.3	3.7	0
Sedan	2.3	5.1	29.3	15.6
Pick-up	9.1	10.3	70.7	1.0
Small Van	44.3	21.8	90.2	53.1
Van	30.7	25.6	84.1	16.7

Source: Survey on Capacity to Introduction and Promote EVs by JICA Study Team (2012), Urban Transport Condition Survey in Priority Cities by JICA Study Team (2012)

6.78 Regarding the public transport system, willingness to use e-public transport system is not so high except public buses. However, considering very low public transport users in Vientiane (7%), 40 – 50% of modal share by public transport means significant improvement (see Table 6.3.6).

6.79 The users' evaluation on the existing e-minibus in Vientiane Capital is not bad. However, in order to attract more people, service level needs to be improved including travel speed and vehicle design (see Table 6.3.7). From the viewpoint of tourists, evaluation of motorcycle taxis and tuktuks/Songthaews are not high in terms of safety, comfort and price. They are one of the important travel modes for the local people, but they cannot satisfy the tourists. Regarding the introducing EVs in Lao PDR, most of tourists have no idea about that. However, e-taxi and e-tuktuk/songthaew have a little bit higher needs than other types of vehicles.

Table 6.3.6 Willingness to Use e-Public Transport System (%)

	No	Yes	Total
Motorcycle Taxi	66.0	34.0	100
Tuktuk / Jumbo	51.0	49.0	100
Songthaew	51.5	48.5	100
Taxi	54.0	46.0	100
Public Bus	34.0	66.0	100

Source: Survey on Capacity to Introduction and Promote EVs by JICA Study Team (2012), Urban Transport Condition Survey in Priority Cities by JICA Study Team (2012)

Table 6.3.7 Assessment on E-minibus in Vientiane Capital by Users (%)

	Good	So-so	Bad	Total
Overall impression	58.8	32.4	8.8	100
Riding comfort	67.6	20.6	11.8	100
Travel speed	44.1	41.2	14.7	100
Vehicle design	52.9	41.2	5.9	100

Source: Survey on Capacity to Introduction and Promote EVs by JICA Study Team (2012), Urban Transport Condition Survey in Priority Cities by JICA Study Team (2012)

Table 6.3.8 Assessment on Travel Mode in Lao PDR by Tourists (% of answered very good/good)

	Safety	Comfort	Price
Motorcycle Taxi	50.0	44.1	52.9
Tuktuk / Songthaew	40.2	40.2	24.4
Taxi	80.4	72.5	49.0
Minibus	76.2	73.8	66.7

	Safety	Comfort	Price
Bus	75.0	62.5	75.0
Hotel Car	90.0	90.0	63.6
Car Rental	86.7	73.3	66.7

Source: Survey on Capacity to Introduction and Promote EVs by JICA Study Team (2012), Urban Transport Condition Survey in Priority Cities by JICA Study Team (2012)

6.80 More than 90% of people agree to the government policy to realize electric vehicle transport in Lao PDR, as well as more than 80% of people is willing to use EVs. In order to encourage people to use EVs in the actual situation, the government policy would be important. As a result of assessment on the policy by people, while the policy which improves the EV use condition is effective to encourage people, one which discourages people to use ICE vehicle is not supported. Former one includes tax reduction on EVs purchase and use, reduction of electric tariff, and others. The latter includes tax increase on ICE vehicle, entering restriction of ICE vehicles in the city center, etc. On the other hand, 71% of people agree to regulate the number of importing gasoline motorcycle. It is a good indication to restrict ICE motorcycles and promote e-motorcycles.

Table 6.3.9 Assessment on the Policy to Encourage EV Use

	Agree	Disagree	Total
1. Tax reduction on electric vehicle/motorcycle purchase	95.8	4.3	100
2. Tax increase on gasoline/diesel vehicle purchase	22.3	77.8	100
3. Tax reduction on corporation tax for using electric vehicle/motorcycles	92.3	7.8	100
4. Increase in fuel price	12.3	87.8	100
5. Reduction on electric tariff	96.0	4.0	100
6. Provision of parking space for electric vehicle/motorcycle in city center	90.3	9.8	100
7. Entering restriction of gasoline/diesel vehicle in city center	60.0	40.0	100
8. Provision of priority lane for electric vehicle/motorcycle along major roads	78.8	21.3	100
9. Provision of free charging stations in the public spaces	94.8	5.3	100
10. Provision of low insurance cost for electric vehicle/motorcycle	95.5	4.5	100
11. Regulating the number of importing gasoline motorcycle	71.0	29.0	100

Source: Survey on Capacity to Introduction and Promote EVs by JICA Study Team (2012), Urban Transport Condition Survey in Priority Cities by JICA Study Team (2012)

6.4 Selected Model Projects

1) Precondition of Implementing Model Project

6.81 In order to success this model project, there are some preconditions for implementation as follows;

(i) To organize preparatory EV taskforce to plan and monitor model project under MPWT in coordination with other relevant ministries and organizations: As learnt from other countries' experience, EV introduction and promotion is not only related to transport sector, but also energy, environment, finance, tourism, education and others. Therefore, preparatory taskforce should involve all relevant ministries and organizations from the initial stage.

(ii) To organize project implementation unit (PIU) to implement and manage each component: PIU can be established at the local level to focus on each component which includes local government, transport service providers, private enterprises, communities, etc. The role-sharing in the PIU needs to be defined clearly, because the PIU need to manage the overall of project such as implementation plan, budgeting, infrastructure development, maintenance services, coordination with the central and local government as well as EV users.

(iii) To establish provisional institutional framework (technical certificate and guideline, tax exemption, etc.) applicable for model project: In order to sustain the EV development, Institutional framework is essential. Without appropriate institutional framework, Lao PDR may face on difficulties and risks such as discouraging people to buy EVs due to high price, importing low cost but low quality of EVs, providing poor quality of EV transport services, and so on; and,

(iv) To ensure financial source and capacity to manage model project: For any project, financial source and management capacity are necessary to success the project. It is one way to approach donors to get ODA as financial source and technical assistance. However, the dependence on the donors is not sustainable manner to develop EVs for the whole country. Therefore, it is also important to establish own financial source (e.g. PPP) and human resource development system (e.g. coordination between the government and university).

