

**Motorbike Recycling and Renewing Program (MRRP): Boosting Bioethanol Consumption
and Improving Old Motorbike Disposal**

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5140735 Case Study (GraSPP Policy Challenge: Global Innovative Public Policy Solutions)

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31 January 2023

ACKNOWLEDGEMENTS

This policy proposal aims to provide an innovative solution to the issue of end-of-life and old motorcycles that run on conventional fuel and E10 blends in Thailand. Specifically, the proposal aims to provide a framework to speed up the proper disposal of old motorcycles, the increase of consumption of bioethanol, and prepare the motorcycle disposal sector for the upcoming regulatory framework on end-of-life vehicle (ELV) management that will be implemented in the coming years.

The authors of this report acknowledge and are grateful for the invaluable contributions, and support of the Ministry of Energy of Thailand; the energy experts from ERIA, the professors and advisors from the GraSPP Global Policy Challenge course; and our classmate. We wish to extend our thanks to Dr. Weerawat Chantanakome from the MOEN, Dr. Thanan from the Bioethanol Project within the MOEN, Dr. Ruengsak, renewable energy expert from the Petroleum Institute of Thailand; Professor Boonrod from the Joint Graduate School of Energy and Environment (JGSEE) of King Mongkut's University of Technology Thonburi; and PhD Candidate Mr. Yongyooth, Chief of International Cooperation Unit1 who is currently conducting RE Policy Research at the National Institute of Development Administration (NIDA). Their first-hand knowledge and expertise on the energy transition process and the role of bioethanol in Thailand provided us critical insight and directions for our policy solution.

We would also like to extend our gratitude to Dr. Joko Purwanto, energy economics from the Economic Research Institute for ASEAN and East Asia, who provided us with a comparative perspective between Indonesia and Thailand's energy transition strengths and weaknesses.

Special thanks Professor Jun Arima, and Professor Kazuyo Hanai for their feedback and guidance on our policy solution directions. Professor Arima connected us to the MOEN team and Dr. Purwanto, who were invaluable to the development process of our proposal.

Finally, we would like to thank our good friend, and classmate, Tanawat Papaeng, for sharing their first-hand experience and perspective on Thailand's motorcycle and ELV management landscape as a native of Thailand. Some of the language barrier that we experienced in our research process for Thai articles was partially mitigated by Tanawat, and their support proved extremely helpful in our efforts to access empirical data.

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January 2023

TABLE OF CONTENTS

ABSTRACT	6
INTRODUCTION	7
BACKGROUND & PROBLEM STATEMENT	9
Motorcycle Industry and Landscape in Thailand	9
Current Methods of Motorcycle Disposal	11
Bioethanol policies landscape	12
Production of Bioethanol	12
AEDP Objectives	13
Electric Vehicles (EV) Policies	13
EV Implementation Challenges	15
Importance of increasing bioethanol consumption	17
Current Policies: Price Adjustments for E20 Blends	18
Challenges with E20 blends: A psychological conception regarding E20 safety concerns	19
PROOF OF CONCEPT & POLICY EXAMPLES	20
POLICY SOLUTION PROPOSAL	22
Objectives	22
Pilot Project Strategy	22
Important Partners Involved in MRRP	23
Description of Pilot Project	24
Location Choice: Ayutthaya	24
Process Steps in the Pilot Project	24
Stakeholders	28
Motorcycle owners	28
Conventional Motorcycle Disposal Actors	29
Motorcycle Dealers and Producers	30
Governmental Agencies: DLT, DIW, PCD, I-E-AT	31
PPT Public Company Ltd.	31
WONG PANICH INTL. CO	32
Expected Results and Targets	33
Expected Quantitative Results	33
Expected Qualitative Results	35
Policy Timeline Implementation	36
Finance	38

MOTORCYCLE RENEWAL AND RECYCLING PROGRAM (MRRP)	5
POLICY IMPLEMENTATION - CHALLENGES, MITIGATION OPTIONS, AND STRENGTHS	40
LIMITATIONS TO CURRENT PROPOSAL	43
FUTURE IMPLICATIONS	44
CONCLUSION	46
REFERENCES	48
APPENDICES	53

ABSTRACT

In order for Thailand to meet their climate targets of reaching carbon neutrality by 2025 and net-zero greenhouse gas emissions (GHGs) by 2065 (Global Climate Promise, 2022), the country needs to carry out initiatives to reduce their dependence on oil imports, and engage in energy transition policies to prepare the market for electrical vehicles, while continuing the promotion of ethanol-blend fuels and vehicles. The current energy and transport landscape of Thailand renders it challenging for the country to fully become a production and consumption hub, which is why the role of motorcycles running on ethanol-blend fuels at a 20% concentration and higher are critical to ensure a successful energy transition for the country. To achieve these ambitious goals, the country must address its high volume of “end-of-life” vehicles, including “end-of-life” motorcycles, and vehicles that are still running on conventional petroleum-based fuels and ethanol-blend fuels at a 10% concentration or lower. This paper proposes a policy solution to replace the ELMCs, and the remaining E10 and conventional-fuel operating motorcycles through the “Motorcycle Renewal and Recycling Program”(MRRP). Specifically, it provides a framework for the recycling of the aforementioned vehicles and the increase of bioethanol consumption through increased use and purchase of E20 and flex-fuel motorcycles. The program is designed to integrate fairly easily into the incoming regulatory framework on the management, and disposal of ELVs that the government will implement in the near future. Based on literature reviews, research, and consultation with the Ministry of Energy of Thailand, this proposal outlines what MRRP would look like as a small-scale pilot project implemented in the region of Ayutthaya.

INTRODUCTION

Climate change mitigation is quite possibly one of the most important yet divisive policy issues in our world today. According to the Intergovernmental Panel on Climate Change (IPCC), global temperatures may rise 4 degrees from pre-industrial levels by the end of the century if Greenhouse Gas (GHG) emissions remain high (IPCC, 2022). Despite the imminent risks of climate change and having environmental protection as moral responsibility and obligation, tensions remain across the globe over the creation of policies to mitigate this crisis. One issue is the division between the global north and the global south. While the global north advocates for drastic levels of commitments throughout the world, developing economies fear the costs to such quick and drastic changes, and require policies that have minimal effect on their industries that many vulnerable populations are dependent on for their livelihoods. Another anxiety is the social effects of climate change mitigation policies, where poorly designed policies can further exacerbate inequality and exclusion of marginalized populations. This is a major concern, as inequality and exclusion is regarded as a major hindrance to political stability (Markkanen & Anger-Kraavi, 2019). Against this backdrop, there is a high importance in creating inclusive, well designed, and cost-effective policies that could cater to the needs of developing countries worldwide.

In such a context, this policy proposal looks into the transportation sector, which accounts for approximately 14% of global GHG emissions (US EPA, 2014). The transportation sector is known to be one of the fastest growing contributors of GHG emissions in developing economies like China, where the growth in the number of vehicles have become a major factor in the increase of oil imports and carbon emissions (Yan & Crookes, 2009, World Bank 2021). Governments have imposed various policies to address this problem. In Thailand, the

government aims to implement 1.2 million electrical vehicles by 2030 (Petchphankul, 2021) as one of their initiatives to achieve a 30% reduction of greenhouse gas emissions by 2030, and carbon neutrality by 2050 (Office of Natural Resources and Environmental Policy and Planning, 2022). However, many challenges remain in achieving this goal. These challenges include the difficulty in creating EV infrastructure, difficulties in enhancing fuel blends among consumers, the existence of energy inefficient End of Life Vehicles (ELVs), and the difficulties in making a sustainable system that allows the renewal of automobile vehicles to have less carbon footprints. As such, the following proposal aims to address these problems for the energy transition of the transportation sector in Thailand.

BACKGROUND & PROBLEM STATEMENT

Motorcycle Industry and Landscape in Thailand

The Asia-Pacific region accounts for 80% of total global sales for motorcycles (Yongpisanphob, 2019), with Thailand being the world's 5th biggest producer of motorcycles, after China, India, Indonesia, and Vietnam. As a lucrative target market, production facilities of foreign companies such as Honda, Yamaha, Suzuki, and Kawasaki—the four largest Japanese producers—have been relocated to Thailand in order to reduce total production costs (Yongpisanphob, 2019). Decades of protectionist policies since the 1960s has allowed the country to expand domestic motorcycle production and expand its motorcycle industry for both domestic consumption and exports to the ASEAN region. Currently, around 80% of outputs are for domestic use, while the 20% is for export. Twelve motorcycle factories are currently in Thailand, with a total production capacity of 3.66 million vehicles per year.

Motorcycles are widely used in Thailand due to its convenience, ease of use and affordability. The Department of Land Transport (DLT) revealed that from 2010 to 2019, almost 2 million new motorcycles were registered per year (Wiratkasem & Pattana, 2021). Latest data from 2019 indicate that the number of registered motorbikes totalled up to 21 403 678 units. While 84% of the operating motorcycles consume 20 % ethanol blended fuel (E20 blend) friendly, the remaining 14% of motorcycles that are currently still running on 10% ethanol blended fuel (E10 blend) and Unleaded gasoline (ULG) , representing 3.1 million vehicles (See Appendix B). As a comparison, data from June 2018 show that the number of registered conventional vehicles, namely, vehicles with no more than seven passengers, topped over 9 million, while motorcycles topped over 20 million (Wonglertkulako, 2018) (See Appendix A). It

is hypothesized that each motorcycle produces approximately 0.7 tons of carbon dioxide every year, which represents a significant amount of GHGs when factoring the volume of motorcycles (Tomkiewicz, Phumejitpakdee & Thambumrung, 2022). It is thus imperative to encourage the use of motorcycles that are more environmentally-friendly. Additionally, a high volume of motorcycles implies that many of them are most likely discarded, and are often called “end-of-life motorcycles” (ELMCs), meaning that they contribute to the waste accumulation, and potential toxicity transfer to the environment (Jamaluddin, Saibani, Mohd Pital, Wahab, Hishamuddin, Sajuri, & Khalid, 2022). A portion of the ones that are still functional have a lower concentration of ethanol-blend or simply run conventional fuel, such as unleaded gasoline, benzine 91, etc., meaning that they are more polluting than E20 and flex-fuel vehicles. Factors such as the country’s vehicle tax structure, and the common practice of reselling an old vehicle, imply that many motorcycles across Thailand are extremely old, and have been through the sale and purchase process multiple times (sometimes up to five times). This means that there are many less performative and more pollutive motorcycles on the road, contributing not only to the emissions problem, but also riders’ safety (Therapat, 2022). One of the challenges in dealing with the density of motorcycles is that Thailand currently does not have a regulatory framework in place to properly manage “End-of-life” vehicles (ELVs) and ELMCs.

Current Methods of Motorcycle Disposal

Currently, there is very little information available regarding the reality of motorbike recycling in Thailand. However, a few sources allow us to make an inference about the likely structure of recycling for motorbikes, and the findings show the risks of environmental degradation through the conventional methods of vehicle recycling conducted in the region.

First, cross-country studies show that there is a second-hand motorbike industry in developing countries like Thailand. Here, motorbikes are reused by various consumers until the motorbike becomes virtually unusable. Once the motorbike becomes unusable, the motorbike is handed over to an individually owned enterprise that disassembles the motorbike and extracts second-hand parts that could still be used for purposes like repairing other motorbikes. Then, the parts that cannot be used are handed over to disassembling/scraping businesses where materials are scrapped and sorted by manual labor. These sorted materials are then processed at places like electric furnaces for steel to be used for various purposes (Jamaluddin, Saibani, Mohd Pital, Wahab, Hishamuddin, Sajuri, & Khalid, 2022). Although this process allows many parts of the motorbike to be reused, it is also a hazardous process where un-reusable materials such as chlorofluorohydrocarbons (CFCs), PCB, liquids from batteries, and other toxic materials are directly disposed of into the environment.

Qualitative studies conducted for the automobile recycling process indicate a similar dynamic with Thailand's vehicle recycling structure. Second-hand vehicles are very popular in Thailand, with approximately 2 million registration changes being made as of 2014 (METI, 2016). An interesting aspect of Thailand's vehicle industry is the role insurance companies take in treating damaged vehicles. If a user with insurance gets into a car accident, the owner usually brings the damaged vehicle to a car repair shop where the insurance company will send spare

parts to fix the car. If the car is not repairable, the insurance company takes the car and sends it to an auction the car to a second-hand shop, dismantling factory, or another repair shop (Faridza et al., 2022) (See Appendix C). In this case, the vehicle will eventually be broken down into usable pieces, recyclable materials, and toxic waste. Although the size of Thailand's second-hand automobile economy is not known, some estimates show the potential scale of this industry. One such estimate is that there are approximately 30,000 second-hand vehicle parts stores in Thailand (METI, 2016). Nevertheless, the contemporary vehicle recycling scheme has serious issues with its impact on its environment, particularly with actors like the repairment centers, second-hand part shops, and dismantling centers emitting used oil/liquids from the dismantling process and emitting CFC into the atmosphere (METI, 2016).

Bioethanol policies landscape

Production of Bioethanol

Reliance on foreign oil imports have been one of Thailand's main concerns. Therefore, domestic bioethanol production rose as a potential solution to improve their national energy security by easing their dependence on foreign oil and promoting a sustainable energy transition to reduce carbon emissions simultaneously. Thailand ranks first as the largest sugarcane producer in the South-East Asian region and fourth in the world (Atlas, 2020), holding great potential for ethanol production and the commercialization of ethanol as a biofuel for the transportation sector. Taking this into account, ethanol production has grown alongside government's supportive strategies which included tax exemptions and subsidies, however the growth has stagnated recently due to high feedstock prices (mainly molasses and cassava) caused by poor harvest and high fuel prices following the Russia-Ukraine war, hindering the process of commercializing bioethanol.

AEDP Objectives

The Alternative Energy Development Plan (AEDP) was re-established in 2018 with an updated goal compared to when it was first introduced in 2015. The main aim remains to invest more in renewable energy power plants and to target an increase in renewable energy accounts in the form of electricity, heat, and biofuels from 15% of total energy consumption in 2018 to 30% in 2037 and reduction in conventional energy consumption from 85% to 70%. According to Department of AEDP, this change is expected to reduce the use of fossil fuels by 39,388 ktoe, amounting to a THB 590 billion reduction; and emission of greenhouse gas will be reduced by approximately 140 million tonnes (20% from GHG emissions recorded in 2005 by 2037) of carbon dioxide equivalents (KPMG, 2020). While the government focuses on biomass as a significant contributor in alternative resources to leverage Thailand's advantage of a large agricultural industry, the target of ethanol consumption has been reduced to 7.5 million liters per day (1,396ktoe) compared to its initial target in 2015 and eliminated its target for biomass production in the transport sector (MOE, 2018). This adjustment was a result of challenges surrounding domestic ethanol production and consumption due to high fuel costs, and a change in transport system development plan to promote electrification of vehicles substantially.

