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Public Attitudes Towards Energy Policy and Sustainable Development in ASEAN Countries

Edited by

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Public Attitudes Towards Energy Policy and Sustainable Development in ASEAN Countries

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Foreword

As a fundamental change in the supply and demand structure towards decarbonisation, the energy transition has become the main theme in the global energy discussion. The most important factor making this change possible is the 'Carbon Neutrality' by 2050 commitment by world governments. This trend was accelerated by the transition from the Trump administration to the greener Biden administration in early 2021 in the United States. Moreover, vaccination efforts are gradually giving the coronavirus disease (COVID-19) pandemic more certainty, although the recent spread of the Omicron variant is seen as a new threat. Therefore, the outbreak continues to wreak serious damage on people and the economy worldwide. Given this shared international, environmental crisis, the International Energy Agency recently released the report 'Net-Zero by 2050: A Roadmap for the Global Energy System,' illustrating a comprehensive pathway towards global net-zero emissions by 2050. As this report says, despite a huge gap between what should be done to attain the goal and what is being done now regarding greenhouse gas emissions, there remains a narrow path to net-zero emissions by 2050. In other words, attainability remains possible.

Carbon neutrality by 2050 must be a process that goes beyond energy. Inevitably, it should involve changes in various areas, such as individual behaviour, society, companies, and organisations. For example, in Japan, many movements have occurred in response to former Prime Minister Suga's statement on the goal of achieving carbon neutrality by 2050. Following up on his statement, in December 2020, the government announced the 'Green Growth Strategy for Carbon Neutrality in 2050.' Accordingly, the Government of Japan is currently reviewing related energy and climate change policies. Meanwhile, carbon neutrality is a global challenge. More than 100 countries have committed to carbon neutrality by 2050, but they only account for 23.2% of global CO_2 emissions.

Carbon neutrality by 2050 is a goal commonly shared at a global level. Thus, as the International Energy Agency emphasises, cooperation is key. Like many other countries, the member countries of the Association of Southeast Asian Nations (ASEAN) are exerting great efforts to achieve the goals of the Paris Accord. This study focuses on the willingness to pay, covering Malaysia, the Philippines, Thailand, and Viet Nam. The study was conducted in collaboration with university professors in the respective countries. The survey in the focal countries was influenced by the COVID-19 outbreak; however, given the collaborative efforts, the impact was minimal. The willingness to pay studies based on surveys in ASEAN countries are scant; thus, this study bridges the gap by expanding the research to ASEAN countries.

This report aims to contribute to energy policymaking in ASEAN countries and stimulate a wider discussion on the willingness to pay and energy and climate change policy in ASEAN.

We sincerely appreciate the Economic Research Institute for ASEAN and East Asia for its continued support of our research. We are also grateful to collaborators in each country.

Acknowledgements

We would like to express our gratitude to the Economic Research Institute for ASEAN and East Asia (ERIA). We would like to thank Professor Jun Arima, Dr Venkatachalam Anbumozhi, and Mr Taizo Hara for their guidance throughout the project. We also appreciate the excellent and meticulous work of our collaborators. Specifically, we would like to thank Dr Awang Noor Abd Ghani, Dr Azlina Abd. Aziz, Dr Gem B. Castillo, Professor Rosalina Palanca-Tan, Professor Vilas Nitivattananon, Ms Ornuma Teparakul, Dr Surasak Jotaworn, and Dr Truong Dang Thuy.