(v) To decide the uniform design of introduced EVs: EV which will be used in the model project is a part of PR activities of EVs. Therefore, it is good to have uniform design for model project EVs. For example, rapping by same color, putting project logo, etc. Design may be collected from the public, or ask Lao designers to make it.

2) Component 1: 100 EV Pioneer Sub-program for Vientiane Capital

(1) Contexts

6.82 This sub-program will target ordinary households, private entities and public transport providers to experience EVs. Vientiane is the capital of Lao PDR, so that the EV program in Vientiane must have the best opportunity to disseminate the EV project for the whole country together with EV development policies.

(2) Objectives and Expected Outcomes

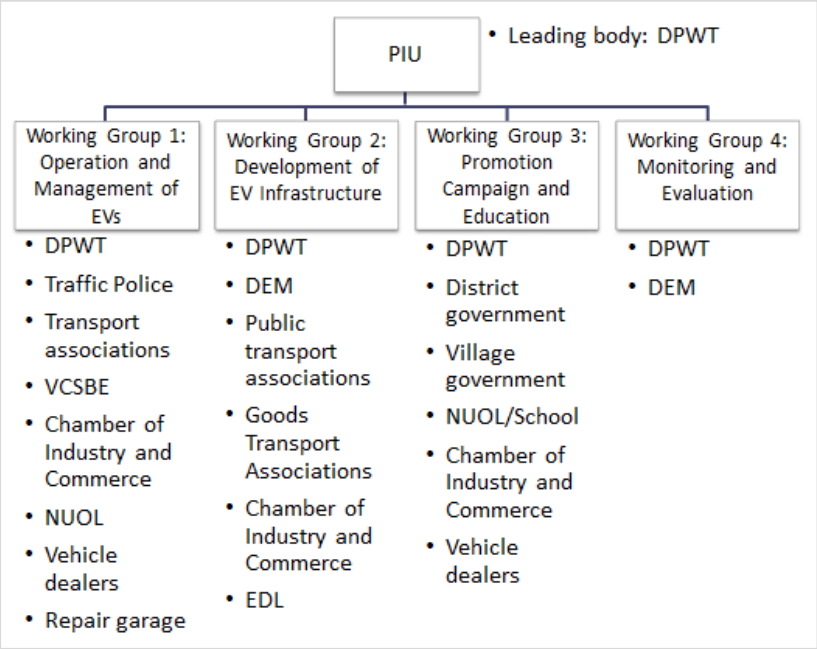
6.83 The main objectives of this sub-program are (i) to evaluate the suitability of EV use in the city, (ii) to evaluate the validity of EV infrastructures (charging stations), and (iii) to

collect the necessary data for EV introduction. In addition to those objectives, it is expected that this sub-program will develop the shared understanding on EV propagation, establish the government organization for EV introduction and propagation, and develop implementation mechanism for full-fledged EV diffusion.

(3) Implementation Organization and Sub-program Participants

6.84 The sub-program will be implemented by PIU led by DPWT of Vientiane Capital. PIU has four working group to conduct each sub-program, namely e-private car program, e-public transport program, e-commercial vehicle program and e-mobility zone program. Each working group has public agency and private agency as well as academic organizations.

Figure 6.4.1 Implementation Organization for Component 1



Source: JICA Study Team

6.85 100 pioneers will be chosen by type of vehicle and travel purpose, from those who travel along main corridors and/or city center areas. In order to promote EVs in the certain area more comprehensively, the city center will be designated as e-mobility zone as well. The proposed target segment of introducing EVs is shown in Table 6.4.1

Table 6.4.1 Sub-program Participants by EV Types

Target EV User		Purpose	No. of EVs					
			MC	Compact EV	Trike	Passenger Car	Van	Minibus
Citizen	Individual	Commuting, at business	5	3	-	10	-	-
	Household	Commuting, private use (sharing)	5	2	-	-	-	-
Enterprise/ Organization	Passenger Transport	Pick-up service, taxi, car rental	5	5	-	15	-	5
	Goods Transport	Mail service, delivery service	5	5	5	-	-	-
	Public Transport	Paratransit, minibus	-	-	10	-	5	5
Government		Patrol car, public services	5	-	-	-	5	-

Source: JICA Study Team

6.86 The supposed responsibility for pioneers and PIU are as follows;

(i) Pioneers: to make regular report to PIU on the use of EVs, and to encourage other people to use EVs through their EV use;

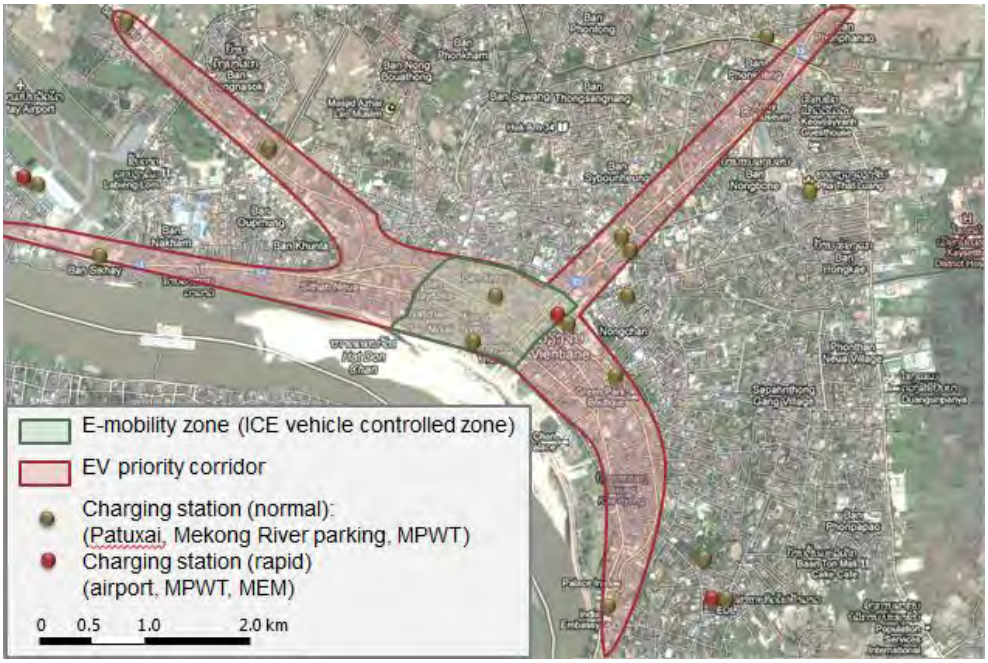
(ii) PIU: to provide certificate for registration and operation of EVs of pioneers, and to provide necessary infrastructure and maintenance service for EVs.