The results of MRRP will be compared to the AEDP objectives to measure the effectiveness of the program, mainly on how much carbon emissions could be reduced by disposing old motorbikes and renewing them to E20 compatible motorbikes.

Electric Vehicles (EV) Policies

The government of Thailand currently has a set of policies lined up to become active in the efforts of encouraging the adoption of EVs. The excise duties for motorcycles, both ICE-powered, and hybrid electric vehicle models are to be set based on their CO₂ emissions,

with the first stage of this policy to take place from 2026-2029. The rates are the following: 4% (CO₂ emissions < 50 g/km), 6% (CO₂ emissions 51-90 g/km), 10% (CO₂ emissions 91-130 g/km), and 20% (CO₂ emissions > 130 g/km). From 2030 onward, where phase 2 will begin, the rates will be increased to 5%, 10%, 15%, and 25%. As for battery-electric vehicle (BEV) motorcycles, the excise duties will only be fixed at 1% as a way to increase the production and purchase of these vehicles. Seeing that there are only 857 BEV registered motorcycles right now (Statista, 2022), the Thai government is planning on providing subsidies to buyers of BEV motorcycles to stimulate growth of the BEV market segment from 2022-2025. For instance, THB 18,000 will be given to those who purchase BEVs that cost no more than THB 150,000. Finally, any BEVs registered between October 2022 and September 2025 will see their road taxes cut by 80% for one year as a way to reduce CO₂ emissions and PM_{2.5} particulate emissions (Thailand Industry Outlook 2023-2025, 2023)

Other regulatory efforts have been planned to meet the AEDP 2030 goals: A roadmap to the country's EV development for the period of 2021-2035 has been developed by The National Electric Vehicle Policy Committee of Thailand. The aim is to implement a well-established supply chain for manufacturing EVs, and in the efforts to do so, the government has set the target of 30% production of ZEVs — battery electric vehicle (BEV) and fuel cell electric vehicle (FCEV) — by 2030. EV manufacturers are also given incentives, including zero import duty for machine and raw materials, and a corporate tax exemption for three to eight years. These incentives are offered by The Board of Investment of Thailand (BOI) who is trying to push for additional benefits, such as corporate tax exemptions for BEV-related components to provide more comprehensive and integrated incentives to develop the EV industry (Arthur Little, 2022).

EV Implementation Challenges

Despite the demand and supply side incentives, the current EV adoption rates are still at a low 0.2% (Arthur Little, 2022). A couple of challenges remain to be overcome in order to meet its carbon neutrality target by 2050. From a production perspective, there are limits to access and availability of raw material in the production process, which affects the EV supply chain. If demand does pick up, the upstream stage dealing with raw materials such as lithium, cobalt, manganese, graphite, and nickel, as well as specialty chemicals, might become dependent on external sourcing, which can lead to additional costs. Due to the limited mineral reserves for lithium-ion batteries (LIB), Thailand's competitive advantage as the automotive hub of Asia may be lost as it becomes an assembly engine of producing models and packs from imported cells. This will limit localization of production facilities due to the low local value addition, and could hinder on foreign investment in high-end technology. In addition, considering the significant role that Japanese original equipment manufacturers (OEMs) play to the development of Thailand's automotive hub (they account for 80-90% of automotive production, domestic sales, and export), Thailand will have to rely on these OEMs in making EV as a priority area for the country in order to fully integrate EVs into their transportation landscape. Currently, Japanese OEMs consider the EV as a low priority due to their belief in a more gradual transition from the ICE powertrain to the electric powertrain (Arthur Little, 2020). Paired with the global shortage of semiconductor chips and the increased inflation rate due to the COVID-19 pandemic and reduction in consumer purchasing power, making it challenging for consumers to purchase EVs, the EV era may require more time to come than the initially planned timeline.

From a consumer's perspective, there is currently a greater preference for non-EVs due to the initial cost. The price of EVs is much more expensive than ICE vehicles due to rising battery

cost, and the small sufficient scale. As a comparison, the cheapest EV car model still costs US \$22,856 post-subsidy, while the cheapest ICE car model is only at US \$9,073. In addition to this pricing gap, model availability is also limited, thus, decreasing the attractiveness of these vehicles. This pricing gap is discouraging many consumers from purchasing EVs currently when there are cheaper alternatives. As such, price still remains one of the biggest concerns for consumers to adopt EVs. Additionally, while the EV fuel costs only represents 20% of ICE vehicles, and maintenance only 25% of ICE, implying a lower running cost, total cost of ownership (TOC) for consumers takes precedence over. The difference between fuel and electricity price become salient if that difference is large, as these represent daily costs for consumers. For example, when the price gap between fuel and electricity cost had widened, Indian consumers were inclined to consider adopting EVs. In Thailand's case, the gap in price for electricity versus fuel is still minimal, currently topping at US 8 cents (See Appendix D for infographics).

The second challenge, and perhaps the most critical, is the limited strategic push for charging infrastructure, with only 693 charging stations across the country as of September 2021 (Arthur Little, 2020). Compared to its neighboring Asian countries, such as China (1.4 million), South Korea (105K), and India (21K), all of which are making efforts to establish a strong EV ecosystem, Thailand has a lot to catch up on. Building public charging stations requires data and information on the user behavior, utilization, location of charger, and time spent by typical user—all of which are currently not captured by any data points, which can hinder decision making in the set up process of public chargers (Arthur Little, 2020). There also has not been any business models that were endorsed by the government for charging infrastructures, which are meant to address financing options, potential investors, and setting up necessary funds for the

initial period of low returns. Third, while Thailand has multiple export markets for its current conventional and ethanol blend automotive industry, these same recipient countries may not attract EV products due to local content regulations, meaning that Thailand must develop its own local EV supply chain. This, in turn, is dependent on the local demand levels. Under Thailand's current policies and projections, the country will not meet its revised Nationally Determined Contributions (NDC) targets, nor become "carbon neutral" by 2050 and produce net zero GHGs by 2065 (Climate Action Tracker, 2022); it is projected that emissions will continue to rise.

Importance of increasing bioethanol consumption

The COVID-19 pandemic brought upon significant setbacks to the bioethanol production, and consumption of Thailand. The demand for domestic ethanol had been rising steadily in the years prior to the COVID-19 outbreak, with an average annual increase by 20.3% in consumption. This outcome is the result of the combination of a number of policies pushed by the governmental authorities. The Krungsri research team is projecting that demand for bioethanol will rise at 2.4 to 3.6% per year between 2021-2023, bringing consumption up to 42.4.5 million liters. As the government continues to promote the use of E20 blend, it is also looking to retrieve E10 blends in 2023 from the market. E85 price subsidies are also ending in order to reduce the pressure on the Oil Fund as an extra push to incentivize consumers to adopt E20 blends only (Industry Team, 2021).

Acknowledging the amendments brought to the AEDP in 2018, which reduced the bioethanol targets in order to make room for EV adoption, it does not imply that bioethanol is losing relevance in the energy transition process for Thailand's transportation sector. Studies have shown that even with aggressive scenarios for EV sales growth, they would still only account for 50% of the global total fleet by 2050. As such, a significant share of vehicles are still

expected to rely on liquid fuels in the near to medium term, and even more so in emerging countries like Thailand, where the investment, and set up in infrastructure is constrained and slow (Debnath, 2019).

Current Policies: Price Adjustments for E20 Blends

Thailand energy authorities are now planning to adopt gasohol E20 as the primary oil fuel at petrol stations instead of E10 by the end of 2023, to encourage motorists to shift their choices of fuel with a higher ratio of ethanol (Praiwan, 2022). The growing demand for ethanol is seen as an opportunity to boost the proportion of Thai-made ethanol used in gasohol mixes, hence sales of E20 will be expected to rise from 21% of all gasohol sales in 2020 to 25-30% of the total by 2023 (Krungsri, 2021). To encourage more E20 users, the retail price of E20 is set lower than E10 by 1.11 baht per litre and the government is planning to gradually increase the price gap to 3 baht per litre within the next few years as one of their strategies to boost domestic consumption for E20 while phasing out E10 and E85 blends. The effect of ceasing E85 blend will be limited due to its extremely low demand and the sales of E85 only accounting for 2.9% of all gasohol distributed to the market (Krungsri, 2021). In addition, this strategy is currently accompanied by a levy on E10 through the Oil Fuel Fund and cutting down subsidies on E85 in order to make E20 cheaper in return. The government aims to achieve only premium gasoline (octane 95 gasoline) and E20 available in the market by 2037 to align with the AEDP goal (Prasertsri, 2022).

Challenges with E20 blends: A psychological conception regarding E20 safety concerns

Although the government will be enforcing E20 blends as primary oil fuel in Thailand within the next few years, major concern from the public was a widespread conception that a higher ratio of ethanol will bring about detrimental effects on their engines. This concern arose

mainly due to ethanol's hygroscopic nature that absorbs water from the air which is suspected to separate the fuel blend that leads to the corrosion of engine and fuel system. However, it is noteworthy that almost every vehicle manufactured after 2008 in Thailand is compatible with gasoline E20, while such engines have been scientifically experimented to test the materials compatibility and drivability of E20 and even higher blends, only to prove no problems have been detected in automotive engines and fuel dispensing equipment when appropriate and compatible metal have been used (Baena, 2021). While the existence of such psychological conception may hint at a hindrance to our program, it could also be seen as an opportunity to capitalize on their mindsets to conduct checkups for their engines to provide an assurance for the safe usage of E20. This method would not only help debunk their misconception of E20 fuels and increase demand but also help detect motorbike users who are using ethanol-incompatible engines or motorbikes that are older than 2008 so that warnings concerning their safety could be provided to them, which would ultimately encourage them to buy a new model.

PROOF OF CONCEPT & POLICY EXAMPLES

With globalization and academic exchange, we now have the tools to properly analyze and potentially replicate policy ideas that are currently being implemented in other nations while learning from their outcomes. And so, having chosen this cross-section of transport, economic, energy, and environmental policy, we view India's efforts in this field to be quite informative and substantial. India shares a couple of issues, goals, traits, and characteristics with Thailand in this respect:

A. Large number of old vehicles in use, thus damaging the environment

B. Healthy domestic industry to support bio-ethanol production and consumption

India has now managed to save a foreign exchange outgo worth over 1 billion USD thanks to the use of Ethanol Blended Petrol (EBP) (ETEnergyWorld, 2021). In addition, the use of E10 petrol cuts hydrocarbon and CO emissions by 20% in both two-wheelers and passenger cars while the use of E20 petrol cuts CO emissions by 50% in two-wheelers and 30% in four-wheelers. Now that India has put in place an official Vehicle Scrapage Policy in order to remove old vehicles and incentivise consumers to buy modern E20 compatible ones, they are in a better position to achieve the E20 target blend, which in turn would save them USD 4 billion per annum. Consequently, with higher bioethanol demand, this would greatly benefit the agricultural industry in India (with similar implications for Thai farmers if Thailand pulls off the same). Their success sheds light on the opportunity being presented in Thailand given the similar socioeconomic, transport, and agricultural conditions seen between the two nations. Past studies have explored the potential for the phase-out of old motorcycles, and the replacement of new ones in the efforts to improve air pollution and quality levels. However, these initiatives have never been adopted by the Government.

Therefore, we estimate that our policies could see similar rates of success and that would not only greatly benefit Thailand as a developing nation, but it may also serve as a model to replicate for other Southeast Asian countries, especially with Thailand playing the lead role as a nation with a robust bioethanol industry.

POLICY SOLUTION PROPOSAL

Objectives

Given the difficulties mentioned in the above section, there is a need for Thailand to provide a streamlined, environmentally friendly process to renew its ELVs to reduce emissions and make minimal impact in the recycling process. Given these needs, the project's main objectives will be as such listed below:

1. Provide a streamlined method for motorbike recycling and renewal in order to address the problems that were outlined in the problem statement section.
2. Minimize the impact to the natural environment in the recycling process (Particularly in the dismantling and scrapping process).
3. Provide an inclusive scheme that engages with all stakeholders.
4. Boost bioethanol consumption on the consumers' side, specifically the uptake in E20 blends.

Pilot Project Strategy

The key idea behind MRRP is to create a program where consumers are incentivized to dispose of their E10, ULG, and end-of-life motorcycles in a simple, easy way, while using an existing network of facilities and actors. To encourage the consumption of bioethanol, and align with the government efforts of promoting E20 blends, the program provides incentives for consumers to purchase E20 or flex fuel motorcycles as a replacement, subsequently leading them to consume E20 fuel blends. The used motorcycles, on the other hand, are sent to a dismantling facility to be properly disposed of, minimizing the environmental impacts. After the dismantling and scrapping process, extracted materials will be sent to relevant industries such as the steel, batter, and tire recycling centers.