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Abbreviations and Acronyms

ACE: ASEAN Centre for Energy

AEDP: Alternative Energy Development Plan

AMS: ASEAN Member States

APAEC: ASEAN Plan of Action for Energy Cooperation

APS: APAEC targets scenario

ASEAN: Association of Southeast Asian Nations

ATS: AMS targets scenario

BAU: business-as-usual

CDR: carbon dioxide removal

CVM: Contingent Valuation Method

DCE: Discrete Choice Experiment

ERIA: East Asia and the Association of Southeast Asian Nations

EU: European Union

FIT: feed-in tariff

GHG: greenhouse gas

IEA: International Energy Agency

IPCC: Intergovernmental Panel on Climate Change

IRENA: International Renewable Energy Agency

LCOE: levelised cost of electricity

Lao PDR: Lao People's Democratic Republic

MM: Metropolitan Manila

NDC: Nationally Determined Contributions

NREP: National Renewable Energy Program

PV: photovoltaic

RE: renewable energy

SDGs: Sustainable Development Goals

TFEC: total final energy consumption

TPES: total primary energy supply

UNESCAP: United Nations Economic and Social Commission for Asia and the Pacific

WTP: willingness to pay

Executive Summary

Worldwide, efforts are being made to tackle climate change and achieve the United Nations' Sustainable Development Goals. In the first half of 2021, the Leaders' Summit on Climate organised by the President of the United States, Joe Biden, and the summit of the Group of Seven demonstrated the accelerating actions on climate change. The International Energy Agency (IEA) in May 2021 released a report on the path to achieving 'Net Zero by 2050,' outlining a concrete roadmap for the global energy sector. In Southeast Asia, all members of the Association of Southeast Asian Nations (ASEAN) have participated in the Paris Agreement and submitted their respective nationally determined contributions. Moreover, Brunei Darussalam, Cambodia, the Philippines, Singapore, Thailand, and Viet Nam submitted their updated nationally determined contributions.

Renewable energy (RE) and electric mobility play central roles in climate change countermeasures. Solar and wind power generation and batteries for electric mobility have achieved significant cost reductions over the past decade. They are even cheaper than fossil fuels in some countries, leading to rapid growth in their adoption. However, there has been insufficient adoption and cost reduction of these technologies in ASEAN countries. Thus, a certain level of policy support is necessary to further encourage the diffusion of RE in the future. It is essential to examine the extent to which citizens in ASEAN countries accept the cost burden and accelerate cost reduction through means such as innovation, including incremental ones.

This study examines the willingness to pay (WTP) for RE and electric mobility in ASEAN countries, using discrete choice experiments (DCEs) and the contingent valuation method (CVM). It targets Malaysia, the Philippines, Thailand, and Viet Nam. Specifically, major cities were chosen as the target regions. For the renewable WTP, Bangkok for Thailand (survey period: December 2020 to March 2021), Manila for the Philippines (December 2020 to April 2021), and Kuala Terengganu and Kuala Nerus for Malaysia (February to March 2021) were selected. The sample size of the household survey was 250 for Bangkok, 300 for Kuala Terengganu, and 250 for Manila (for each of DCE and CVM).

We estimated household WTP using the conditional logit regression. In the regression equation, the utility, the dependent variable, was assumed to be a linear function of the attributes of RE share and price. Types of RE, including solar, biomass, hydropower, wind, mini-hydro, and small-scale hydro, were represented by dummy variables. Solar (Thailand

and Malaysia) and hydro and geothermal (Philippines) energy were considered to be the status quo types in the model. Respondents preferred higher RE shares, and the RE share coefficients in all three cities were positive and significant at the 1% level. Increased prices reduced the utility for households, and this effect was also found to be statistically significant at the 1% across the three countries.

For the estimation of the mean WTP as a percentage of monthly electricity bills in United States dollars when increasing the RE share to different levels, households prefer a higher renewable proportion in the electricity mix. The WTP values for solar are highest in all the three countries. When the RE share was 40%, the WTP values of solar cells were 5.54% in Thailand and 17.31% in the Philippines. The WTP values for biomass were lower compared to other options in Thailand and Malaysia: 1.17% in Thailand and 3.04% in Malaysia when the RE share was 30%.

To check the robustness of the results, a contingency valuation method was also utilised in the Philippines to assess the WTP to increase the RE share to 50%. The resulting values are broadly consistent with those from the DCE.

The WTP for RE is only a few percent in most cases, and the highest value is about 20% for solar in the Philippines (for an increase in RE share to 60%). These figures are mostly consistent with those estimated for developing countries, according to the literature review. This result suggests that consumers are willing to pay more money for RE, but the amount is not significantly large. RE itself has been steadily decreasing in cost worldwide, but as more RE is introduced, there will be increasing costs for grid measures such as transmission expansion and energy storage deployment. Innovations to lower the cost of system integration as well as to develop renewable energy technologies will be increasingly necessary in the future, and there is a need to strengthen innovation so that the total cost can be kept within this small figure.