6.87 Regarding the project cost, it is advisable that PIU will share with pioneers because it is still expensive for both pioneers and the government. For example, the pioneer shares the introduction cost of EV which will not exceed that of equivalent ICE vehicle. The tax reduction on EV purchase is one of the measures to lessen the project cost.

(4) Sub-program Location and Individual Projects

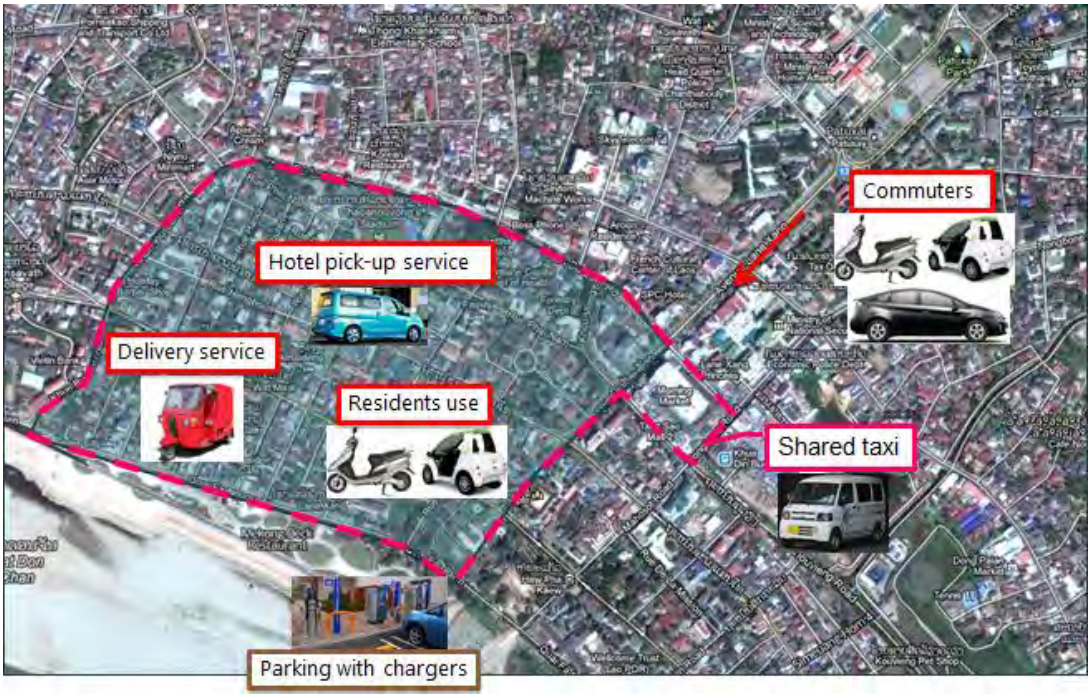
6.88 The e-mobility zone which will be a showroom of EV project is assigned in the central area in Vientiane Capital. The ICE vehicles are basically prohibited to enter this area except residents' vehicles, or they may be charged some entrance fee. On the other hand, EVs can enter freely. Instead of prohibition on ICE vehicles, park & e-public transport ride will be encouraged. Several parking spaces will be built around the e-mobility zone, and e-public transport system will pass through those parking lots and go around within the e-mobility zone. E-public transport system is composed of e-minibus loops (e-minibus or e-songthaew) and e-paratransit (e-motorcycle taxi, e-tuktuk, e-taxi, etc.).

Figure 6.4.2 Proposed Location of Charging Stations



Source: JICA Study Team based on Google map

Figure 6.4.3 Schematic of E-Mobility Zone



Source: JICA Study Team

6.89 In order to realize the e-mobility zone, traffic management, parking management, creation of urban landscape and others will be conducted in conjunction with EV development. It is important to get cooperation from residents, enterprises and others in this area as well as traffic polices. The possible traffic measures for e-mobility zone are listed below.

Table 6.4.2 Example of Possible Traffic measures for E-Mobility Zone

Measurements	Contents
Entry regulation on ICE vehicles	ICE vehicles are prohibited to enter the e-mobility zone. However, in order to ensure accessibility and mobility of ICE vehicle users, park & e-public transport ride should be provided. Furthermore, it is also important to provide bypass road to avoid through traffic.
Preferential treatment for private EVs	Charging stations for EVs is one of the key factors to encourage EV use. Therefore, priority parking lot with charging stations will be provided at parking areas. Setting different parking fee between ICE vehicle and EVs is also considered.
Provision of e-public transport	Not only for ICE vehicle users, but also for others, e-public transport service needs to be provided within e-mobility zone as well as access traffic from other areas (e.g. airport, central bus stations, tourism spots, etc.).
Preferential treatment for NMT	In order to protect NMT, the pedestrian spaces and bicycle lane need to be developed. Many roads already have sidewalk, yet there are too many obstacles including car parked on the sidewalk. Those illegal parking should be strictly enforced.
Parking management	In order to solve some of the bottleneck of traffic congestions, improve streetscape, encourage NMT and others, parking areas should be developed as well as strictly control illegal parking.
Field demonstration	Some of the measurements are difficult to apply soon. So until people understand and accept the new measurements, it is useful to conduct them as field demonstration.

Source: JICA Study Team

6.90 Installing charging stations is also a part of this sub-program. The supposed number of charger is 80 units for e-motorcycle, 120 units of standard charger for EVs and 3 units of rapid charger for EVs. E-motorcycle chargers and standard chargers will be installed both parking spaces at origin and destination. For each EV, one charger is provided at origin, and another is done at destination. Rapid chargers are not so important for inter-city use of EVs. Therefore, it will be introduced just as experiment. Specific

location to install chargers depends on 100 pioneers. The location should be their origin and destination.