Important Partners Involved in MRRP

ACTORS	DESCRIPTION OF ROLE	REASON FOR CHOOSING ACTOR
DLT Offices in Ayutthaya	<ul style="list-style-type: none"> • Send notices to registered motorcycles that are E10 blends, ULG, and ELMCs • Carry out inspection of vehicle, with the help from PCD personnel • Ensure that motorcycle owner is eligible for the program by assessing their registration profile and their motorcycle model • Process the deregistration of vehicle • Administer the Certificate of Recycling • Provide educational pamphlets on the environmental benefits of switching motorcycles to E20/flex-fuel types. 	<ul style="list-style-type: none"> • Ensure an easy, streamlined process for motorcycle owners. • Work with an established network of facilities to reduce confusion among consumers' and logistical tasks.
Wong Panich International Co., Ltd. (Wongpanit Recycle)	<ul style="list-style-type: none"> • Dismantle and organize E10 motorcycles, ULG motorcycles, and ELMCs in a responsible and environmentally manner • Sell scrapped parts to appropriate recycling centers • Cooperate with inspections from PCD and DIW 	<ul style="list-style-type: none"> • Wong Panich was chosen as the main partner facility because it is only one of the two car scrapping facilities in Thailand that properly disposes of ELVs (Therapat, 2022) • Work with an established recycling center that is located in Ayutthaya (reason for choice of location for pilot project)
Private waste transport company	<ul style="list-style-type: none"> • Transport the dropped-off motorcycles from the DLT to the dismantling center 	<ul style="list-style-type: none"> • Government is already currently sub-contracting the waste transport process to private companies. It makes sense to follow this approach.
PCD and DIW/I-EA-T personnel	<ul style="list-style-type: none"> • Carry out on a frequent basis the inspection of the dismantling center to ensure compliance in the disposal of hazardous material. • Provide technical assistance and appropriate support to the dismantling center team in a way that upholds the standards outlined in the Hazardous Substance Act (Wonglertkunakorn, 2018), The Maintenance of the Cleanliness and Orderliness Act (Wonglertkunakorn, 2018), and the Factory Act. 	<ul style="list-style-type: none"> • No existing enforcement or regulatory framework exists to ensure compliance of environmental standards for recycling centers. The best alternative is to rely on existing resources, and establish new methods of collaboration between them to somewhat mitigate environmental concerns. The establishment of strict regulations and standards on environmental standards are outside of the scope of this project, as the current government is working on developing one.
Motorcycle dealerships in Ayutthaya	<ul style="list-style-type: none"> • Provide the appropriate discount to any customer who presents the Certificate of Recycling and who intends to purchase an E20 or flex-fuel motorcycle. • Provide free check-ups of motorcycles who were purchased from the dealership within the extended warranty period. • Contribute to the appeasement of E20 fuel concerns 	<ul style="list-style-type: none"> • Work with established motorcycle dealerships to ensure easy purchase of new motorcycles. • Encourage private-public partnerships • Motorcycle dealerships can support the PR campaign for disposing old motorcycles, and switching to E20 blends; can increase consumers' trust as information source does not only come from the government

Description of Pilot Project

Location Choice: Ayutthaya

Just 70 km north of Bangkok, Ayutthaya is a strategic region that has various important stakeholders involved in vehicle recycling. One major factor contributing to Ayutthaya's comparative advantage is the existence of a large second-hand vehicle parts market located in the Wangnoi district, with approximately 200 second-hand motor shops located there (METI, 2016). This is known to be one of the largest second-hand vehicle parts markets in Thailand, as second-hand vehicle parts dealers have relocated from Bangkok to avoid the high costs of operating their business in the capital. This has helped Ayutthaya to have a high concentration of other vehicle recycling-related businesses, such as vehicle repair, disassembling, and scrapping businesses. The high concentration of actors associated with vehicle recycling makes Ayutthaya a prime location for the program to find and coordinate with potential partner agencies that could start our pilot projects. One of these dismantling centers include Wong Panich Intl. Co., which is known to be one of the Nation's two proper vehicle disposal facilities.

Moreover, Ayutthaya has a high potential for facilities and resources that could process the materials extracted by private recycling businesses, such as the electric furnace for steel located in the nearby Saraburi prefecture and other facilities scattered around the greater Bangkok region (METI, 2016).

Process Steps in the Pilot Project

The pilot project can be strategically held in Ayutthaya as we could utilize the aforementioned comparative advantages of the location and its conditions.

We begin with the role of the DLT, who is responsible for vehicle registration, and would have access to provincial and national databases concerning various details of the vehicles in question - from the make of the model to the insurance and age of the same. The DLT would then issue a digital/physical notice to citizens whose vehicles (motorbikes in this case specifically) have crossed a certain age limit (say, 10 years for example). In the pilot project, those in Ayutthaya who receive the notice can voluntarily head to the Ayutthaya Provincial Land Transport Office where licensed technicians from recycling and second-hand parts companies (who can be hired in Ayutthaya) carry out an inspection as per Thailand's ToRorOr system or perhaps a whole new framework (which the Thai and Japanese Governments are currently collaborating on). The goal here is to gauge the quality of the vehicle, its carbon emissions, and finally the recyclability of said vehicle. Based on the results of the inspection, a decision would be made on what parts of the bike need to be scrapped completely and what parts could be sold to second hand parts dealers (as E10 vehicles would be phased out).

If the criteria for safe and secure recycling and/or scrappage is met, the DLT office would issue an E20 and Flex-Fuel Subsidy Certificate ("Certificate of Recyclig") to the vehicle owner who could then use that to buy a modern E20-E85 compatible motorbike from their preferred brand in Thailand. This Subsidy Certificate acts as a unique coupon that enables the consumer to avail a discount at a vehicle dealership specifically for E20 and Flex-Fuel motorbikes, thus acting as one major incentive for the new purchase. In addition, an extended warranty would be granted alongside the facility of free check-ups for the prospective consumer so as to put any fears of Ethanol-driven engine corrosion to rest (which apparently has been a matter of great concern for vehicle owners, hence the existing hesitation of moving onto higher EBP compatible vehicles).

Once the procurement of the old vehicles is done, they are then collected by private recycling/scrappage companies (based on formal contracts) and sent to the closest or most suitable recycling/scrappage facility, the likes of which can make money on the scrap material as well as the working parts of the to-be scrapped vehicle. For the pilot project, Wongpanit Suvarnabhumi Recycling Station Co, Ltd. would be a low risk - high ceiling partner with respect to this project given their experience in waste management and scrappage procurement.

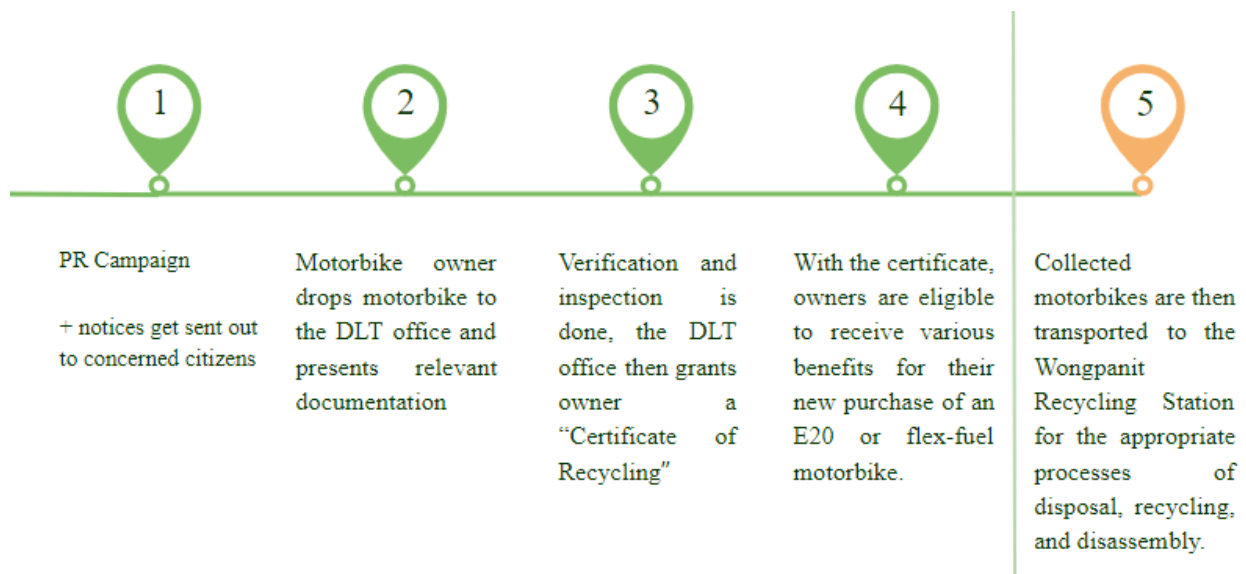
More on the consumer subsidy, the expectation is that private companies who currently struggle to boost flex-fuel bike sales would benefit from this programme as consumers are incentivized to make such purchases, thus harmonizing the demand and supply of the same in theory. And with respect to the funding of this policy, we expect the Government to rake in revenue from the tenders they auction or contracts they negotiate with existing companies (companies would bid for the right to provide the exclusive service of transportation of the motorbikes to the appropriate recycling centers).

After the consumer disposes of the motorbike, the partner dismantling/scraping facility will come to the DLT to collect the vehicle and process it. In order to assure that the motorcycle is dismantled/scrapped in an environmentally friendly manner, the facilities will be receiving technical advice to reduce environmental impact when they are beginning their partnership and regular inspections/consultation opportunities once in three months during the pilot project. The technical advice and inspection will be conducted by the technical experts from the Pollution Control Department, Department of Industrial Works, and external consultants, and the inspection will mainly look at the treatments of disposed liquids, oils, and CFC handling.

Based on our research, we acknowledge that this idea contains various moving parts, but at the same time, it is to be noted that this system is compatible with Thailand’s existing governance structures as various existing mechanisms and stakeholders are utilized to make this project a reality. The Thai Government already maintains a similar approach to regular garbage recycling and disposal (by having public-private partnerships), and so our policy proposal hinges on that very concept itself which in turn would not only fulfill the Thai Government’s goal of reducing the number of old vehicles, but it also would tip the scale in the market where the demand for higher Ethanol Blended Petroleum (EBP) based vehicles increases.

Currently in Thailand, all cars over seven years old and motorbikes over five years old must undergo regular inspection by official test centers, and the TorRorOr certificate, which certifies that the vehicle is roadworthy. No reminder is issued in this case, but without the TorRorOr it is not possible to get the annual tax sticker once the car is over seven years old.

The graphic below briefly summarizes the process of the pilot project in a few steps:



Stakeholders

Motorcycle owners

In comparison to higher-income countries such as Germany or Norway, Thai motorcycle owners place total ownership costs (TOC) as their number one concern (including those who work as motorcycle taxi drivers), as opposed to environment and sustainability (Artur Little, 2022). Initial costs of the motorbike, and its maintenance fees remain consumers' biggest concerns and factors into the decision-making process. The up-front cost of the vehicle is a critical factor for motorbike owners in their decision to purchase a new vehicle or keep the old one. Another issue that exists in the acquiring process of motorcycles is the reselling of old vehicles. Specifically, motorcycles that are resold the fourth or fifth time poses environmental risks as well as health risks. This is partially due to the seller's desire to earn extra income, all while meeting the needs of demand by other buyers who wish to purchase a cheaper, second-hand vehicle. One reason that encourages owners to keep their bike for as long as possible is due to the tax structure on vehicles in Thailand. For instance, with each additional year a vehicle is kept by the owner, the tax percentage is reduced annually. The sum of these policies, and conditions create a level of resistance for motorbike owners to delay the replacement of their motorcycles. In the near future however, due to the plans of halting the distribution of E10 gasohol, motorbike owners will have no choice but to replace their old vehicles with E20 blend friendly ones. In addition, those who already own an E20 blend friendly motorcycle, but who are still consuming E10 blends are also obliged to switch their fuel type. Considering the different outlets for an owner to dispose of their vehicle, including re-selling it to a connection, online, to a second-hand car shop, or a car dealership service center, the

perceived value and rewards that can be provided by MRRP must be higher than any of the alternatives above.

Conventional Motorcycle Disposal Actors

The recycling industry, and current vehicle disposal ecosystem has a high stake with this project as the program has a potential to fundamentally change their supply chain. The current method of procuring old vehicles is based on market arrangements between car repair shops, second hand car part shops, disassembling/scraping businesses, and other actors (See below for the list of actors). As an ecosystem that emerged organically, the introduction of MRRP may disrupt the current arrangements as the project will streamline the market ecosystem and may induce drastic changes in how old vehicles are supplied and processed in the industry. Possible issues caused by our policy may include the exclusion of certain actors, such as the auctioning companies and second hand motorcycle shops, and our policies benefiting specific companies instead of improving the capabilities of the entire sector. The implementation of the project should be cautious of these potential issues and try to provide equal opportunities for the stakeholders to participate in the program.

Moreover, second hand vehicle shops and second-hand car part shops may have a negative stance toward this program as it could potentially decrease the demands for reselling and repairing. For the second hand vehicle shops, this concern could be addressed in the future phases of the program by incorporating them into MRRP, allowing consumers to purchase second hand E20 vehicles so that the scheme could also provide customers to compensate for the possible losses caused. However, the pilot project will not include them as part of the process. As for insurance companies, auction sites, and motorcycle repairs shops, the MRRP project acknowledges their presence in the current disposal process, but for the scope of the pilot project,

these actors will also not be engaged. The reason is because for these three actors, there is an element of repair and re-sale of motorcycles (the entire vehicle, not the parts that have been dismantled), which is not relevant to the MRRP pilot project. The pilot project is not meant to reuse old motorcycles that are running on E10 and conventional fuels, but rather to dispose of them entirely. As such, these vehicles should not find themselves in these shops, as the shop owner will not benefit from accumulating them (since E10 blends are getting phased out, and increasingly less people are looking for E10 and conventional fuel-running motorcycles).

As for the subsequent recycling centers, such as the battery, steel, tire, etc. industries, they may benefit from an increase of material received, which may contribute to their sales. Due to the scope of the project, there are limited mechanisms to ensure proper regulation, which means they will operate business-as-usual. These industries can be heavy polluters in the recycling process, but the incoming regulatory framework by the government is anticipated to address these issues, and further expansion of the MRRP project may contribute to solutions.

Motorcycle Dealers and Producers

Motorcycle dealers in the Ayutthaya region may benefit from an increased clientele as people come in to trade in their certificate of recycling while purchasing their E20 or flex-fuel new motorcycle. Since the certificate is built on governmental subsidies, the dealerships will experience no financial loss. As such, the idea is these dealerships can mostly experience benefits in the form of increased clientele and revenues. The free check-ups that MRRP is proposing the dealerships to offer may feel like an extra step too far in the services and benefits they are providing to customers. However, the increased customer base and profit may prove to be a solid trade-off for the dealerships.

Motorbike producers include Thailand's country's most popular motorcycle companies, such as Honda, Yamaha, Suzuki, Kawasaki, BMW, Triumph, and Ducati (MotorCycles Data, 2023). For these producers, the MRRP project may create an issue of inventory surplus of E10 and older motorcycles. While these models are not promoted nor sold in comparison to their E20 and flex-fuel counterparts, producers as well as dealerships may find alternative methods of selling them or disposing them. MRRP will actively work on a framework that allows these producers and dealerships to responsibly dispose of these vehicles, while experiencing minimal financial loss.