Solar photovoltaic systems have the highest awareness amongst RE and are regarded as the most environmentally-friendly energy as shown in the surveys of all target countries. Furthermore, in all the countries investigated, biomass receives a consistently lowest value. The WTP also corresponds to this tendency, with a higher price for solar photovoltaic and a lower price for biomass energy, and the other technologies (wind and small hydro) mostly falling in between. It is a fact that biomass energy can cause air pollution if not used with end-of-pipe technologies. In addition, air pollution ranks high on the list of environmental problems that people are concerned about, which may explain why people have a bad impression of biomass. However, since biomass is an important RE that can be dispatched, it is necessary to properly regulate biomass energy and dispel its bad image. As for solar power generation, the WTP is high and the impression is good, so it may be prioritised for expanding deployment.

The research team also explored consumers' preferences for sustainable transportation by estimating the willingness to pay for electric motorbikes in Viet Nam. Previous studies have suggested the importance of electric motorbikes use in developing countries to reduce the high levels of air pollution and provide an alternative to private cars. However, few studies have analysed consumer attitudes and the type of policy interventions that could promote wider adoption. We conducted a survey and choice experiment for electric motorbikes in Viet Nam, including questions on personal mobility, knowledge of electric motorbikes, a choice experiment, and attitudes towards environmental problems. All the attributes including price, speed, range, fuel cost, and maintenance cost, except for charging time, were found to be statistically significant. The marginal willingness to pay for each of the attributes is USD17.6 to improve the top speed by 1 kilometre per hour (km/h), USD27.3 to improve the range by 10 km, USD25.5 to reduce the fuel cost by 4.4 cents/km, and USD7.5 to reduce the maintenance cost by 4.4 cents per month.

Compared to the results of phase one, the percentage of people who have been economically affected by COVID-19 has generally increased. Therefore, this may have influenced the results of this survey. Although we do not know how long the impact of COVID-19 will last, we need to be careful when comparing the results from this survey of WTP with those in the literature.

Chapter 1

Introduction

Worldwide, efforts are on the rise to tackle climate change and achieve the United Nations' Sustainable Development Goals. The climate summit in April 2021, organised by the President of the United States, Joe Biden, indicated that climate change will continue to be a major topic for discussion at the Group of Seven and Group of 20 summits in 2021. Further, the International Energy Agency in May 2021 released a report on the path to achieving 'Net Zero by 2050,' outlining a concrete roadmap for the global energy sector. Accordingly, all Association of Southeast Asian Nations (ASEAN) countries have participated in the Paris Agreement and submitted their respective intended nationally determined contributions. Moreover, Brunei Darussalam, Cambodia, the Philippines, Singapore, Thailand, and Viet Nam have submitted their updated nationally determined contributions.

Renewable energy (RE) and electric mobility play a central role in the climate change countermeasures of each country. Solar and wind power generation and batteries for electric mobility have achieved significant cost reductions over the past decade. They are even cheaper than fossil fuels in some countries, leading to rapid growth in their adoption. However, there has been insufficient adoption and cost reduction of these technologies in ASEAN countries. Thus, a certain level of policy support is necessary to further diffuse RE in the future. It is essential to examine the extent to which the citizens in ASEAN countries accept the cost burden and accelerate cost reduction through means such as innovation.

Hence, this study examines the willingness to pay (WTP) for RE in ASEAN countries. It reports the results of the second research phase. In 2020 (phase one), we conducted a household survey in Myanmar, the Lao People's Democratic Republic, Viet Nam, and Thailand; the WTP for RE was investigated based on the discrete choice experiment and contingent valuation method (Yoshikawa, 2020). This study targets Malaysia, the Philippines, and Thailand. Given the impact of the coronavirus disease (COVID-19) on 2020's investigation, we renewed the survey in Thailand for this study.

In addition to REs, this study also surveyed electric mobility, especially electric motorbikes. It compared gasoline-powered and electric motorbikes in Viet Nam to ascertain how WTP depends on various attributes in the discrete choice experiment.

Unfortunately, like in 2020, the pandemic impacted the survey this year. Some refused to take the survey for fear of infection, and the WTP was undeniably affected by the short-term COVID-19 factor. Thus, the WTP amount revealed in this report is probably within a certain minimum value for future policy design implications regarding RE and electric mobility.