6.91 Except commuting and private purpose, the specific purpose of EV use in the target area may include the followings;

(i) EV taxi/ EV rental/ air-port pick-up service by hotels;

(ii) Mail service/ delivery services of restaurant, etc.;

(iii) Commercial vehicles for private enterprises;

(iv) E-paratransit (e-tuktuks, e-minibuses): and,

(v) EV patrol service/ EV garbage truck.

(5) Implementation Cost

6.92 It is assumed that introduced EVs and chargers are all Japanese products. Therefore, the unit price of them was calculated as the total of selling price in Japan and transport cost[2]. Regarding the maintenance cost, there are many uncertain factors. And it should avoid that people stop to use due to lack of spare parts and maintenance. Therefore, the maintenance cost is assumed to require for the lifespan of EVs.

Table 6.4.3 Initial Cost of Sub-program

Item			Unit	Unit Price	Base Cost (USD 000)	Alternatives (USD 000)		
						Tax Exemption	(1) + Sharing EV Cost1)	(2) + Sharing Charger Cost2)
					(0)	(1)	(2)	(3)
Vehicle Cost	E-motorcycle	SEED60	30	2,300	128	69	24	24
	Compact EV	B-com Basic	15	9,350	259	140	118	118
	E-three wheeler	Nihon Elec-Trike	15	17,000	421	255	218	218
	PHEV	Prius PHV S	20	42,000	2,264	840	399	399
	E-car	Minicab MiEV CD10.5kwh	10	32,000	528	320	100	100
	E-car	e-NV200	10	49,000	1,321	490	197	197
	Sub-total		-	-	4,920	2,114	1,056	1,056
Conversion Cost of Three-wheeler	Conversion kit	OZ-Motors	5	1,700	14	9	9	9
	Conversion cost		5	1,000	6	5	5	5
	Sub-total		-	-	20	14	14	14
Rigging Cost	Three-wheeler		20	2,000	44	40	40	40
	Four-wheeler		10	2,000	22	20	20	20
	Sub-total		-	-	66	60	60	60
Charging Equipment Cost	Outdoor outlet for e-motorcycle		80	60	6	5	5	2
	Level 2 charger wall mount type		60	1,200	87	72	72	0
	Level 2 charger stand type		60	2,700	196	162	162	162
	Level 3 charger		3	17,000	62	51	51	51
	Sub-total		-	-	351	290	290	215
Installation Cost of Charger	Outdoor outlet for e-motorcycle		80	100	9	8	8	4
	Level 2 charger wall mount type		60	500	33	30	30	0
	Level 2 charger stand type		60	1,000	66	60	60	60
	Level 3 charger		3	10,000	33	30	30	30
	Sub-total		-	-	141	128	128	94
Total			-	-	5,499	2,607	1,549	1,439

Source: JICA Study Team
1) Volunteers pay equivalent cost of ICE vehicles, 2) Volunteers pay charging infrastructure for garage/origin side.

[2] Transport cost was calculated based on the 40 feet container transport cost which is about USD8,000. One container can carry 4 passenger cars or 40 motorcycles. Thus, transport cost of passenger cars and motorcycles is 2,000 USD/unit and 200 USD/unit, respectively.

Table 6.4.4 Maintenance Cost for 10 Years

Item			Unit	Unit Price	Base Cost (USD 000)	Alternatives (USD 000)		
						Tax Exemption	(1) + Sharing EV Cost1)	(2) + Sharing Charger Cost2)
					(0)	(1)	(2)	(3)
Spare Parts and Maintenance Cost	E-motorcycle	SEED60	30	2,300	80	69	2	24
	Compact EV	B-com Basic	10	9,350	108	94	79	79
	E-three wheeler	Nihon Elec-Trike	15	17,000	295	255	218	218
	PHEV	Prius PHV S	20	42,000	970	840	399	399
	E-car	Minicab MiEV CD10.5kwh	10	32,000	370	320	100	100
	E-car	e-NV200	10	49,000	566	490	197	197
	Outdoor outlet for e-motorcycle		80	100	9	8	8	4
	Level 2 charger wall mount type		60	500	35	30	30	0
	Level 2 charger stand type		60	1,000	69	60	60	60
	Level 3 charger		3	10,000	35	30	30	30
Total			-	-	2,536	2,196	1,144	1,110

Source: JICA Study Team
1) Volunteers pay equivalent cost of ICE vehicle, 2) Volunteers pay charging infrastructure for garage/origin side.

Figure 6.4.4 Assumed EVs for Cost Calculations

SEED60 (Terra Motors)

B-com Basic (TOYOTA)

Nihon Elec-Trike

Prius PHV S (TOYOTA)

Minicab MiEV (MITSUBISHI)

e-NV200 (NISSAN)

Source: Web-site of auto manufacturer

Figure 6.4.5 Other Candidate EVs

EC-03 (YAMAHA)

EV-neo (HONDA)

e-Tuktuk (Tuk Tuk Factory, Netherland)

Leaf X (NISSAN)

Minicab MiEV Truck (MITSUBISHI)

Source: Web-site of auto manufacturer

3) Component 2: EV Tourism Sub-program for Luang Prabang

(1) Contexts

6.93 This sub-program will aim to realize the model world city with zero-emission. Luang Prabang City is defined as an environmental city, so that introducing EVs can also support to be an environmental city from transport sector. Furthermore, this sub-program will improve the image of Luang Prabang City as a center of tourism in Lao PDR, and it must be a good opportunity to appeal Lao PDR to other countries.