Governmental Agencies: DLT, DIW, PCD, I-E-AT

The governmental agencies involved in the project are critical to the smooth operations of MRRP. Considering the added workload onto the DLT, DIW, PCD, and I-E-AT, there is an assumption that there will be an increase in human resources and the new demands and tasks brought upon the project. While employment opportunities may increase, the financial support to hire, train, restructure and/or reclassify certain roles, and implement the material resources required may be limited. The management of employees from these agencies must be well carried out to prevent over workload and ensure role and responsibilities clarity within these teams.

PPT Public Company Ltd.

PPT Public Company Limited is a state-owned company in the oil and energy sector. It is involved in the development and exploration of gas properties and operates through segments of oil and gas production, electricity generation, gasoline retailing businesses, and petrochemical products. As a company with the largest market capitalization on the Stock Exchange of

Thailand, with the country's Ministry of Finance holding more than 50% of the share, the company is extremely influential in the country. While it is not an actor directly involved with the MRRP project, it may be impacted by the program's push towards the gradual phasing out of gasoline and conventional-fuel by governmental policies (Nikkei Asia). The company however entered the biofuel sector in 2014 (Ono, 2014), and has partnered with different ethanol production companies since, including as Ubon Bio Ethanol Co. PPT's role in the biofuel sector is one of development and research to help develop more innovative and efficient ethanol production processes for the energy industry and other commercial industries. As such, the MRRP project may align with the company's general directions. The approach to take for this stakeholder would be continued monitoring.

WONG PANICH INTL. CO

Wong Panich Intl. Co is an important stakeholder in the MRRP pilot project considering its dismantling and disposal role. The foreseeable benefits that the company can receive are an increase in revenue from the sale of scrapped materials. As there will be an increase in motorcycles that will arrive at the dismantling center, the company can expect to produce more scrapped output, which they will then sell to relevant buyers. The increase in motorcycle volume may also require more labor force, which can induce an increase in employment for the company. One thing to take into consideration is the relationship between the inspection and monitoring personnel from the government agencies, and Wong Panich Intl. Co. It is important to maintain a balance between ensuring the corporation's proper handling of scrapped material, while also not infringing on their autonomy as a private company. Any perceived excessive attempts to command or regulate the company's branch for vehicle disposal can result in a strained relationship between the two entities, which will counteract against the program's aim to

develop fruitful private-public partnerships. As such, it is important to keep the team at Wong Panich satisfied in the monitoring process by the government.

Expected Results and Targets

This section provides multiple assumptions of the possible quantitative and qualitative outcomes MRRP aims to achieve based on data available to us and assuming that the program was effective with the maximum number of targeted motorbikes (3.1 million). To measure the effectiveness of our program, the results will be compared to how much it could be contributed to Thailand's AEDP 2018 goal.

Expected Quantitative Results

- a. Expected Quantitative Results: How much fossil based GHG emissions can be reduced through MRRP?

Step 1: Calculate 20% CO₂ emission reduction

Assumption: 1) Assuming that MRRP was effective in transitioning all 3.1 million motorbikes to E20 compatible models and 2) motorbike users are only using E20 fuels as it will be the only fuel available in the market, the amount of CO₂ emissions reduction have been calculated based on annual fossil CO₂ emissions (tons) recorded in 2005.

The calculation is based on AEDP 2018 goal of reducing 20% of annual fossil CO₂ emissions (tons) that have been recorded in 2005 by 2037.

Annual Fossil CO₂ emissions (tons) of Thailand in 2005: **224, 976, 320 tons**

(source: worldometer, 2016)

20% CO₂ emissions reduction: 224, 976, 320 tons x 0.2 = 44, 995, 264 tons

Expected Annual Fossil CO₂ emissions (tons) of Thailand in 2037:

224, 976, 320 tons - 44, 995, 264 tons = 179, 981, 056 tons

With given data, we can assume that AEDP 2018 goal aims to reduce 44, 995, 264 tons of CO₂ emission by 2037.

Step 2: Calculate annual CO2 emission per motorbike

Assumption: 1) Assuming that all 3.1 million motorbike owners ride the same amount of distance every day for 365 days, 2) use the same E20 incompatible motorbike model, brand, size and 3) use the same type of gasoline fuel.

Average Daily Travel per motorbike/ capita = **7km**

(source: Kerdlap & Gheewala, 2016)

Average CO2 emissions by a medium size motorbike* / km= **0.13kg**

Average Carbon footprint per capita* when medium size motorbike is used daily for a year:

$$(7\text{km} \times 0.13\text{kg}) \times 365 \text{ days} = 333.63 \text{ kg} \approx \underline{\underline{0.37 \text{ tons}}}$$

*Carbon Footprint calculator: <https://www.yourfootprint.app/configco2/general/motorbike/>

* *Medium-size motorbike refers to motorbikes from 125cc to 500cc which are the most popular and commonly used sizes in Thailand.*

** *The calculated carbon footprint (CO2e) includes: 1) Material: Input for production and transport of primary fuel, 2) Production: production of road fuel, 3. Distribution of the fuel, 4. Use: burning fuel related emission. (might vary depending on scenario)*

Step 3: Total amount of CO2 emissions by 3.1 million E20 incompatible motorbikes that can be reduced through MRRP

Assumption: 1) Assuming that all 3.1 million motorbike owners ride the same amount of distance every day for 365 days, 2) produce the same amount of CO2 emissions per year, and 3) upgrade their model to E20 compatible motorbike and use E20 gasohol.

Expected CO2 emissions (tons) reduction through MRRP =

Average Carbon footprint per capita/ year x no. of targeted motorbikes

$$0.37 \text{ tons} \times 3,100,000 \text{ motorbikes} = \underline{\underline{1,147,000 \text{ tons}^*}}$$

*What are the social costs of 1,147,000 tons?

$$\underline{\underline{1,147,000 \text{ tons} = \text{USD } \$212,195,000}} \text{ (1 ton of CO}_2\text{ = USD } \$185)^*$$

(Source: Auffhammer, 2022)

Equivalent to 18,965,744 tree seedlings grown for 10 years

1,357,400 acres of U.S. forests in one year

396,886 tons of waste recycled instead of landfilled

(see appendix for more CO₂/ ton equivalent calculation by <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>)

Step 4: How much MRRP can contribute to AEDP 2018 Goal:

Total percentage of CO₂ emission reduction by MRRP expected to contribute to the 20% reduction proposed by AEDP 2018.

$$\frac{\text{Expected CO}_2 \text{ emissions reduction through MRRP}}{20\% \text{ CO}_2 \text{ emissions reduction AEDP 2018 goal}} \times 100\% = \frac{1,147,000 \text{ tons}}{44,995,264 \text{ tons}} \times 100\% \\ = \underline{2.5\%}$$

Evaluation: Although the percentage seems proportionally small to the AEDP 2018 goal of 20%, it is to be considered that 20% is an aggregate effort made across all sectors including transport, industry, electric power, commercial and residential, and agriculture. The numbers are solely based upon the assumption that all factors remain constant to provide a vast estimation, while actual numbers may vary to a greater extent depending on each and every circumstance. It is important to note that ELVs and many other factors MRRP contributes to have not been accounted into the estimated percentage, therefore qualitative results should be equally considered.

Expected Qualitative Results

In anticipation of the gradual E10 and ULG phase out, this program aims to prepare motorcycle owners to fully integrate and adapt into a transport sector that only offers E20 blends. The goal of the certificate of recycling is to provide financial incentives for those who may not have chosen to purchase an E20 blend motorbike. More importantly, it aims to support those who need an extra hand in buying a new motorbike, so as to not leave them behind in the market sweep of E20 fuel. Furthermore, we anticipate that the PR campaign which focuses on the

environmental benefits of this fuel transition and ELMC phase out will contribute to motorcycle owners' knowledge base. The hope is that the increased environmental consciousness produces a long-term effect on people, allowing them to adopt an outlook and make future decisions that are more environmentally-friendly, especially when it comes to their behaviors in regards to the transport sector. In addition, given the general concerns that many motorcycle users have towards the effects of E20 blends on their vehicle engines, the combination of the program's PR campaign, the gradual increased consumption of E20 blend adoption, and the vehicle check-up support, we anticipate that MRRP will contribute towards the gradual phase out of these concerns. Finally, the growth potential of the MRRP pilot project, paired with the incoming regulatory framework that will come into effect, the waste management industry may become increasingly lucrative, inciting entrepreneurs to invest and venture into this domain.

Policy Timeline Implementation

The MRRP will be a long term project that consists of a pilot-project and 4 phases to foster both short run and long run impact on Thailand's economy. The timeline below gives an overview of how the MRRP will operate towards achieving our target and goals.

RPROJECT PHASES	YEAR SPAN	TARGET/GOAL	DESCRIPTION
Surveying/ Planning	March 2023 - May 2023 (3 months)	Obtain a clearer picture of the MRRP operation through internal research and acquire official approval for implementation	<ul style="list-style-type: none"> Conduct more extensive survey and research on the fuel outlook of motorbike/ vehicles in Thailand Finalization of policy planning and cost-benefit analysis of the program Secure financials
Consultation Process	May - December 2023 (7 months)	Negotiations and Consensus-building among stakeholders involved in the MRRP for upcoming pilot project	<ul style="list-style-type: none"> Explain the program and tasks delegated to each stakeholders Explain the costs and benefits for each stakeholders participating in the program Achieve approval and partnerships with private companies
Pilot Project + UGL, E10 and E85 gasohol phase out + End of Oil Fund	January 2024 - December 2024 (1 year)	<ul style="list-style-type: none"> Test the feasibility of the program in XX city Increased motorbike users with E20 compatible models Increased Ethanol consumption and E20 fuel users CO2 emission reduction 	<ul style="list-style-type: none"> Prepare required documentations, infrastructure, and advertise the program to local motorbike owners Detect any inefficiencies, obstacles, and propose solutions. Track the motorbike owner's renewal rate to an E20 compatible model and usage of E20 fuel when compared to initial sample size Conduct regular intermediate surveys to assess the smooth operation of the program and realize what adjustments are needed. Evaluate the results and any revenue/ loss generated through the pilot project on CO2 emissions and assess if the program should be continued on a larger scale or deterred as oil funds will be ending.
Phase I + E20 gasohol as the primary source of fuel in the market	January 2025 - December 2026 (1 year 11 months)	<ul style="list-style-type: none"> Official implementation of the MRRP at a national scale Obtain partnerships with Japanese companies to build sustainable vehicle recycling centers across Thailand Increased motorbike users with E20 compatible models Increased Ethanol consumption and E20 fuel users CO2 emission reduction 	<ul style="list-style-type: none"> Adjustments made after pilot-project to enhance efficiency for a smooth operation Building infrastructures required for the program (increased sustainable recycling centers, efficient transportation of motorbikes, etc) Monitor the process and track renewal rate of motorbikes to a E20 compatible model and the usage of E20 fuel Random check-ups at the recycling centers and DTLs to ensure sustainable recycling process and fraud identifications Assessments on efficiency and effectiveness of the program, regular cost-benefit reviews to keep track of financial flow
Phase II	2025 - 2027 (2 years)	<ul style="list-style-type: none"> Apply and duplicate the MRRP recycling and renewing framework to other vehicle types (cars, trucks, etc) Increased owners of E20 compatible vehicles Increased Ethanol consumption and E20 fuel users CO2 emission reduction 	<ul style="list-style-type: none"> Conduct research to assess the feasibility of duplicating the MRRP framework for other types of vehicles Increased no. of appropriate recycling centers for different types of vehicles.
Phase III + EV transition	2027 - 2030 (3 years)	<ul style="list-style-type: none"> Apply and duplicate the MRRP recycling and renewing framework for EV transition Increased Green Vehicles in the Thai market CO2 emission reduction 	<ul style="list-style-type: none"> Conduct research to assess the feasibility of duplicating the MRRP framework for EV transition as vehicle owners will dispose their current flex-fuel vehicles Cut down spending on ethanol production and consumption as demand for fuel-driven vehicles decrease
Phase IV + EV transition and expansion + E20 and Premium gasoline as only fuels available in the market + AEDP 2018 goal achieved	2030+	<ul style="list-style-type: none"> Towards net zero CO2 and GHG emissions Completed transition into EVs and 100% share of environmentally-sustainable vehicles Become a successful and versatile model for renewable energy transition in ASEAN countries, Global South, and beyond 	<ul style="list-style-type: none"> Well facilitated and regulated recycling centers prepared to sustainably recycle dispose E20 vehicles as demand decrease Evaluate the success of MRRP and the renewable energy transition framework

Finance

Current foreseeable expenses include the additional human resources required for administrative purposes at the DLTs in Ayutthaya, transportation of the motorcycles from the DLT to the dismantling center, additional technical and monitoring assistance from the DIW and the PCD, and subsidies for the certificate of recycling. Each aforementioned expenses are planned to be carved out from the existing budgets from respective departments. Funding can also potentially be granted from the Ministry of Industry, the Ministry of Energy, the Ministry of Transport, and the Ministry of Natural Resources and Environment (Kojima, 2019). These four Ministries are directly related to the objectives and actors involved in the MRRP project (Royal Thai Embassy).

