END-OF-LIFE VEHICLE MANAGEMENT IN THAILAND

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Abstract - This study has objectives 1) estimate number and distribution of ELV of passenger cars (4 wheels but less than 7 seats) by estimating battery, steel, tire, and plastics 2) study life cycle of costs of vehicle including ELV management 3) provide policy recommendation for ELV management policy. The results showed that the estimated ELV based on 1) accumulated number of new registered car (assuming the lifetime usage is 15 years) 2) number of de-register car (section 79) and non-annual renew for 3 consecutive years. The total ELV was 63,171-102,661 cars, converting to steel weight 48,404-78,662 tons and lead from battery 778-1,265 tons and plastics 5,445-8,849 tons. There is no ELV management system in Thailand. In general, the usage lifetime is very long due to the costs of purchasing new vehicle and very high car tax. Businesses involved in auto segmentation can be divided into seven categories. 1) Car Repair shop which link to insurance companies 1,402 shops; 2) Insurance companies 3) Second hand parts 258 shops; 4) Sorting and recycling (Industrial Sector Type 106) 629 factories 5) Battery recycling 6 factories 6) Steel melting 17 factories 7) Plastic recycling factories 773 factories. The recycling business can gain profit approximately 6-9 million Bath and 44-71 million Bath per year for battery recycling and steel recycling, respectively.

Index Terms - End-of-life vehicle, life cycle assessment, management.

I. INTRODUCTION

There is an increasing number of passenger cars every year. According to the Transport Statistics Sub-Division, as of February 2017, there were 37.5 million vehicles in Thailand, of which 36.3 million were vehicles under the Motor Vehicle Act and 1.2 million were vehicles under the Land Transport Act. In 2016, approximately 5.53 million cars were new registered cars (less than seven passengers) [1]. The so-called first-car buyer scheme in Thailand, an incentive introduced in 2012 by the populist government, turned out to be a huge failure. Under the scheme, low-income earners in particular, have been encouraged to buy or reserve a car and benefit from generous tax bonuses. For a mid-size car, tax refunds could amount to up to 100,000 Baht (or approximately US$3,250) [2].

Currently, most of the countries addressing the improvement of ELV recycling processes are industrialized countries, with a high national based automotive industry, and especially those competing in European automotive markets [3]. Many countries in European country, United States, and Japan, have long before developing the system for ELV management. They have enacted law and regulations for ELV management in environmentally friendly and sustainable way aiming at reuse, recycle, and recovery. The ELV management system has different guidelines for each country e.g. in EU, car producers are responsible for ELV management. In Japan, car owners pay for ELV management and The Japan Automobile Recycling Promotion Center (JARC) will management the ELV and the fee. The ELV normally set the object/target for reuse and recycle and recovery e.g. in EU, the ratio of reuse/recovery must be more than 85% by weight and the reuse/recycle at least 80% by weight. No heavy metal in the car part of spare part of car. For example, in EU and Japan, all the imported car or car part after July 1, 2003 must be free of Pb, Cd, Hg, Cr. Even though in Thailand, there is no ELV management regulation, but many car parts manufacturing must apply this regulation.

In Thailand, there is no direction for ELV management system. The total number of ELV generated yearly remains unknown. The management of products at their end of life stage has not yet been addressed by environmental authorities as an important issue. At the current system, ELV was managed by the owners of dismantling facilities or car repair shops. The management is driven by market, where valuable materials and components are recovered from ELV, and the main operators' target is to obtain high profitability thus proper separation process is not followed. The lack of de-pollution of ELV before shredder operations would lead to toxic substance contamination in the environment.

One of the approaches that can lead to sustainable management is life cycle assessment (LCA). LCA can provide policy-relevant recommendations to designers, managers, regulatory agencies, and consumers which can assist in decision-making on environmental, design, and business matters. LCA focuses on the environmental aspects and the potential impacts throughout a product's life from origin to disposal. LCA permits fair comparison of products and services. The aim is to improve

products and processes by reducing energy consumption and/or environmental impacts [4].
This bring to the questions on how many ELV were generated each year and how the country manage the ELV. An overview of the ELV management system in the world should be reviewed and discussed. The objectives of this study are to 1) to understand ELV management status quo 2) to analyze LCA of ELV and 3) to provide policy recommendations for the government.