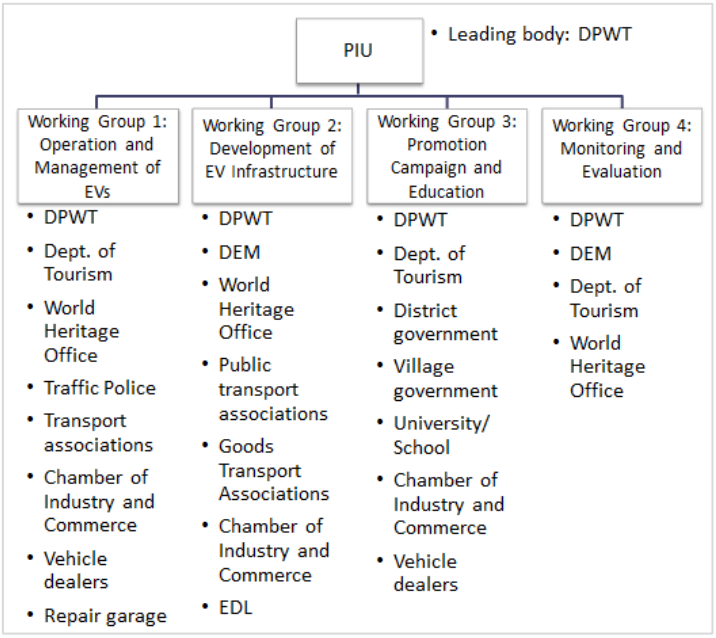
(2) Objectives and Expected Outcomes

6.94 Objectives and expected outcomes of this sub-program are the same as component 1.

(3) Implementation Organization and Sub-program Participants

6.95 The sub-program will be implemented by PIU led by DPWT of Luang Prabang Province. PIU has four working group to conduct each sub-program, namely e-private car program, e-tourism program and e-mobility zone program. Each working group has public agency and private agency as well as academic organizations.

Figure 6.4.6 Implementation Organization for Component 2



Source: JICA Study Team

6.96 100 pioneers will be chosen by type of type of tourism related services and vehicle from residents and service providers in the city center, especially in the protected area. In order to improve the environment in the protected area, the protected area will be designated as e-mobility zone. The proposed target segment of introducing EVs is shown in Table 6.4.5

6.97 The possible e-public transport and e-tourism related service include EV sharing for tourists, local tour/cruise by EVs, airport EV shuttle services (e.g. e-taxi, e-minibus), e-light truck for goods delivery within the protected area, and so on.

Table 6.4.5 Sub-program Participants by EV Types

Target EV User		Purpose	No. of EVs					
			MC	Compact EV	Trike	Passenger Car	Van	Minibus
Citizen	Individual	Commuting, at business	10	3	-	-	-	-
	Household	Commuting, private use (sharing)	5		-	-	-	-
Enterprise/ Organization	Passenger Transport	Pick-up service, taxi, car rental	10	7	-	15	15	20
	Goods Transport	Mail service, delivery service	-	-	5	-	-	-
	Public Transport	Paratransit, minibus	-	-	5	-	-	-
Government		Patrol car, public services	5	-	-	-	-	-

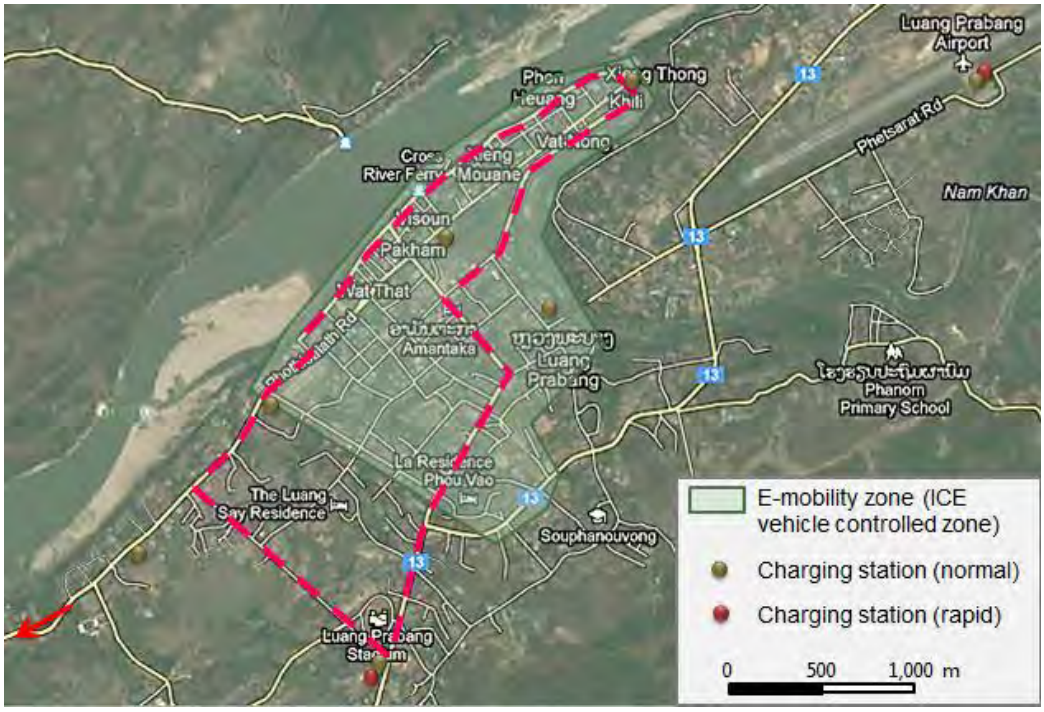
Source: JICA Study Team

6.98 The expected responsibilities of the pioneers and PIU are the same as that in component 1. The cost-sharing between the pioneers and PIU is also necessary to consider.

(4) Sub-program Location

6.99 The main target area of this sub-program is the urban area and the main routes to neighboring tourist sites. The e-mobility zone which will be an exclusive area from the ICE vehicles which cause traffic pollution, noise, etc. is assigned in the protected area in Luang Prabang City. The ICE vehicles are basically prohibited to enter this area except residents' vehicles, or they may be charged some entrance fee. On the other hand, EVs can enter freely. Instead of prohibition on ICE vehicles, park & e-public transport ride will be encouraged. Several parking spaces will be built outside of the e-mobility zone, and e-public transport system will pass through those parking lots and go around within the e-mobility zone. E-public transport system is composed of e-paratransit (e-tuktuk, e-taxi, etc.) and airport EV shuttle service.

Figure 6.4.7 Proposed Location of E-mobility Zone and Charging Stations



Source: JICA Study Team based on Google map

Figure 6.4.8 Target Tourism Routes

Source: JICA Study Team

6.100 In order to realize the e-mobility zone, traffic measurement mentioned in component 1 (see Table 6.4.2) will be also implemented in Luang Prabang City.