EXPENSE	REASONING	POTENTIAL SOURCE OF FUNDING
DLT Office Human Resource (HR)	Considering the added tasks for the DLT offices in Ayutthaya, increased human resources support will be required to meet the demands of deregistration and motorcycle drop offs. Specifically, more employees will be hired, and training sessions on motorcycle de-registration and certificate of recycling hand out will be implemented. In addition, the added inspection task of the vehicles may be carried by personnel from the PCD (or, the latter is tasked to train DLT employees to carry out inspections, which in any case will incur additional HR costs).	Ministry of Transport (DLT) Ministry of Natural Resources and Environment (PCD)
Certificate of Recycling (discount, registration fee waiver, and subsidy)	The Certificate of Recycling provides a discount, a waived fee, and a subsidy. The discount for the new vehicle could be funded from the Ministry of Industry, as it pertains directly to dealerships from the motorcycle industry. The waived registration fee would be funded from the Ministry of Transport, considering that the DLT (a sub-branch of the agency) is the one who processes the administrative work of registration and deregistrations. The subsidy could come from the Ministry of Energy, as it aims to promote the consumption of bioethanol. The MOEN also has a history of providing subsidies for different types of fuel, which indicates a potential openness to subsidize the vehicle compatible with the biofuel they are trying to promote.	Ministry of Industry Ministry of Transport Ministry of Energy
Contract with private recycling and/or scrapping transport companies	The transportation of E10 and older motorcycles that do not run on E20 from the DLT to the dismantling facility (Wongpanit) will be carried out by a sub-contracted private company. Expenses related to the hiring of the aforementioned private company will be incurred, most likely by the PCD (Ministry of Natural Resources and Environment) as it deals with the transport of waste.	Ministry of Natural Resources and Environment
DIW & PCD Personnel	There will be either additional hiring or re-classification of certain roles within the Department of Industrial Works, as personnel from this branch will be sent to monitor the dismantling center. Personnel from the Pollution Control Department will also be sent to ensure proper handling of scrapped materials.	Ministry of Industry (DIW) Ministry of Natural Resources and Environment (PCD)
Potential financial assistance for recycling center transformation	There would be some costs that the recycling industries might struggle to pay such as implementing methods/facilities to manage wastewater/waste oil and CFC emissions. These costs may be a burden for the recycling industry which could be supported by government bodies.	Ministry of Industry (DIW) Ministry of Natural Resources and Environment (PCD) Board of Investment (BoI)

POLICY IMPLEMENTATION - CHALLENGES, MITIGATION OPTIONS, AND STRENGTHS

CONCERNS & RISKS	MITIGATION OPTIONS
<p><u>Low adoption and resistance of program</u></p> <ul style="list-style-type: none"> Consumers may not be aware of the program, which leads them not to participate in the program. Moreover, many studies show that motorbike owners have fears of using E20 fuel blends (). Even if the consumers know about the MRRP program, they may have skeptical attitudes in using E20 fuel blends and decide not to participate. Motorbike owners may face financial constraints, as the incentives offered by the certificate of recycling may not prove to be sufficient. As such, encouraging them to dispose of their old motorbike when they are not positioned to purchase becomes a challenge. 	<p><u>PR campaign and loan options</u></p> <ul style="list-style-type: none"> A public relations campaign targeting the demographics of motorcycle owners will be implemented to encourage program adoption. Strategies include educational pamphlets, commercials, social media ads, etc. Gathering of data surrounding enrollment rates will inform directions, and adjustments to the ads' output. There are many motorcycle loan schemes in Thailand to support those who wish to purchase a motorcycle. The MRRP initiative is open to explore partnerships with specific loan companies in the Ayutthaya region to offer a loan scheme with conditions that are specific to MRRP.
<p><u>Limited capacity to enforce and monitor dismantling facility</u></p> <ul style="list-style-type: none"> Although the upcoming regulations on ELV treatments could be an incentive for dismantling/scrapping centers to reduce their environmental impacts, their high costs associated with such transitions may lead the relevant industries to not comply. In addition, ensuring proper handling of scrapped materials by subsequent recycling actors, such as the steel, battery, tire, etc. recycling centers may be difficult. There may be a potential of conflict between the participating recycling industry actors and the advisors in the process of the transition. 	<p><u>Personnel support from governmental agencies</u></p> <ul style="list-style-type: none"> While there are unfortunately little mechanisms that can be implemented to mitigate the handling of hazardous materials by the steel, battery, tire, etc. centers, there are ways to monitor the dismantling facility that MRRP partners with. A small number of personnel from the DIW and the PCD can be sent on a monthly or bi-monthly basis to provide technical assistance and ensure that minimal environmental consequences are generated. Maintaining an arm's length between the dismantling center and the DIW and PCD advisor/personnel should be ensured in order to avoid any authoritative conflicts. To avoid and/or minimize these scenarios, training can be provided to the governmental agencies' team to provide proper guidance on how to monitor without invading the center. In addition, different personnel can be sent to the dismantle center each time to avoid prolonged tensions, corruption, and more, though this may be slightly challenging due to limited human resources.
<p><u>Budget constraints</u></p> <ul style="list-style-type: none"> Due to the demands of this program to the motorcycle owners and the costs related to the transitions of dismantling/recycling centers are not clearly known, there is a possibility of the program going over the estimated budget. The budget itself 	<p><u>"Bite-size" funding and frequent updates of project</u></p> <ul style="list-style-type: none"> The first phase of the MRRP program is intentionally designed to operate on a small scale in order to assess how well it rolls out. While no separate funds are created specifically for this project, the idea is to carve out a small proportion of the existing budgets that are dedicated to each governmental actor involved in the program implementation. For instance, the BOI and the Ministry of Transport are potential sources of funding. MRRP intends to provide frequent updates to demonstrate the successful rollout of the program. When encountering issues, the MRRP team will transparently share these issues while proactively providing mitigation options.
<p><u>Participation of second hand motorbike shops</u></p> <ul style="list-style-type: none"> Although MRRP was designed uniquely for individual motorcycle owners, there may be second hand motorbike shops' owners who wish to dispose of their E10 and ULG motorcycle inventory in order to get rid of their motorcycles, and collect certificates of recycling. This could create some problems with the illegal resale of certificates, as well as frustration by the second hand shop owners in not being able to dispose of their inventory (which could translate into a loss of revenue). 	<p><u>Enforcement of registration information</u></p> <ul style="list-style-type: none"> Acknowledging that second hand motorcycle shop owners' will have an inventory of ELMCs and E10/ULG motorcycles that may not be sold off, the first phase of the MRRP pilot project will have to restrict participation of the program to individual owners. As such, the registration/deregistration will be tightly enforced in DLT offices to make sure no shop owners drop off bikes that they do not own in order to collect coupons. In the meantime, MRRP will continue to develop expansion strategies to implement a pathway for small motorbike owners to dispose of their old, unusable motorcycles.

Strengths

The current policy proposal can potentially serve as testing grounds, and prepare all concerned stakeholders for the upcoming regulatory framework for ELVs that will be implemented in the near future. Acknowledging simultaneously the incoming implementation of new regulations and the urgency of tackling climate change through energy transition, MRRP addresses the need of disposing more than 3 million outdated motorcycles without implementing drastic changes to existing regulations and disrupting significantly the current self-emerged ecosystem of motorcycle recycling and disposal. Designed in anticipation of the changes to come, such as potentially an enforcement of inspection rules, a restructure of vehicle taxation, private-public partnerships with scraping facilities (i.e., Green Metals Thailand Co, Suntech Recycle & Decarbon Co., etc.) (Green Metals) (Apisitniran, 2022), creation of specific standards related, implementation of financial incentives, and more, MRRP aims to set the conditions for these changes to be integrated smoothly, with low resistance from the public and high cooperation and support with the stakeholders. Working in a system that has already been set up by the government, with critical actors such as the DIW, PCD, and DLT increases the chances for quick and smooth implementations. Additionally, our literature review on the different existing ELV management systems across Asia demonstrates that these regulatory frameworks are centered around cars, i.e., conventional passenger vehicles with no more than seven passenger seats, with little focus on motorcycles (Kimura & Yamane, 2021). This can be demonstrated through the case of Japan with its voluntary recycling system of end-of-life motorcycles, in which a motorcycle recycling program emerged out of voluntary efforts (2021). The End-of-Life Vehicle Recycling Law that was enforced in 2005 aimed to ensure that the waste of ELVs is properly disposed of and resources be used effectively in the recycling process: vehicle

manufacturers and related businesses were required to collect and deliver ELVs and come up with ways to recycle them appropriately in order to contribute the preservation of the environment, while developing a sound economy (Kimura & Yamane, 2021). This Act, however, only addressed cars, seeing that motorcycles, in comparison the four-wheeled vehicles, saw a greater export volume, as well differed in components, such as the absence of fluorocarbons and airbags, which rendered them to different recycling procedures. From this emerged a separate motorcycle recycling program as a means to address the lack of specialized motorcycle recycling programs. The point is that considering the lack of information on the incoming strategy for ELV disposal—which may or may not integrate motorcycles—the MRRP is well positioned to begin immediately the disposal of ELCMs, and to either develop into a full-fledged recycling program for motorcycles or to integrate itself into the incoming regulatory framework.

Finally, one additional positive externality from MRRP is the potential contribution towards the gradual decrease in steel imports, considering its expensive price (Therapat, 2022). With a consumption of 19 million tonnes of steel of year, 12 million of that is currently imported into Thailand, showing the significance of the metal in the country's industries, especially for the production of vehicles. As such, recycling the steel from old motorcycles, despite the smaller volume it represents compared to a car, can contribute towards the reduction costs for importing steel (Therapat, 2022).

LIMITATIONS TO CURRENT PROPOSAL

There are a couple of limitations to our proposed policy solution. First, accessing empirical, up to date data on the motorcycle industry in Thailand was challenging. The literature and general information surrounding ELMCs and recycling systems designed specifically for motorcycles is limited, especially compared to the ones for ELVs. Data on conventional cars (“four-wheeled vehicles with less than 7 passenger seats”) were also much more accessible compared to motorcycles. Second, transparent government databases were also challenging to access, and factoring the language barriers and the general lack of English resources online, our proposal benefited from strengthened empirical data. Finally, given the time constraints for write-up of this proposal, we acknowledge that some areas of concern may not have been addressed. Room for improvement on this proposal is definitely present, and additional consultation with experts from various fields, including but not limited to the energy sector, the motorcycle industry, the waste management sector, as well as contact with additional relevant governmental actors will strengthen the feasibility, and quality of this proposal.

FUTURE IMPLICATIONS

With respect to what this program holds for the future, we believe this policy would have a major impact on various sectors in many ways. There are qualitative and quantitative fronts on which we expect to see policy and technological shifts in particular.

1. Scalability and Demand for Bioethanol

- a. Agriculture
- b. Vehicle Manufacturing and Sales

Bioethanol is playing an important role as an alternative fuel in Thailand, and this policy would only boost the demand for the same (the lack of which has been a chronic obstacle to large-scale adoption of this resource). This growth would mean the demand for sources of such produce, thus upscaling the profitability and income of small/medium/large farmers who are actively involved in sugarcane production and farming of other such produce. And with this policy enabling the demand, vehicle manufacturers would be incentivized on their own terms to come up with products that are not only cheaper and accessible but also compatible with higher ethanol blends of petroleum. This could have a knock-on effect on manufacturing and employment within Thailand as sales/revenues and production may rise. Therefore with this scaling up of bioethanol from the perspectives of both suppliers and consumers, we expect to see some progress in the micro-economies of their primary, secondary, and tertiary sectors.

2. Future EV adoption and improvement in Waste Management

- a. MRRP and EV transition
- b. Emphasis on Waste Management and Circular Model

The potential success of the pilot project to be specific would also mean that we not only have the tools to ensure a successful transition for motorbike owners, but we could also replicate the same process for other types of transport (including the potential for a future transition into EVs).

And given the nature of our pilot project, this would then kick start a whole new era for waste management and recycling. not only would this policy make this space far more environmentally relevant (with emphasis on circular and sustainable production cycles), but the sheer monetization of such a field would also potentially lead to entrepreneurship opportunities as well. Thus bringing in some new energy to what is often considered a dormant field (even in the era of climate policies).

3. Learning Curve for South and Southeast Asia

a. Bioethanol Trade b. Sustainable Development

With all the domestic benefits being covered, we could see a major learning curve for Thailand's ASEAN partners as well as their South Asian neighbours because this could serve as a model for circular development as we make use of Thailand's agrarian conditions to boost the link between Bioethanol production and consumption. Having witnessed years of ASEAN development, this could be Thailand's moment in the spotlight as they have their own Flying Geese Model with respect to the growing industry of bioethanol, and so it would be beneficial on an academic and trade-related note as more nations would seek to replicate Thailand's success.

CONCLUSION

As stated at the beginning of this policy paper, climate change mitigation is one of the most important yet divisive policy issues in our world today, and so we took it upon ourselves to focus on a niche where we provide a potential solution that not only caters to said niche, but to also open up a world of opportunities by having this as a model for various countries along the socioeconomic spectrum. Given the many challenges that the transportation industry faces in light of the role of fossil fuels in climate change, we intended to innovate upon existing mechanisms that act as drivers for progress in various policy spheres. Hence, we wanted to try harmonizing various components of a major cross-section of different spaces, which is why we looked to engage with many stakeholders in order to articulate optimism for a unique opportunity to boost various sectors of Thailand's economy – from agriculture to manufacturing, and from transportation to trade and finance – which in turn would be a model for similar economies (or countries with similar ambitions) to replicate as stated earlier. We see Thailand as a country with brimming potential in this cross-section, hence we chose this nation for our policy experiment, and we hope we justified the thought process that went behind this massive undertaking.

And so, through constant deliberation and stakeholder engagement, our team tried to bring to this forum a proposal that hinges on the balance of being ambitious yet practical by ensuring that we maintain a healthy relationship between the moving parts of what drives our policy proposal. We also utilized our team's internal diversity of backgrounds and expertise to bring in a more holistic understanding of what our policy strives to achieve both directly and indirectly as we also wanted to pay special attention to any positive and negative externalities that arise from the execution of our policy proposal, and not simply focus on the immediate outcome of our ideas.

With that said, we humbly submit our policy proposal as proud representatives of the Graduate School of Public Policy and The University of Tokyo.