II. LITERATURE REVIEW

This section reviews ELV management system in many developed countries.

European Union
EU has developed very solid regulation for ELV management. The number of ELV in the EU is increasing continuously. Around 75 percent of an ELV are recyclable metals. The rest of the car is considered waste and generally goes to a landfill, which is increasingly regarded as a problem. The forecast growth in the number of ELVs calls for regulation that aims to minimize the environmental impact of a car Smink [5]. The ELV management follows the Directive 2000/53. Mainly, the free-take-back mechanism has been adopted. The collection/dismantling facilities must be authorized, final owners will receive a certificate of destruction, treatment facilities must fulfill specific requirements. The EU set the target that the reuse/recovery rate of all ELVs will have to be 95% of the weight while reuse/recycling 85% by January 2015; energy recovery is thus allowed up to 5% of weight by 2006 and up to 10% by 2015 [6].

United States: In the US, ELV recycling operates autonomously based on the market mechanism. In the U.S., relatively little in the way of laws and regulations apply to ELV management activities. Instead, market forces have for the most part dictated operations and outcomes. ELV recycling has been promoted by the Automotive Recyclers Association (ARA). Although there is no mandatory recycling target, the rate of material recycling was reported to reach 80%. More emphasis is placed on the promotion of environmentally sound management at the dismantling or recycling facilities under this system than in an integrated management system. The ELV recycling program is, therefore, the subject of strict monitoring under environmental laws. Among the relevant regulations are the Resource Conservation and Recovery Act (RCRA), the Clean Air Act (CAA), and the Clean Water Act (CWA). In addition to federal laws, state governments also impose their own regulations. Thus, ARA disseminates complementary information to ELV recyclers regarding the latest environmental regulations at the state level through an electronic database. Currently, in most states, Automotive shredder residue (ASR) is classified as a nonhazardous waste and ends up in a landfill. However, its potential for environmental risk has become a growing concern [7].
Japan: In Japan, the Law for the Recycling of ELV was enforced in 2005. Car manufacturers and importers are responsible for the recycling of air bags and ASR, and fluorocarbons. One, if these three most-difficult-treatment items are removed, the rest of the ELV can be properly treated by the existing recycling operators on a market economy basis. Two, by obligating vehicle manufacturers and importers to handle only the three items, their monopoly on the vehicle dismantling market can be avoided while respecting the current business of the existing dismantlers. However, recycling fees are paid by buyers at the time of purchase, and these fees are deposited into the deposit management entity. Each vehicle manufacturer or importer decides the amount of recycling fee on the basis of the costs of recycling the three items. The amount of recycling fee varies according to vehicle size, the number of airbags and so on, but the average is about 10,000 yen for the ELV [8, 9].

III. METHODOLOGY

Estimate number of ELVs and understand the status quo of ELV management

The data of new vehicle registration 2000 - 2015 in all 77 provinces were obtained from the Department of Transportation. Since the government agency has no official record of ELV, then there are two methods for estimating ELV based on data availability. Method 1: Assessment of vehicle number was based on the new car registrations 2000 – 2015 from Transportation Statistics Division, Department of Transportation and assumed all cars will be discarded after 15 years of usage (upper bound estimate) Method 2: Assessment of vehicle number was based on total number of deregister car (section 79) note that not all ELVs are deregister and non-renewal annual car tax for 3 consecutive years (lower bound estimate). Then, the amount of battery, steel, and plastic from ELV were estimated. To understand the status quo of ELV management, field data collection and interview of all stakeholders were conducted.

Life Cycle Greenhouse Gas Emissions: LCA GHG
Calculate greenhouse gas emissions throughout the life cycle. Calculate the duration of a 15-year car with a mileage of 300,000-750,000 km. The calculation

starts with 1) Part production 2) Component assembly 3) Motor car use 4) Car repair 5) Transport of ELVs from dismantling (industry type 106) to battery recycling plant. 6) Transportation of ELVs from dismantling (industry type 106) to steel recycling plant. 7) Recycling process of steel 8) Recycling process of battery.