The report is structured as follows. Chapter 2 summarises the policy trends regarding RE. Chapter 3 presents the methodology and survey design. Chapter 4 summarises the sampling strategies adopted for each of the cities included in this research. Chapter 5 provides an overview of the descriptive statistics of the responses. Chapter 6 and Chapter 7 analyse the results of the survey on the WTP for renewable energy in the five ASEAN cities, and the WTP for electric motorbikes in Ho Chi Minh City, respectively. Chapter 8 provides policy implications and conclude this report.

Chapter 2

Review of Energy Policies

1. Introduction

This chapter reviews the energy situation and main energy and climate policies of the Association of Southeast Asian Nations (ASEAN) region and three selected countries: Malaysia, the Philippines, and Thailand.[1]

The policy review is based on qualitative and quantitative data, and the materials herein are mainly collected from (1) academic papers; (2) reports and documents of international organisations such as the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), and REN21; (3) documents and information from regional intergovernmental organisations such as the ASEAN Centre for Energy (ACE); and (4) government websites.

This chapter is structured as follows. Section 2.2 gives a general review of the energy situation and policies across the ASEAN countries. Section 2.3 presents the ASEAN engagement in climate change and energy scenarios. Section 2.4 provides a more detailed review of the energy situation and policies in Malaysia, the Philippines, and Thailand. Section 2.5 concludes the chapter.

2. Overview of the Energy Situation and Policies in ASEAN Countries

2.1. General Energy Situation

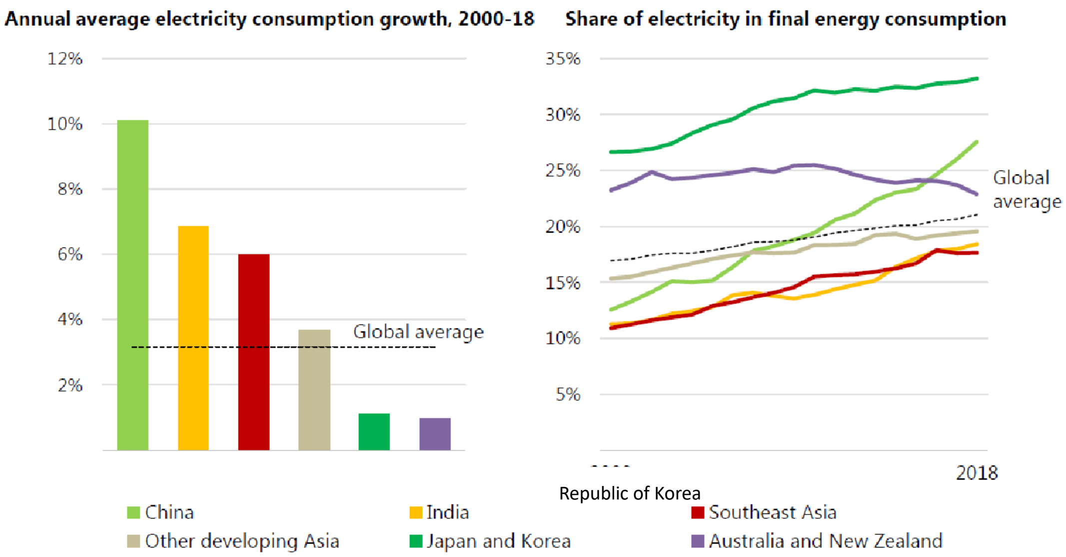
Currently, ASEAN countries possess 8.5% of the global population, and their economic growth has been amongst the fastest worldwide. This economic community is expected to have over 5% economic growth per year to become the fourth-largest economy globally by 2030 (ACE, 2020b). Although the COVID-19 pandemic has induced a downturn in this area (as in many countries worldwide), as the economy rebounds, energy demand supporting economic and industrial development is experiencing significant growth.

[1] Viet Nam is skipped because it was covered in the 2020 report (see Yoshikawa, 2020).

Achieving energy needs from economic growth is a key challenge for ASEAN's energy and climate policies.

Electricity demand in ASEAN countries is amongst the fastest-growing areas worldwide, growing by more than 6% annually over the past 20 years on average (Figure 2.1). For the past 2 decades, the four largest electricity consumption countries were Indonesia (26%), Viet Nam (22%), Thailand (19%), and Malaysia (15%), comprising more than 80% of total demand in the region (IEA, 2019b, 2020a). According to ACE's sixth ASEAN Energy Outlook, ASEAN's demand for primary energy is projected to more than double from 2017 to 2040; that is, from 625 million tons of oil equivalent in 2017 to 1,589 million tons of oil equivalent in 2040, in the baseline scenario (ACE, 2020b).