6.101 The supposed number of charger is 80 units for e-motorcycle, 120 units of standard charger for EVs and 3 units of rapid charger for EVs. E-motorcycle chargers and standard chargers will be installed both parking spaces at origin and destination. For each EV, one charger is provided at origin, and another is done at destination. Rapid chargers are not so important for inter-city use of EVs. Therefore, it will be introduced just as experiment. Specific location to install chargers depends on 100 pioneers. The location should be their origin and destination.

6.102 Except commuting and private purpose, the specific purpose of EV use in the target area may include the followings;

(i) EV airport tax/ airport pick-up service by hotels;

(ii) EV rental (motorcycle, compact car, passenger car);

(iii) EV taxi/ EV tourism bus;

(iv) E-paratransit (e-tuktuk, city tour e-minibus); and,

(v) Delivery services by restaurants and others.

(5) Implementation Cost

6.103 It is assumed that introduced EVs and chargers are mainly Japanese products. Only e-microbus is made in China, because there is no available e-microbus in Japanese market at present. Therefore, the unit price of them was calculated as the total of selling price in Japan and transport cost[3]. Regarding the maintenance cost, there are many

[3] Transport cost was calculated based on the 40 feet container transport cost which is about USD8,000. One container can carry 4 passenger cars or 40 motorcycles. Thu, transport cost of passenger cars and motorcycles is 2,000 USD/unit and 200 USD/unit, respectively.

uncertain factors. And it should avoid that people stop to use due to lack of spare parts and maintenance. Therefore, the maintenance cost is assumed to require for the lifespan of EVs.

Table 6.4.6 Initial Cost of Sub-program

Item			Unit	Unit Price	Base Cost (USD 000)	Alternatives (USD 000)		
						Tax Exemption	(1) + Sharing EV Cost1)	(2) + Sharing Charger Cost2)
					(0)	(1)	(2)	(3)
Vehicle Cost	E-motorcycle	SEED60	30	2,300	128	69	24	24
	Compact EV	B-com Basic	10	9,350	173	94	79	79
	E-three wheeler	Nihon Elec-Trike	10	17,000	281	170	145	145
	E-car	NV200E	30	49,000	3,962	1,470	591	591
	E-microbus (8 seat)	Chinese	10	17,000	281	170	45	45
	E-microbus (12 seat)	Chinese	10	17,000	458	170	45	45
	Sub-total		-	-	5,281	2,143	929	929
Charging Equipment Cost	Outdoor outlet for e-motorcycle		80	60	6	5	5	2
	Level 2 charger wall mount type		60	1,200	87	72	72	0
	Level 2 charger stand type		60	2,700	196	162	162	162
	Level 3 charger		3	17,000	62	51	51	51
	Sub-total		-	-	351	290	2890	215
Installation Cost of Charger	Outdoor outlet for e-motorcycle		80	100	9	8	8	4
	Level 2 charger wall mount type		60	500	33	30	30	0
	Level 2 charger stand type		60	1,000	66	60	60	60
	Level 3 charger		3	10,000	33	30	30	30
	Sub-total		-	-	141	128	128	94
Total			-	-	5,773	2,560	1,347	1,239

Source: JICA Study Team
1) Volunteers pay equivalent cost of ICE vehicles, 2) Volunteers pay charging infrastructure for garage/origin side.

Table 6.4.7 Maintenance Cost for 10 Years

Item			Unit	Unit Price	Base Cost (USD 000)	Alternatives (USD 000)		
						Tax Exemption	(1) + Sharing EV Cost1)	(2) + Sharing Charger Cost2)
					(0)	(1)	(2)	(3)
Spare Parts and Maintenance Cost	E-motorcycle	SEED60	30	2,300	80	69	24	24
	Compact EV	B-com Basic	10	9,350	108	94	79	79
	E-three wheeler	Nihon Elec-Trike	15	17,000	296	255	218	218
	E-car	e- NV200	10	49,000	566	490	197	197
	E- microbus (8 seat)	Chinese	10	17,000	196	170	45	45
	E-microbus (12 seat)	Chinese	10	17,000	196	170	45	45
	Outdoor outlet for e-motorcycle		80	100	9	8	8	4
	Level 2 charger wall mount type		60	500	35	30	30	0
	Level 2 charger stand type		60	1,000	69	60	60	60
	Level 3 charger		3	10,000	35	30	30	30
Sub-total			-	-	1,589	1,376	736	702

Source: JICA Study Team
1) Volunteers pay equivalent cost of ICE vehicle, 2) Volunteers pay charging infrastructure for garage/origin side.

Figure 6.4.9 Assumed EVs for Cost Calculations

SEED60 (Terra Motors) 	B-com Basic (TOYOTA) 	Nihon Elec-Trike 
e-NV200 (NISSAN) 	E-microbus (FusionEV, China) 	E-microbus (Suzhou Eagle, China) 

Source: Web-site of auto manufacturer

Figure 6.4.10 Other Candidate EVs

EC-03 (YAMAHA) 	EV-neo (HONDA) 	E-tuktuk (Tuk Tuk Factory, Netherland) 
e6 (GEM) 	Leaf X (NISSAN) 	Minicab MiEV (MITSUBISHI) 

Source: Web-site of auto manufacturer

4) Component 3: EV Introduction Support Sub-program

(1) Outline of Sub-program

6.104 This sub-program will be conducted to facilitate smooth and effective implementation of component 1 and 2 sub-programs as well as to provide support mechanism for other initiatives with following specific objectives;

(i) To draft necessary regulations and technical norms;

(ii) To provide a platform for discussion and coordination on other matters related to EV introduction in Lao PDR;