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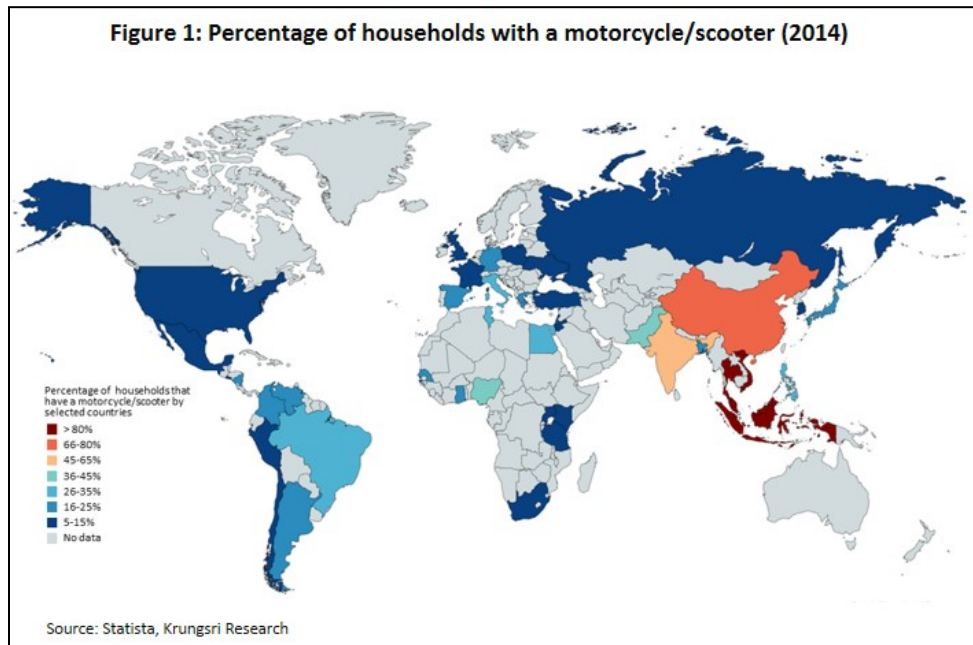
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APPENDICES

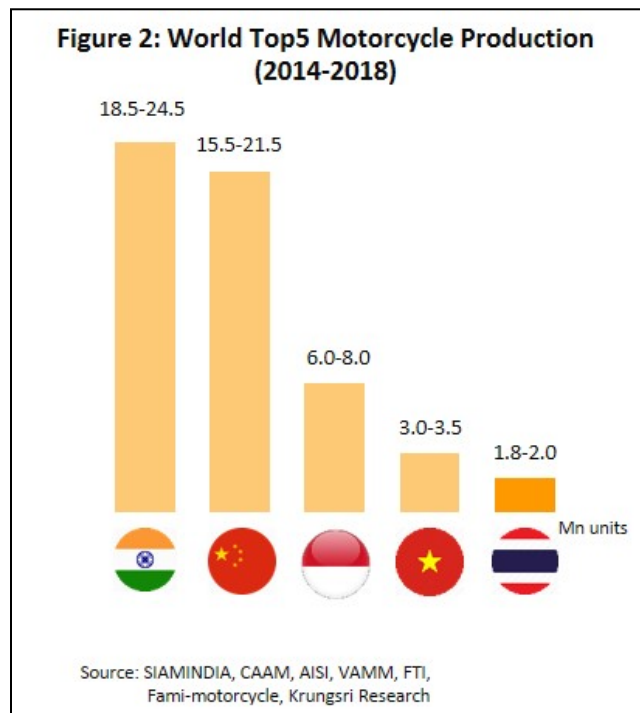
APPENDIX A: Background and problem statement figures

Figure 1: Percentage of households with a motorcycle/scooter (2014)



Source: Yongpisanphob (2019)

Figure 2: World Top 5 Motorcycle Production (2014-2018)



Source: Yongpisanphob (2019)

Figure 3: Number of New Registered Motorcycles in 2018

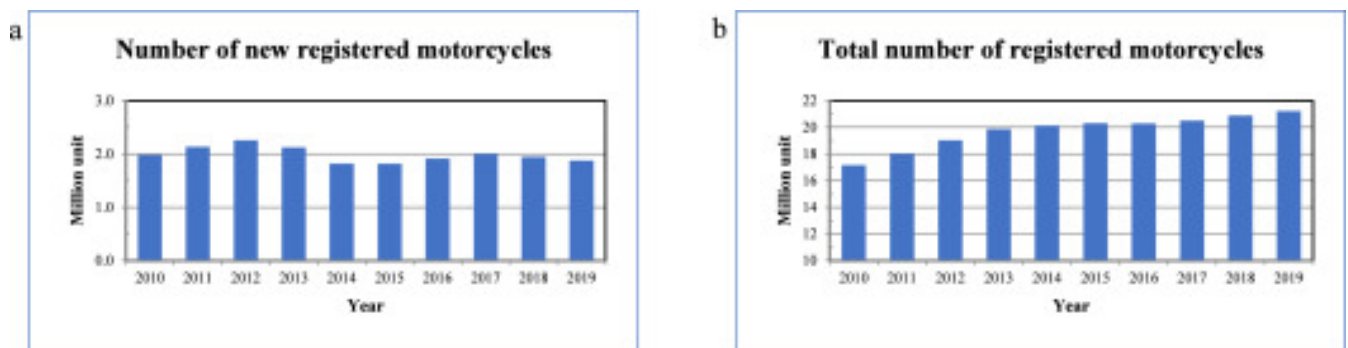
Table 2.4 Cumulative number of Vehicles Registered in Thailand as of 30 June 2018:
A comparison between Bangkok and other provinces

Type of Vehicle	Whole Kingdom	Bangkok	Regional
Grand Total	38,969,601	10,030,055	28,939,546
<i>Total Vehicle under Motor Vehicle Act</i>	<i>37,702,262</i>	<i>9,844,313</i>	<i>27,857,949</i>
Not more than 7 Pass	9,074,573	4,386,852	4,687,721
Microbus & Passenger Van	425,005	214,600	210,405
Van & Pick Up	6,527,058	1,347,127	5,179,931
Motortricycle	1,572	854	718
Interprovincial Taxi	-	-	-
Urban Taxi	84,005	79,871	4,134
Fixed Route Taxi	2,657	2,140	517
Motortricycle Taxi (Tuk Tuk)	20,117	9,322	10,795
Hotel Taxi	4,401	647	3,754
Tour Taxi	5,178	1,780	3,398
Car For Hire	93	69	24
Motorcycle	20,709,434	3,602,636	17,106,798
Tractor	532,879	95,907	436,972
Road Roller	14,421	3,918	10,503
Farm Vehicle	107,913	7	107,906
Automobile Trailer	4,785	2,805	1,980
Public Motorcycle	188,171	95,778	92,393
<i>Total Vehicle under Land Transport Act</i>	<i>1,267,339</i>	<i>185,742</i>	<i>1,081,597</i>

Source: Department of Land Transport (2018b)

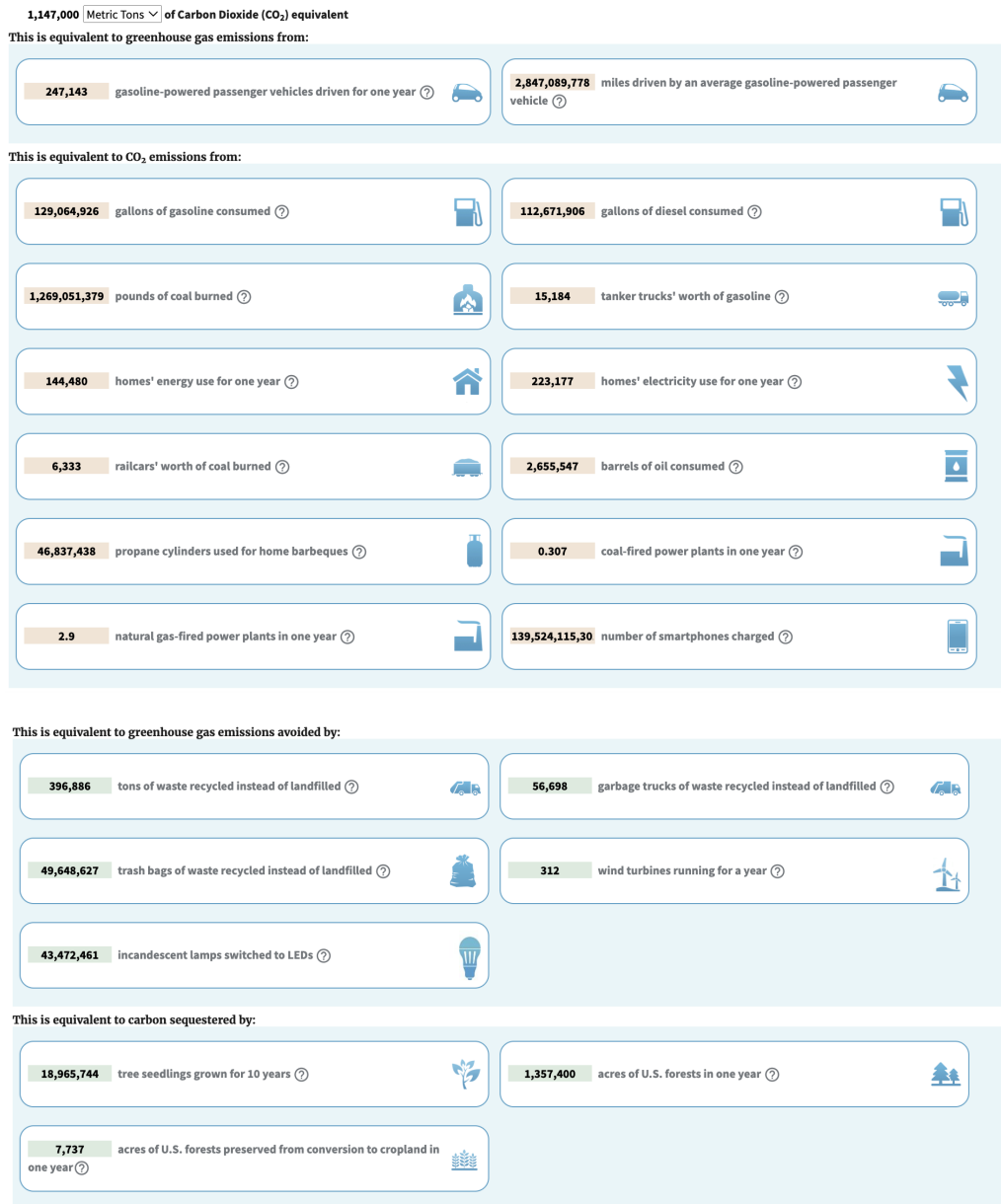
Source: Wonglertkunakorn (2018)

Figure 4: Data on Number of Newly Registered Motorcycles and Total Number of Registered Motorcycles



Source: Statista (2022)

Figure 5: Greenhouse Gas Equivalent Quantities, Damages, Trees needed to be planted, etc



APPENDIX B: Data shared by Dr. Weewarat’s team from the Ministry of Energy of Thailand