Figure 2.1: Annual Average Electricity Consumption Growth (2000–2018)

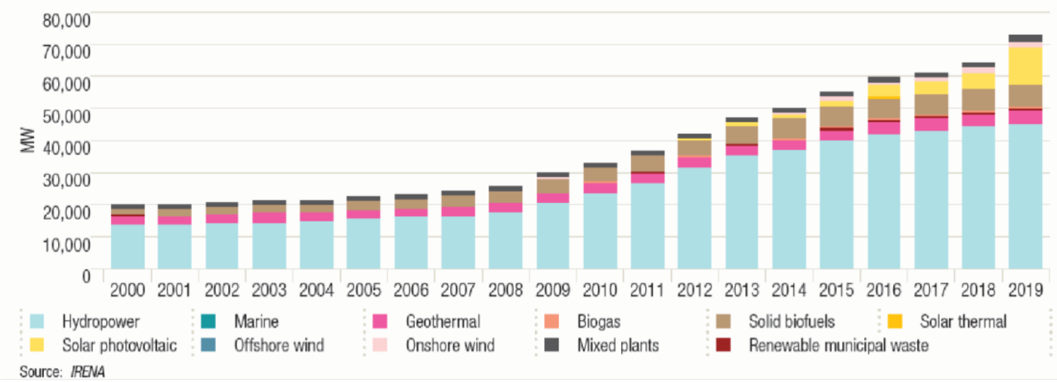


Source: IEA (2019b).

However, fossil fuels have mainly driven the approximately 80% growth in energy demand for the past 2 decades. Although Southeast Asia has abundant resources for developing RE, particularly solar energy, modern renewables currently support only approximately 15% of the energy demand (IEA, 2019b). Besides, not all have access to electricity. The current electricity access rate is 95%, with a plan that ASEAN countries will achieve universal access to electricity by 2030. Moreover, only 60% of the population has access to clean cooking, presenting as another issue to be solved (IRENA, 2020b).

A closer look at the deployment of renewables in ASEAN countries shows that conventional hydropower has been the main source of RE, whilst diversification of the power sector has been observed in recent years (Figure 2.2). In 2019, for the first time, variable RE capacity additions surpassed hydropower additions (UNESCAP, 2020) (Figure 2.3). A comparison amongst ASEAN countries shows that the share of modern renewables in energy consumption has recently been increasing in several countries, such as Viet Nam, Thailand, and Malaysia, whilst it is falling in others like the Philippines (Figure 2.4).

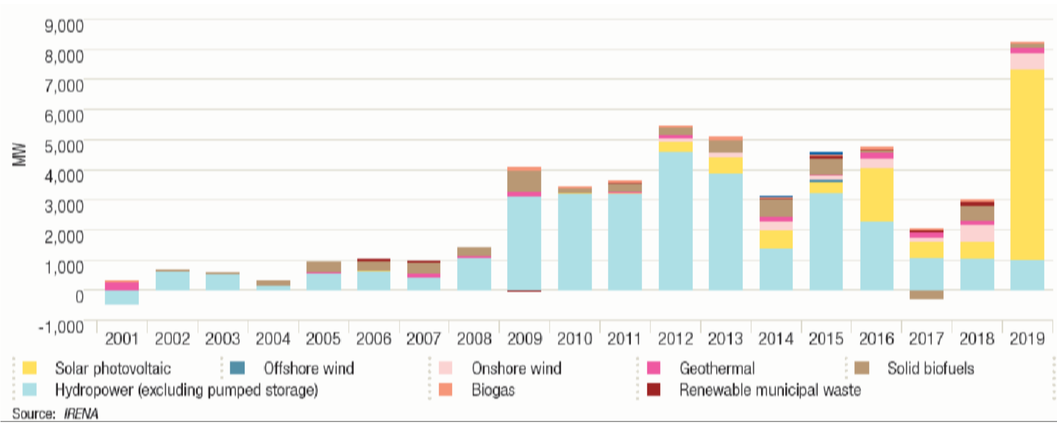
Figure 2.2: Renewables Cumulative Installed Capacity in the ASEAN Countries (2000–2019)



MW = megawatt.