In LCA calculations of battery and steel recycling use primary and secondary data. Primary data is data from the survey and interview from the recycling group related to collection and sorting. Disposal of vehicles (battery, steel and plastics). Secondary data is information obtained from research studies such as the manufacture of batteries, steel and plastics and also, data from Sima Pro. The emissions factors used in this calculation were from Thailand Greenhouse Gas Management Organization (Public Organization).

IV. RESULTS

Estimate number of ELVs

Since there is no official number of ELVs in Thailand. This study applied 2 methods of estimation. The estimated number of ELVs in 2015 were 63,171 - 102,661 ELVs. Bangkok, the capital city is the hotspot of ELV. The estimated number of battery, lead extract from battery, steel, plastic, and tire as of 2015 were 63,171- 102,661 batteries, 779 - 1,265 tons of lead, 48,404-78,662 tons of steel, 5,445-8,849 tons of plastics, and 2,021-3,285 tons of tires, respectively.

The status quo of ELV management systems in Thailand

At present, there are no rules or regulations about ELV management in the country. First, when the car owners (with insurance) have a car accident, the car owner sends it to the car repair shop. Normally, the insurance company prepares spare parts for the car repair shop and then the worn car parts are sent back to the insurance company. An unfixed car (the cost of fixing is above the insurance premium) will be returned to the insurance company and then sent to a car auction. The car auction company will then sell the used car to a second-hand shop, car repair shop, or dismantle shop. From the dismantling industry, car parts are then sold to the recycling industry, e.g., steel industry, plastic industry, and battery/lead recovery. At present, steel from used car, battery/lead recovery and used tire were recycled ELV part. Plastic from ELV was not reported to be recycled in the industry.

Batteries are usually left with the battery shops when car owner purchases new tires. Batteries were then sold to dismantling facilities. The average weight of car battery is approximately 17.6 kg/battery and lead contain in battery is accounting for 70% which is 12.32 kg/ battery.

There is not much iron ore in the country. Thus, steel is 100 percent recycled by Electric Arc Furnace. Steel is collected from various sources e.g. construction site, car manufacturing, dismantling industry.

Scrap tires are usually left with the tire vendor when replacement tires are purchased. In certain areas (e.g. urban areas), used tires are left in front of the shop for scrap tire haulers to pick up without any charge. The subsequent costs associated with scrap tire handling are also set by market forces. According to a personal interview, the hauler is not required to register. There are tire shredding technologies that shred car/truck tires for further processing. Shredding technology could help to flatten materials before transportation. According to interview with tire collectors who are using truck for transporting ELT, crushing ELT cannot reduce the cost of transportation. When tire is chopped into small pieces, the volume of tire actually increases and fewer amounts can be transported. There are 2 technologies that were used for tire recycling which are pyrolysis and crumb and reclaimed tire [10].

Business related to ELV recycling business

The business dealing with ELV can be categorized into 7 types 1) car repair shop 2) insurance company 3) second car part shop 4) dismantling industry (Code 106) 5) battery recycling industry 6) steel industry 7) tire recycling industry (Table 1)

Table 1: Infrastructure for ELV management in Thailand

Type of business	Units	Data sources
Car repair shop	1,402	Field data collection
Second hand car part shop	258	Field data collection
Dismantling industry	629	Field data collection
Steel mill	17	Field data collection
Tire recycle	12 pyrolysis 14 grinding/reclaimed rubber	[11]
Battery recycle	6	Field data collection

Life cycle greenhouse gas emission

Calculate greenhouse gas emissions throughout the life cycle. Calculate the duration of a 15-year car with a mileage of 300,000 - 750,000 km. The calculation starts with 1) Part production 2) Component assembly 3) Motor car use 4) Car repair 5) Transport of ELVs from dismantling (industry type 106) to battery recycling plant. 6) Transportation of ELVs from