Figure 6: The use of gasoline and ethanol groups

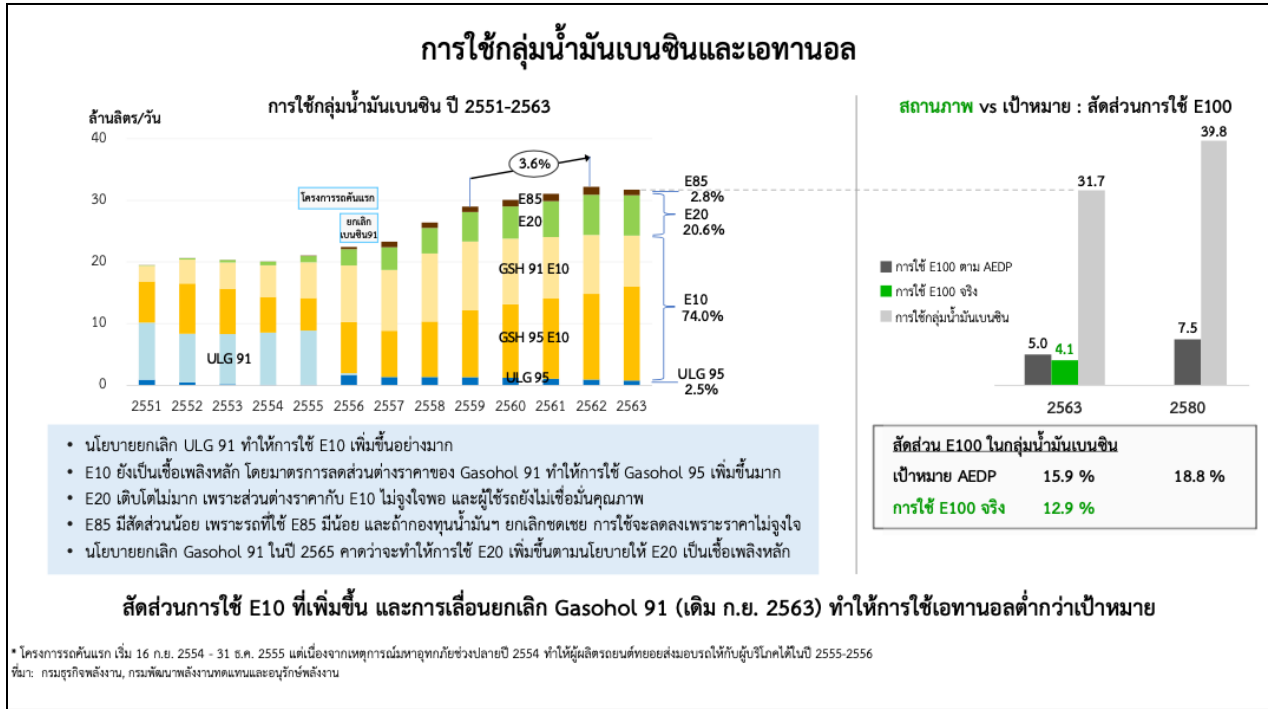


Figure 7: The use of gasoline and ethanol according to the AEDP 2018 plan

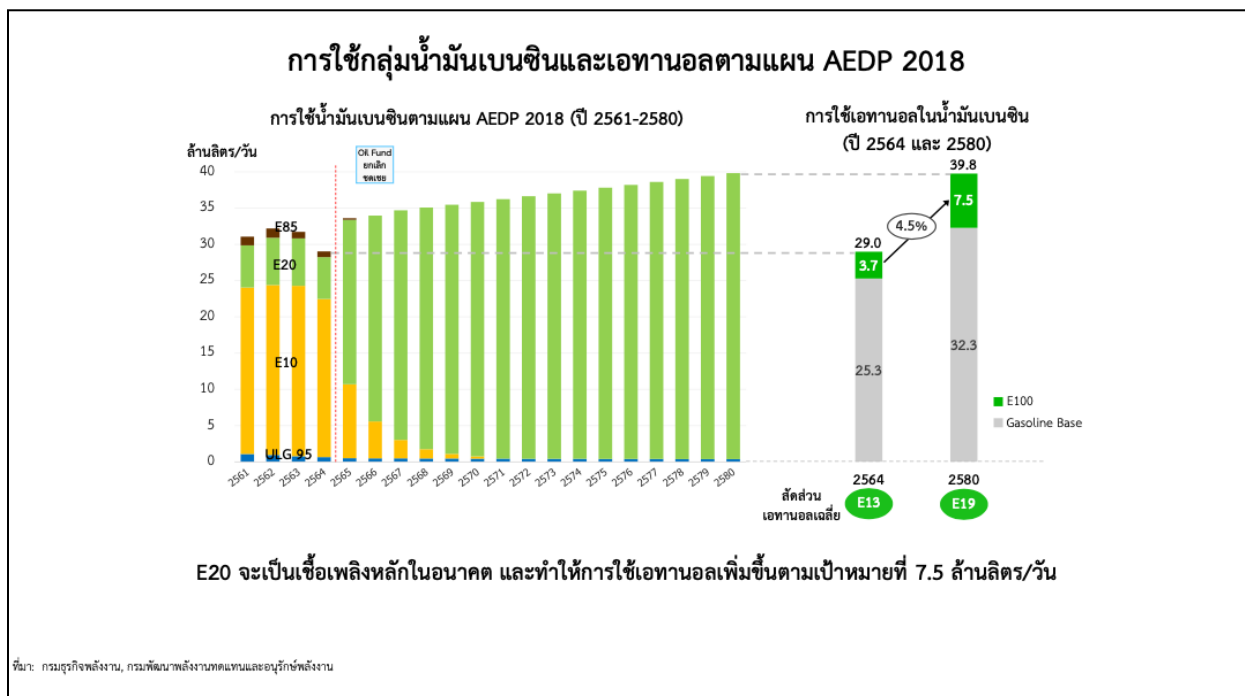


Figure 8: Number of cars that use gasoline and the use of benzene

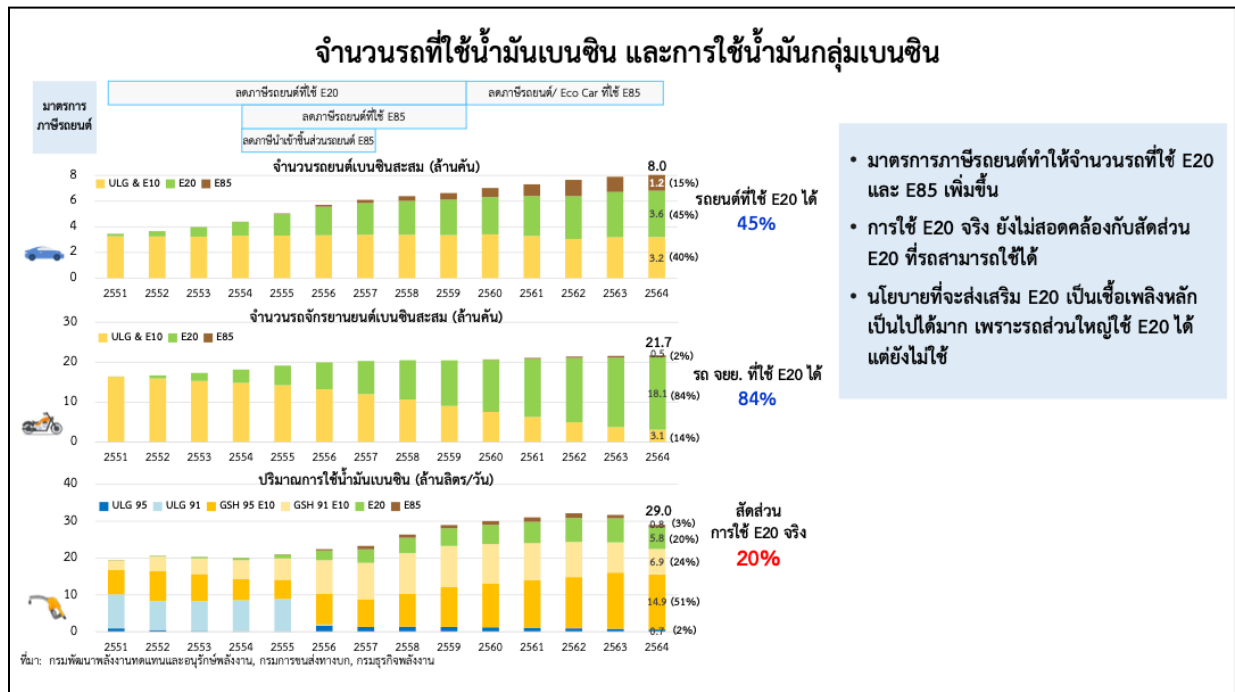


Figure 9: Survey results of refueling behavior of gasoline car users

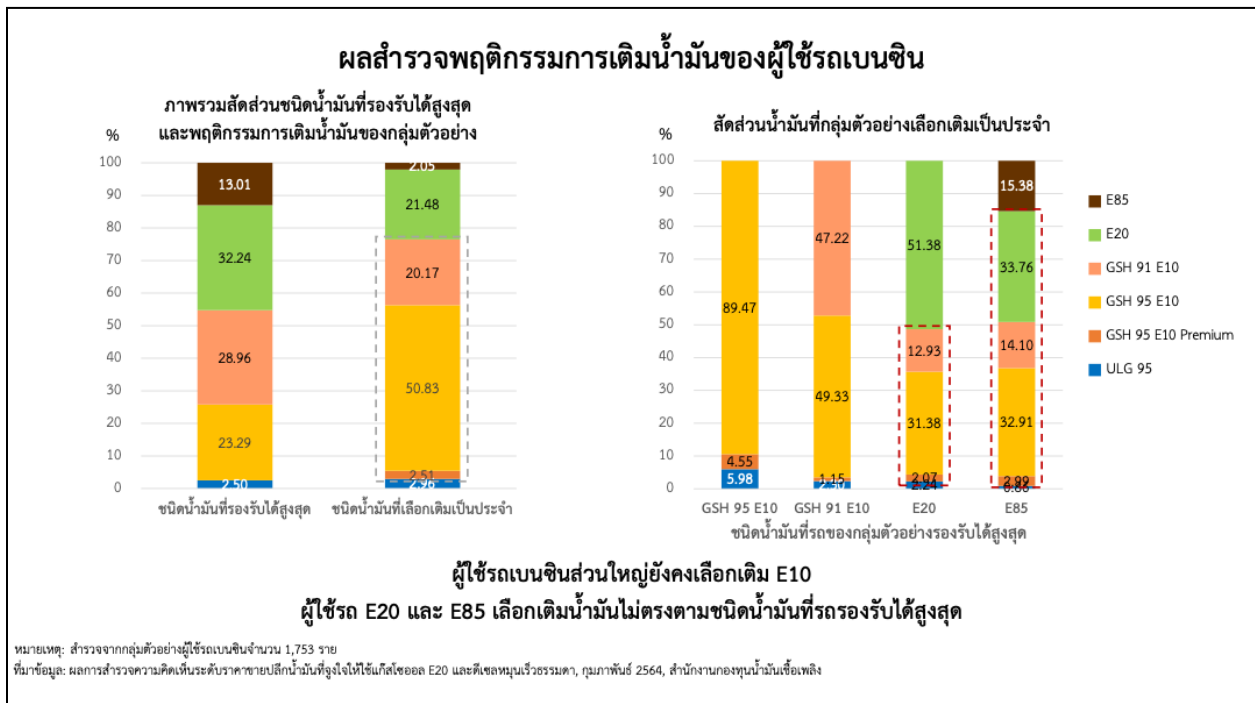


Figure 10: Survey results on the retail price difference that motivates people to switch to E20

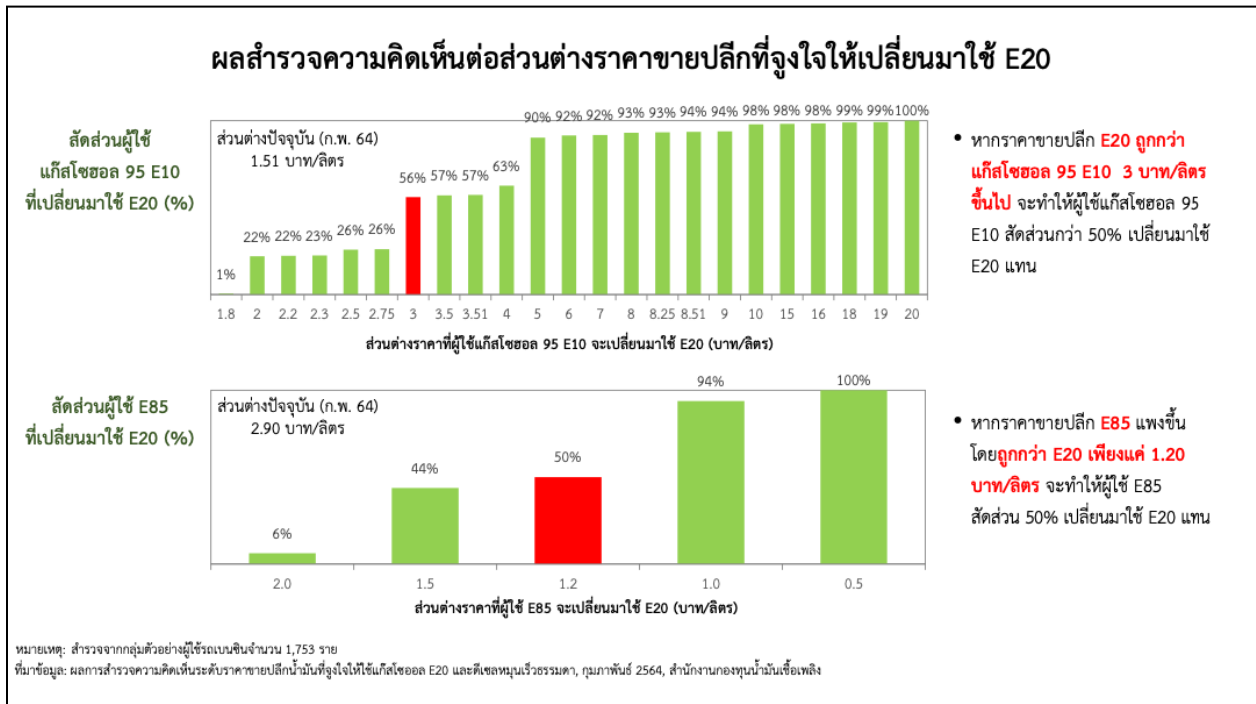
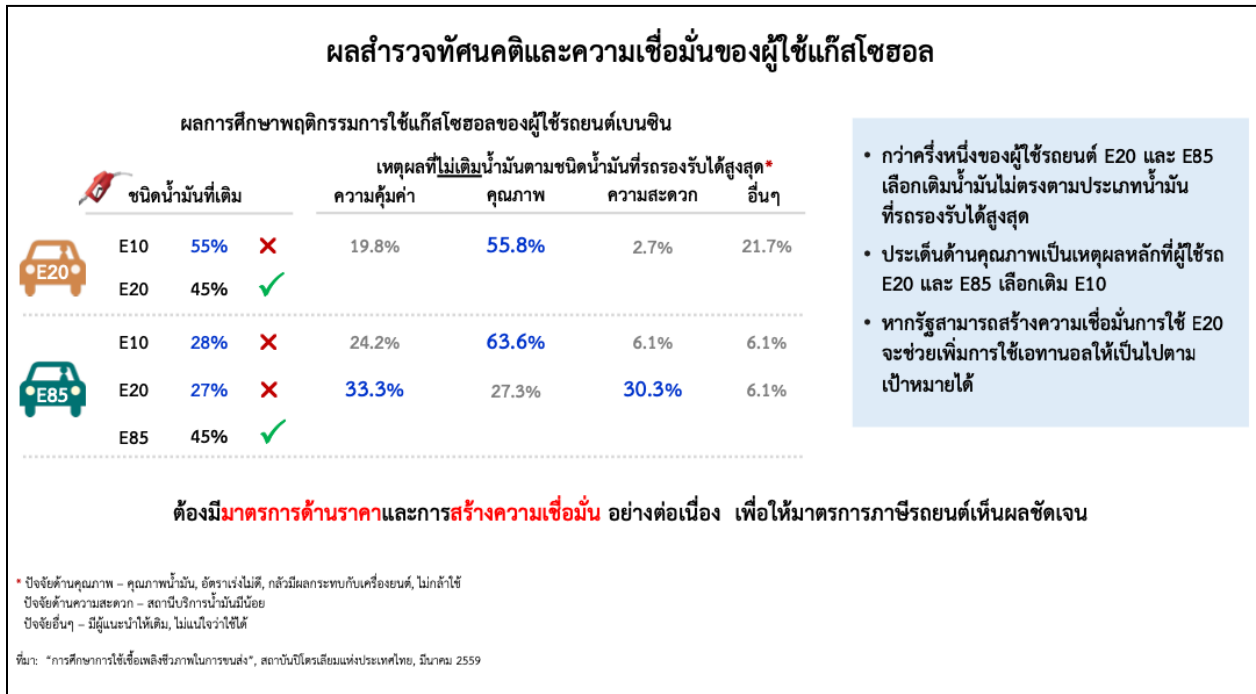
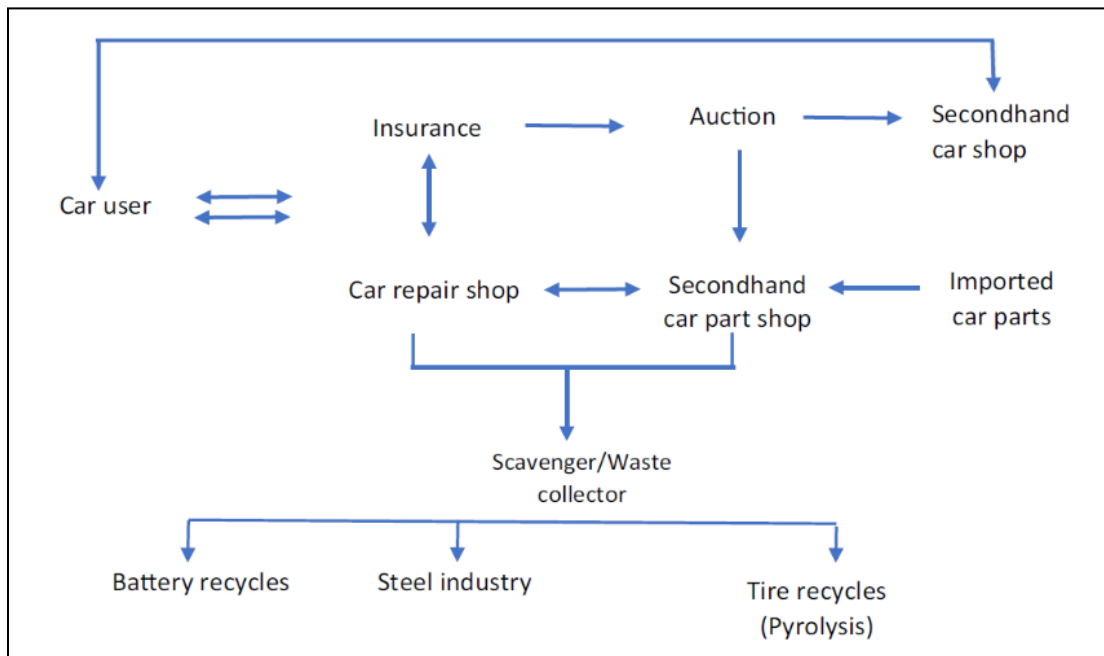