Source: Figure created by UNESCAP (2020) based on IRENA data.

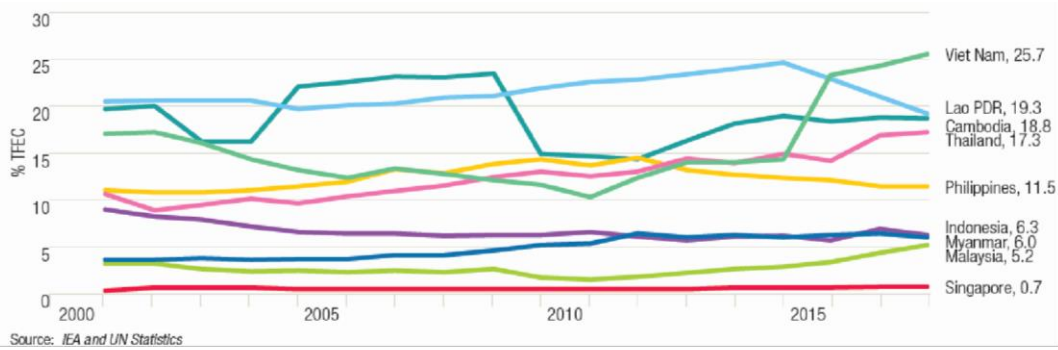
Figure 2.3: Annual Renewables Capacity Addition in ASEAN Countries (2001–2019)



MW =megawatt.

Source: Figure created by UNESCAP (2020) based on IRENA data.

Figure 2.4: Modern Renewables Share in Total Final Energy Consumption (2000–2017)



Lao PDR = Lao People's Democratic Republic, TFEC = total final energy consumption.

Source: Figure created by UNESCAP (2020) based on IEA and UN statistics data.

2.2. Energy Policies and Targets of Renewables in ASEAN

ASEAN Member States (AMS) target to increase RE to 23% of ASEAN's total primary energy supply (TPES) by 2025, according to the official documents: the ASEAN Plan of Action for Energy Cooperation (APAEC) (2016–2025) (Phase I: 2016–2020) and the ASEAN Economic Community 2025 Consolidated Strategic Action Plan. APAEC, a series of documents endorsed by the ASEAN Ministers of Energy Meeting, serves as the 'guiding policy document that aims to promote multilateral energy cooperation and integration to attain the goals of the ASEAN Economic Community' and 'the platform for deeper cooperation both within ASEAN as well as with Dialogue Partners… and International Organizations… toward enhancing energy security, accessibility, affordability, and sustainability within the framework' (ACE, 2020b). Before the current — fourth — APAEC (i.e., APAEC 2016–2025), APAEC 1999–2004, APAEC 2004–2009, and APAEC 2010–2015 were announced.

APAEC 2016–2025 spans a longer period of 10 years. It is divided into two phases (Phase I: 2016–2020 and Phase II: 2021–2025). The ongoing APAEC Phase II was endorsed in November 2020. It maintained the short- to medium-term strategies (Enhancing Energy Connectivity and Market Integration in ASEAN to Achieve Energy Security, Accessibility, Affordability and Sustainability for All) as in Phase I, with a new subtheme: Accelerating Energy Transition and Strengthening Energy Resilience through Greater Innovation and Cooperation.

APAEC 2016–2025 indicated seven programme areas and key strategies (Table 2.1). Amongst these programme areas, the ASEAN Power Grid is a way to achieve the ASEAN target of 23% RE, aiming at regional interconnection and trade of electricity (Figure 2.5).

The idea is to connect on cross-border bilateral terms, expand to the sub-regional level, and achieve an integrated Southeast Asian power grid system (IEA, 2020a).