dismantling (industry type 106) to steel recycling plant. 7) Recycling process of steel 8) Recycling process of battery 9) Recycling process of tire. 70,265-166,384 kilograms of CO_2 / vehicle. In the use of greenhouse gas emissions are more than 80%, while the process of carcass removal is only 0.7%. At present, there is no government agency that collects ELV data and there is no ELV management system in Thailand. Based on the estimation, there was ELV material generated in 2015 of approximately 135,384 cars discarded per year or roughly 79,147 tons of steel and 2,805,953 discarded batteries. Without proper management, these ELVs could cause harm to the environment. This led to the objectives of this study, which are 1) study the distribution of ELVs, batteries, and steel of ELVs in Thailand and 2) provide policy recommendations. ELV management systems of other countries are also reported and discussed. According to literature reviews, many developed countries, e.g., European countries, the United States, and Japan have long applied ELV management systems in their countries. They have set the standard for using toxic materials or reducing harm to the environment. In other words, they set standards to minimize the use of toxic material in car manufacture and, in the meantime, promote reuse, recycle, and recovery within the countries. There is no ELV management system in Thailand and no report that described the life cycle from the car owner to the end of its life. When the car owners would like to discard their car, they normally sell to second-hand shops. Normally, the used city cars are sold and used outside the city. When the cars have an accident, if the car owners have insurance, the insurance will supply the car spare parts to the car repair shop and the partly worn car parts will be returned to the insurance company. Then, the insurance company will sell the partly worn car parts and unfixable cars (used car) to an auction company. The auction companies then sell to customers, e.g., repair shop, second-hand car shops. The dismantling facilities (industry types 105 and 106) sometimes accept passenger cars and taxis to separate and sell to recycling plants, e.g., steel, plastic, and battery-recycling plants. There are four types of business related to ELV management: 1) repair shops who have deal with the insurance company, which are approximately 1,798 shops nationwide, 2) insurance companies, 3) second-hand (cars/spare parts) shops 196 shops, 4) recycling industries (six battery-recycling industries, 17 steel-making industries, 72 plastic-recycling industries). It seems that there are several ELV industries related to ELV with more capacity to recycle ELV, but they cluster only in the central areas. It seems that the car manufacturers, car owners, and all industries related to ELV management systems have run business as usual and unalignment with the sustainability concept nor SEP.

In other words, they have run businesses to make the highest profits possible, which means they discard or dispose of, e.g., oil and toxic materials into the environment. To achieve sustainable development, the government should apply an ELV management system in the country**.**

REFERENCES

[1] Transport Statistics Sub-Division, Number of Vehicle Registered in Thailand. 2017, Department of Land Transport.

[2] Maierbrugger. Thailand's First-Car Buyer Incentive Scheme A Failure. Southeast Asia's Business News Site 2013 February, 2017]; Available from: http://investvine.com/thailands-first-car-buyer-incentive-scheme-collapsed/.

[3] Schultmann, F., M. Zumkeller, and O. Rentz, Modeling reverse logistics tasks within closed-loop supply chains: An example from the automotive industry. European Journal of Operational Research, 2006. 171: p. 1033–1050.

[4] Mangmeechai, A., An economic input-output life cycle assessment offood transportation in Thailand. International Journal of Environmental Studies, 2016. 73(5): p. 778-790.

[5] Smink, C.K., Vehicle recycling regulations: lessons from Denmark. Journal of Cleaner Production 2007. 15: p. 1135-1146.

[6] Mazzanti, M. and R. Zoboli, Economic instruments and induced innovation:The European policies on end-of-life vehicles. Ecological Economics 2006. 58: p. 318- 337.

[7] Shin-ichi Sakai, et al., An international comparative study of end-of-life vehicle (ELV) recycling systems. Journal of Material Cycles and Waste Management, 2014. 16(1): p. 1-20.

[8] Koshiba, K. The recycling of end-of-life vehicles in Japan. 2006 July, 2018]; Available from: https://www.japanfs.org/en/news/archives/news_id027816.html

[9] Sakai, S., et al., An international comparative study of end-of-life vehicle (ELV) recycling systems. Journal of Material Cycles and Waste Management, 2014. 16(1): p. 1-20.

[10] Mangmeechai, A., Moving towards sustainable end-of-life tire management from the cost and environmental perspectives: a case study of Thailand. International Journal of Technology Policy and Management, 2017. 17(1): p. 77-93.

[11] Pavasant, P., et al., Policy Analysis on End of Life Tire Management in Thailand. 2014, National Research Council of Thailand, Bangkok: Grand number RDG5650136.

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