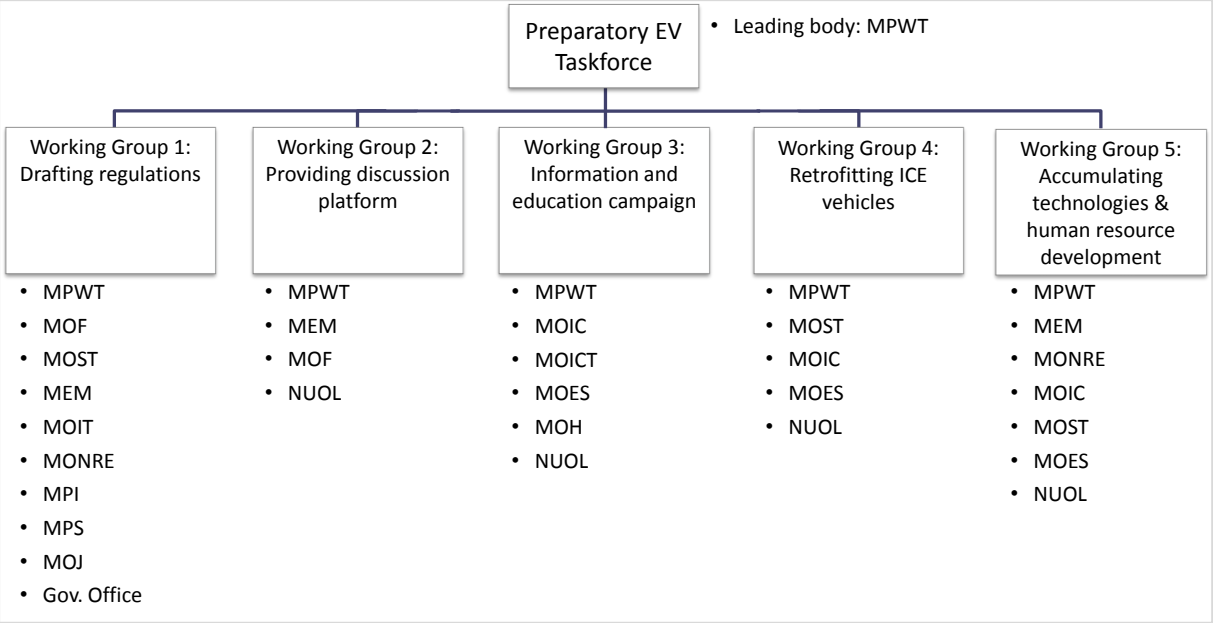
(iii) To conduct information and education campaign;

(iv) To experiment retrofitting of existing vehicles to EVs; and,

(v) To accumulate related technologies and train human resource.

6.105 This sub-program will be implemented by the preparatory EV taskforce led by MPWT. Under the preparatory EV taskforce, working groups will be established to achieve each objective. However, five working groups are not standing alone. They are correlated each other. (see Figure 6.4.11)

Figure 6.4.11 Implementation Organization for Component 3



Source: JICA Study Team

(2) Drafting Regulations and Technical Norm

6.106 The procedure to issue and enforce new regulation always takes time, and there is no EV related industry in Lao PDR yet. So, during the model project, only minimum required regulations will be drafted and applied as trial. Then, the results of trial will be useful to finalize the regulations for actual enforcement.

6.107 During the model project, the following regulations and technical norm will be drafted;

(i) Registration of EVs;

(ii) Automotive standard and battery charger standard for EVs;

(iii) Building standards for installing charging stations;

(iv) Standard for retrofitted EVs;

(v) Accreditation system for electrician and automobile mechanic specialized for EVs;

(vi) Inspection system for EVs;

(vii) Tax incentives for purchase and use EVs; and

(viii) Electric tariff for EVs.

(3) Providing Discussion Platform

6.108 In order to establish the cross-ministerial coordination as well as cooperation among government, industry and academia, provision of discussion platform is useful. In the beginning, MPWT will be a secretariat for discussion platform and hold periodic discussion forums. The participants on the forum have a responsibility to provide the discussion topic or at least make some comments. It is also possible to invite some speakers from outside domestically and internationally. The main purpose of this discussion platform is to provide the place where people can speak out on EVs freely.

6.109 EV development is new challenge for Lao PDR. There must be many queries, difficulties, requests, etc. Therefore, discussion platform can play a role to share and solve those constraints to develop EVs more effectively.

(4) Information and Education Campaign

6.110 As mentioned in ***Chapter 4***, addressing different information dissemination and communication tools to specific targets encourage the establishment of an effective and continuous information flow. In cooperation with media, information can be widely disseminated. Required information is varied by target audience. While information on the features of EV and direct benefit from EV use may be important for residents, the tax incentives and other preferential treatment to use EVs in the business is more important for private sector. Not all people can access to TV or internet, so that it is also necessary to disseminate information through newspapers, seminars, etc.

6.111 Furthermore, information and education campaign is not only for residents and private sector, but also among the public sector. EV development is inter-ministerial issue. The working group meeting should be held periodically to share the information too.

6.112 In another way, the information and education campaign is a good opportunity to involve public. The design of logo, mascot and rapping for EVs in the model projects can be invited from the public.

6.113 The main actions for this sub-component as follows;

(i) Establish common database on EVs which is partially used for information dissemination to the public;

(ii) Provide and disseminate the data and information on EVs to public through web-site, media, newsletter, and other means;

(iii) Prepare the teaching material and presentation materials to be presented in the school;

(iv) Conduct periodical workshop which invites both public and private sectors; and,

(v) Invite the design of a logo, a mascot and rapping for EVs in the model project from public.

(5) Retrofitting ICE Vehicles to EVs

6.114 The experiment of retrofitting existing vehicle to EVs will be conducted in NUOL as a retrofitting center. The purposes of retrofitting center is (i) converting conventional vehicles to EVs, (ii) accumulating EV related technologies through conversion activities, and (iii) train mechanical engineers for EVs including those in the repair workshops. EVs in the market are still very expensive for people in Lao PDR. Even if they can afford EVs, the disposal of the conventional vehicles will be a problem. Therefore, retrofitting is one of the ways to promote EVs. However, it is dangerous to convert ICE vehicle to EV by a nonprofessional. The retrofitting center will train and provide professionals for this activity.

6.115 Furthermore, when EVs are introduced, repairers in the country need to learn how to maintain EVs. The retrofitting center can be a training center for them. As long as the retrofitting center is in the university, it also provides a good opportunity for students to study EVs as a part of curriculum. After being on the right track, this activity can expand to other universities as well as vocational schools.