Table 2.1: APAEC Phase II: 2021–2025 Key Strategies

Programme Areas	Key Strategies
ASEAN Power Grid	To expand regional multilateral electricity trading, strengthen grid resilience and modernisation, and promote clean and RE integration
Trans-ASEAN Gas Pipeline	To develop a common gas market for ASEAN countries by enhancing gas and liquefied natural gas connectivity and accessibility
Coal and Clean Coal Technology	To optimise the role of clean coal technology in facilitating the transition towards sustainable and lower emission development
Energy Efficiency and Conservation	To reduce energy intensity by 32% in 2025 per 2005 levels and encourage further energy efficiency and conservation efforts, especially in transport and industry sectors
Renewable Energy	To achieve an aspirational target for increasing the RE component to 23% by 2025 in the ASEAN energy mix, such as increasing the share of RE in installed power capacity to 35% by 2025
Regional Energy Policy and Planning	To advance energy policy and planning to accelerate the region's energy transition and resilience
Civilian Nuclear Energy	To build human resource capabilities on nuclear science and technology for power generation

APAEC= ASEAN Plan of Action for Energy Cooperation, ASEAN = Association of Southeast Asian Nations, RE = renewable energy.

Source: ACE (2020b).

Figure 2.5: ASEAN Power Grid in the Three Regions

ASEAN = Association of Southeast Asian Nations, Lao PDR = Lao People's Democratic Republic.

Source: IEA (2019a).

However, the regional AMS commitments are not binding, and the ASEAN secretariat cannot intervene (i.e. the so-called principle of non-interference in ASEAN countries), which induces policy design 'flexibility' (Malahayati, 2020). It may lead to a gap between actual AMS policies and achievements and committed ambitious, regional targets. Moreover, no monitoring and evaluation mechanisms have been noted as a flaw where AMS progress may go unchecked (Malahayati, 2020).

Apart from cooperation under the ASEAN secretariat, some ASEAN countries have still not joined IRENA, comprising most of the emerging and developing countries. As of April 2021, the Lao PDR, Viet Nam, and Myanmar are not member states of IRENA; Cambodia is in the process of accession.[2]