Figure 11: Survey results of attitudes and confidence of gasohol users



APPENDIX C: Current Disposal Ecosystem and Processes

Figure 12: ELV Management current status of passenger cars in Thailand



Source: Jamaluddin, Saibani, Mohd Pital, Wahab, Hishamuddin, Sajuri, & Khalid, 2022

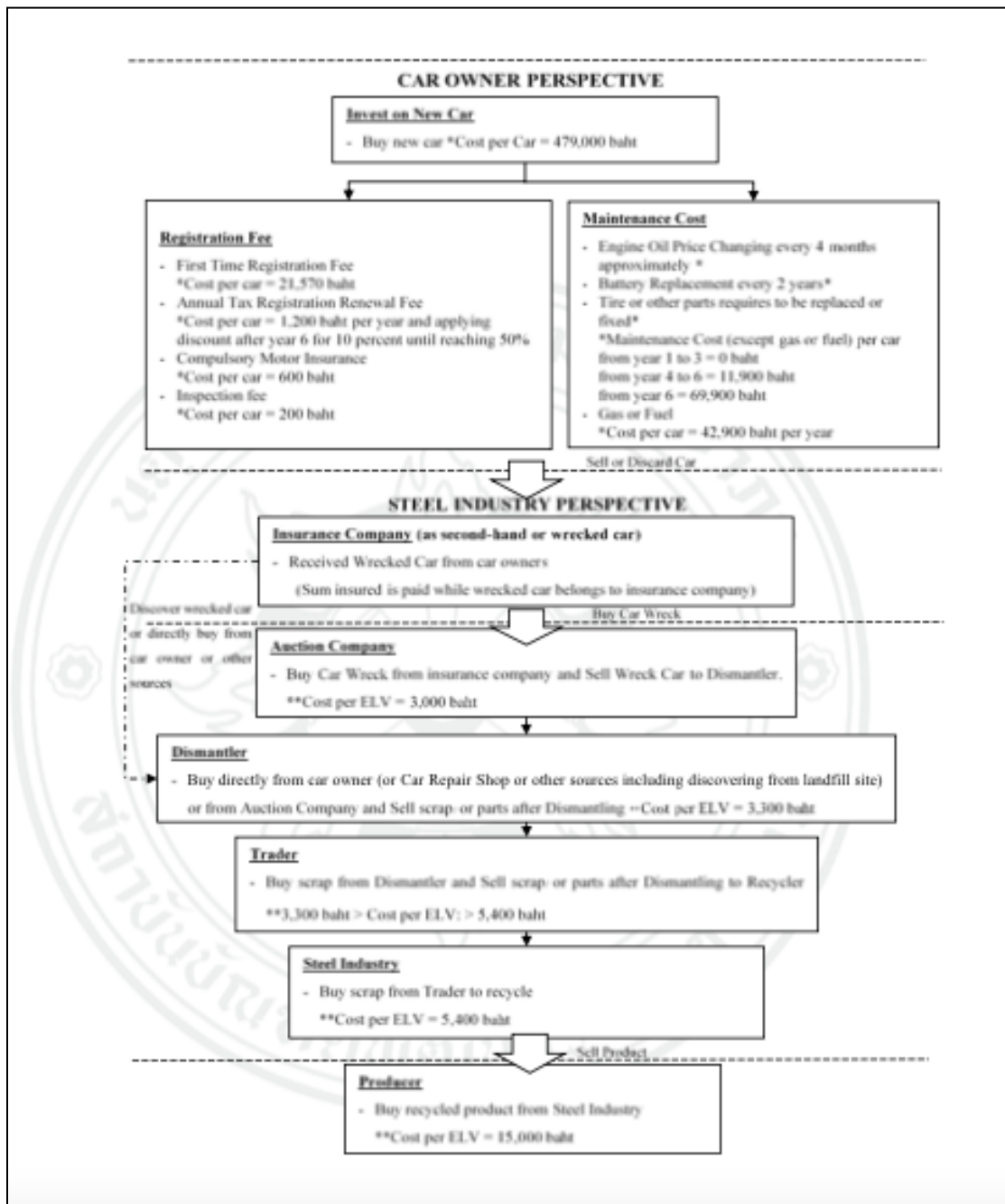
Figure 13: Figure showing stakeholders

Table 3.1 Number of organization/shop/industries visited

Visited Place	Number of organizations/shops/industries
Department of Land Transport	1
Auction company	1
Automobile repair shop	2
Insurance Company (association)	2
Second-hand car shop	2
Collector (Dismantler)	2
Steel Industries	2
Car Manufacturer	1
Pollution Control Department	1
Department of Industrial Works	1

Source: Wonglertkunakorn (2018)

Figure 14: Disposal Process from Car Owner's Perspective



Source: Wonglertkunakorn (2018)

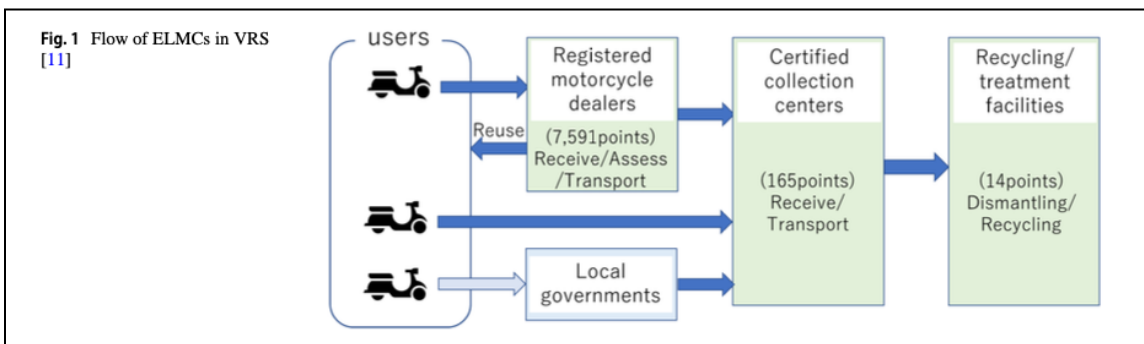
Figure 15: Current Regulator Framework for ELVs in Thailand

Table 4.9 ELV management methods in Thailand

Topic	Thailand
Law enforcement	Indirect law enforcement e.g. as act on The Maintenance of The Cleanliness and Orderliness of the country, and Factory Act
Background of ELV management	No ELV management program.
Party responsible for recycling costs	Market driven based. Stakeholders are responsible for the costs.
Target automobile	No regulation
Recycle target	No target

Source: Wonglertkunakorn (2018)

Figure 16: ELMCs in the Japanese Motorcycle Recycling System



Source: (Kimura & Yamane, 2021)

Figure 17: Stakeholders Value Chain Process

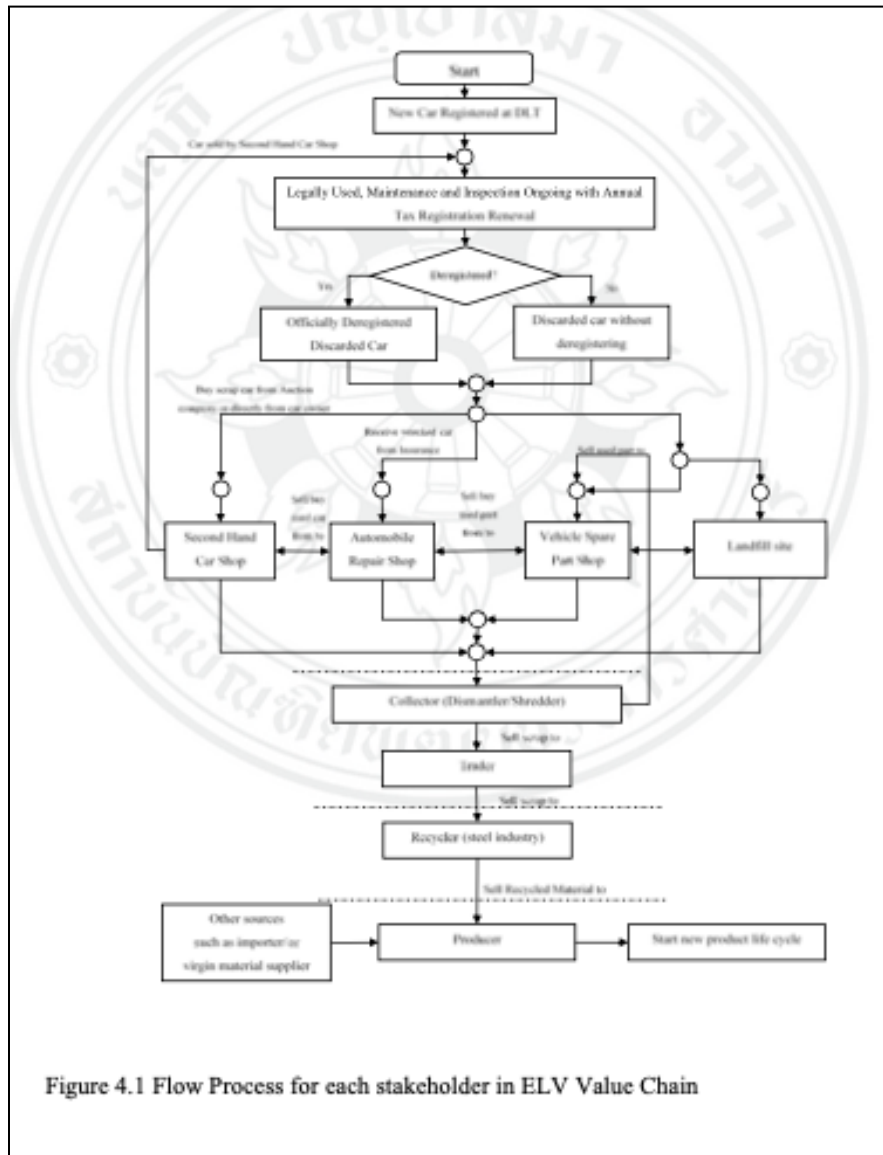


Figure 4.1 Flow Process for each stakeholder in ELV Value Chain

Source: Wonglertkunakorn (2018)

APPENDIX D: EV Policies and Implementation Challenges

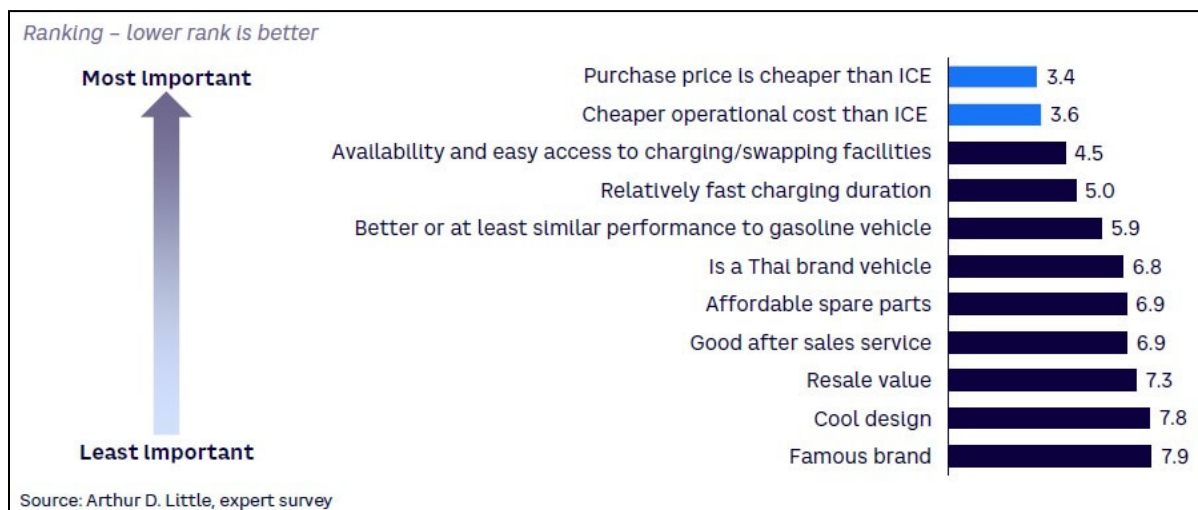
Figure 18: Comparison of EVs and Conventional Vehicle

PARAMETERS	UNITS	ICE	EV
Model	Name	MG ZS 1.5X+	MG ZS EV x (BEV)
Purchase price	THB	768,000	1,269,000
Subsidy	THB	0	150,000
Net purchase price	THB	768,000	1,119,000
Registration & road tax	THB	8,000	6,000
Insurance	THB	74,000	80,000
On-road price	THB	850,000	1205,000
Difference of on-road price ¹	THB		355,000
Cost of fuel/electricity	THB/liter; THB/kWh	53	5.4
Mileage	Km/liter; Km/kWh	14	8
1: fuel/electricity cost	THB/km	3.71	0.7
Total maintenance cost	THB	57,000	39,000
Total distance	KM	80,000	80,000
2: maintenance cost	THB/km	0.7125	0.4875
Total operating cost (1+2)	THB/km	4.42	1.16
OPEX savings	THB/km		3.26
Distance for EV price premium recovery	KM		108,862
Assumed vehicle ownership period	Years		5
Distance per year	KM		21,772
Distance per day	KM		91

Source: Arthur D. Little, expert survey

Source: Arthur Little (2022)

Figure 19: Important EV Buying Decision Buying Factors



Source: Arthur Little, (2022)