6.116 Main actions include;

(i) Study on the structure of EVs through reference books and imported EVs among working group members;

(ii) Build the prototype EVs converted from ICE vehicles;

(iii) Conduct test runs of converted EVs;

(iv) Make a manual how to convert ICE vehicles to EVs;

(v) Train mechanical engineers to convert and maintain EVs;

(vi) Invite people who want to convert their vehicle to EVs, and retrofit them to EVs; and,

(vii) Include EV related topics into the curriculum of university.

(6) Accumulating Technologies and Human Resource Development

6.117 There is no accumulated information and technologies in Lao PDR to share the relevant agencies. The human resource is also still limited to introduce and promote EVs. Therefore the human resource development (HRD) will play significant role in the EV development in Lao PDR. Human resource needs to be developed for formulating related regulations, formulating implementation strategies and plans, implementing regulations and model projects and monitoring and evaluating projects. At the implementation stage, there should be specialists for electric vehicles, charging infrastructures, financial including PPP scheme, environment (e.g. monitoring pollution), and so on.

6.118 These HRDs can be done through technical assistance by ODA as well as coordination with neighboring countries. Lao PDR is a member of ASEAN, so that Lao PDR can propose to include EVs as one of the topic for ASEAN land transport working group to discuss and study on EVs in the region.

6.119 Main actions include;

(i) Allocate people for EV development from each related agency;

(ii) Research the experiences on EVs in other countries, involving universities and private sector;

(iii) Conduct periodic workshops on EVs; and,

(iv) Approach to international organizations as well as neighboring countries to get any technical assistance.

5) Organizational Framework for Implementing Model Project

6.120 The organizational framework is established under MPWT, which is composed of mainly three organizations, namely preparatory EV taskforce, project implementation unit (PIU), and advisory committee. While the EV preparatory taskforce and the advisory committee are organized mainly by the central government, PIU are established at local government level.

6.121 The EV preparatory taskforce will be led by MPWT to formulate EV introduction strategies and plans, establish necessary institutional frameworks, arrange budget, develop human resource, attract EV related industries, and so on, in cooperation with relevant ministries and organizations. The institutional framework should include tax incentives, technical standard for EVs, electric instrument standard, battery disposal, etc.

6.122 PIU will be established for each component to operate and monitor the projects. PIU is composed of not only public sector but also private sector such as public transport service providers, vehicle related business owners, etc.

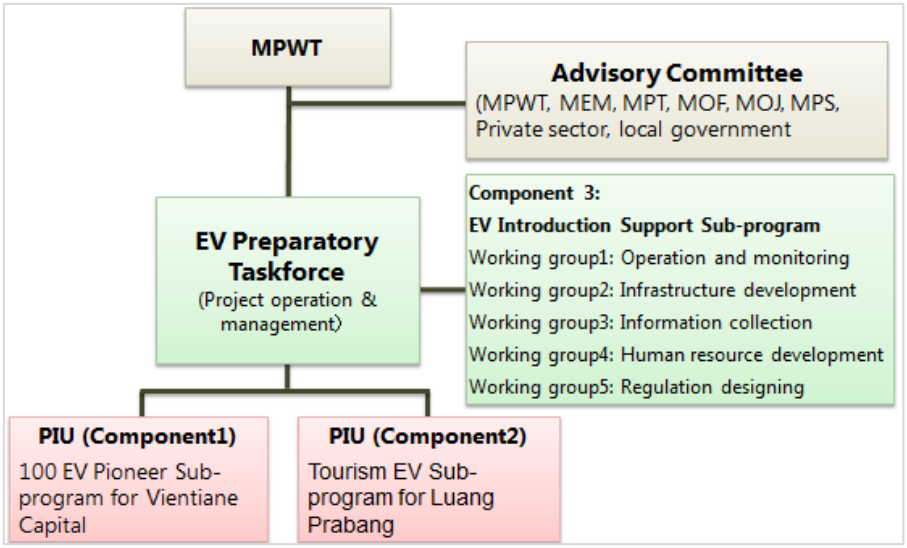
6.123 Advisory committee will be established to advice EV preparatory taskforce when they face on some difficulty especially related to the laws and regulations. The advisory committee should be an inter-ministerial committee to be impartial to the project.

Table 6.4.8 Overall Organizational Framework for EV Introduction

Organization	Supposed Involved Agencies
Preparatory EV Taskforce	Ministry of Public Works and Transport, Ministry of Finance, Ministry of Energy and Mines, Ministry of Natural Resource and Environment, Ministry of Industry and Commerce, Ministry of Planning and Investment, Ministry of Tourism, Ministry of Science and Technologies, Ministry of Education, Electricite du Laos, National University of Laos, others
Project Implementation Unit	Department of Public Works and Transport, District government, Village government, Traffic police, Electricite du Laos, Chamber of Industry and Commerce, Public transport associations, Goods transport associations, others
Advisory Committee	Ministry of Public Works and Transport, Ministry of Energy and Mines, Ministry of Finance, Ministry of Law, Ministry of Public Security, Private sector, local governments, others

Source: JICA Study Team

Figure 6.4.12 Organizational Framework



Source: JICA Study Team

6) Roadmap

6.124 The sub-programs are supposed to conduct for three years. For Component 1 and 2, first one year is mainly for preparation to operate and monitor EVs by volunteers. Last two years are mainly for the demonstration by pioneers and assessment on the program. It is advisable to start Component 3 before Component 1 and 2 to conduct Component 1 and 2 effectively and efficiently (see Table 6.4.9).

Table 6.4.9 Preliminary Timeline for the Model Project

			1st Year	2nd Year	3rd Year
Component 1 & Component 2	Establish PIU/Prepare implementation plan				
	Invite pioneers from public/Conduct orientation				
	Prepare charging installation plan and install				
	Use EVs by pioneers/Monitor				
	Assess program				
Component 3	Regulation/ Technical standard	Prepare draft			
		Apply to Model Project			
		Revise/Finalize			
	Provide discussion platform				
	Conduct information and education campaign				
	Conversion center/ Training	Establish center/Prepare training program			
		Conduct training/ Convert to EVs			
	Develop human resources				

Source: JICA Study Team