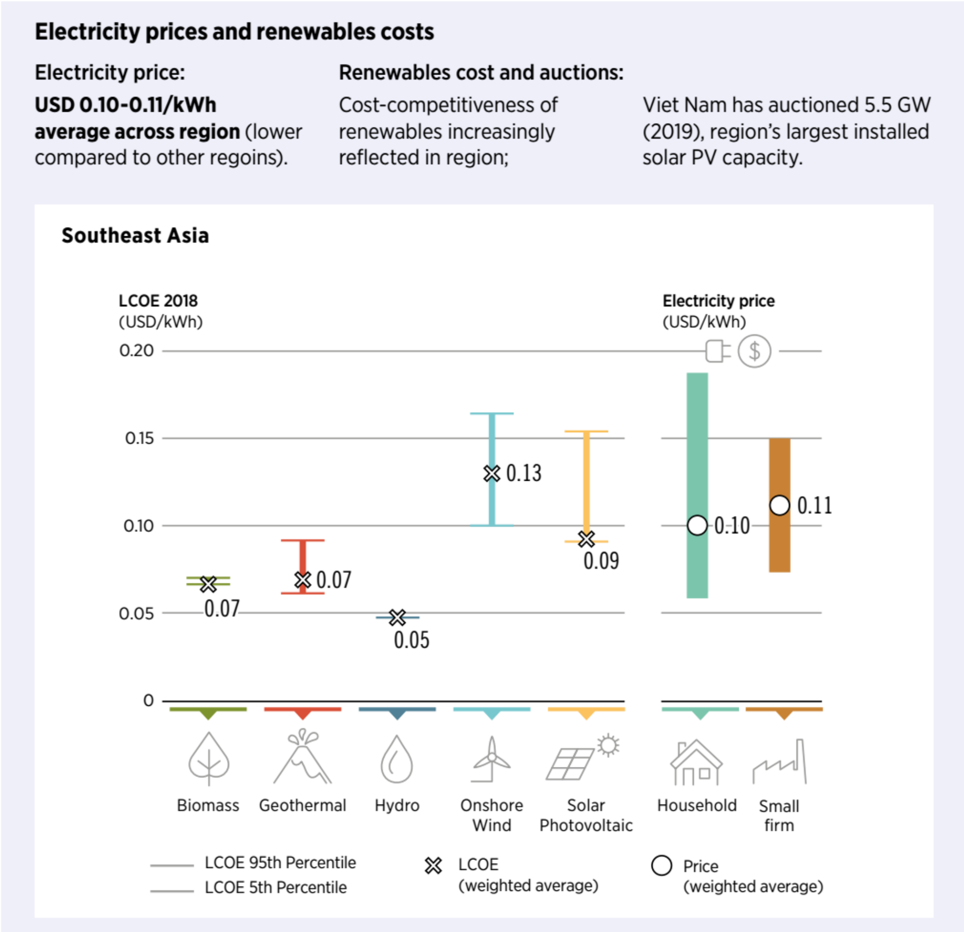
2.3. Costs of Renewables

In the last decades, the world has witnessed a remarkable drop in the cost of RE. During the 2010–2019 period, the levelised cost of energy (LCOE) of solar photovoltaic (PV) declined by 82%, and onshore wind power declined by 39% (IRENA, 2020a). LCOEs of solar PV and wind power are even cheaper than those of conventional coal-fired and nuclear power in some countries. This observation shows that RE is a more competitive and economical deployment option. A similar trend also appears in ASEAN countries, where RE is becoming increasingly competitive, with the LCOE close to the electricity rates (Figure 2.6) (IRENA, 2020a, 2020b). In Malaysia and Cambodia, solar power auction rates are lower than coal-fired power (Bellini, 2020; REI, 2020).

Whilst power generation from onshore wind power is usually cheaper than that from solar PV in other RE early-mover countries, solar power is generally cheaper than wind power in ASEAN countries. Further, the average LCOE of solar PV in ASEAN countries remains higher than the global average rate (IRENA, 2020a), revealing that further work to reduce cost is vital for diffusing RE in the ASEAN regions.

[2] See https://www.irena.org/irenamembership

Figure 2.6: Electricity Prices and Renewables Costs in ASEAN



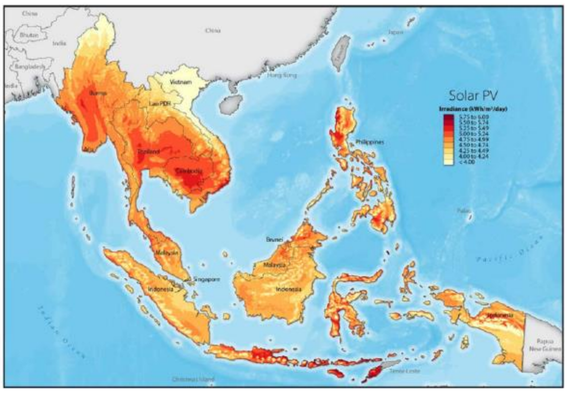
GW = gigawatt, kWh = kilowatt hour, LCOE = levelised cost of energy.

Source: IRENA (2020b).

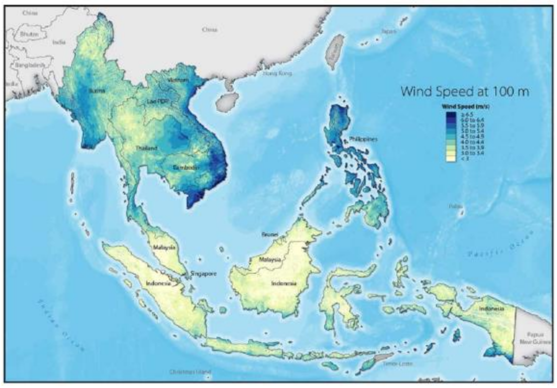
Research by the National Renewable Energy Laboratory of the United States demonstrated the abundant solar and wind resources and potentials in ASEAN countries (Figure 2.7, Table 2.2) (Lee et al., 2020). Moreover, the resources are not equivalently distributed across the region, implying that promoting RE in each country requires different considerations, and the power grid interconnection between countries may further facilitate the utilisation of RE.

Figure 0.1: Potentials and LCOEs of Solar PV and Wind Power Across ASEAN Countries

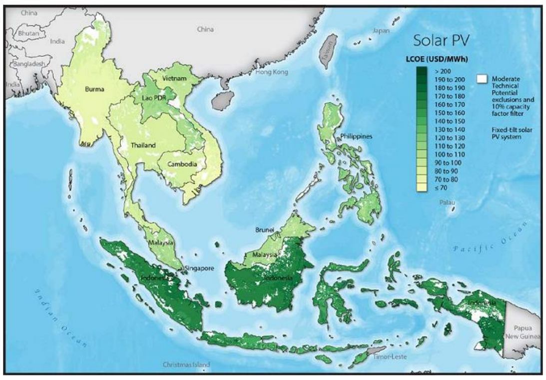
Solar resource potentials



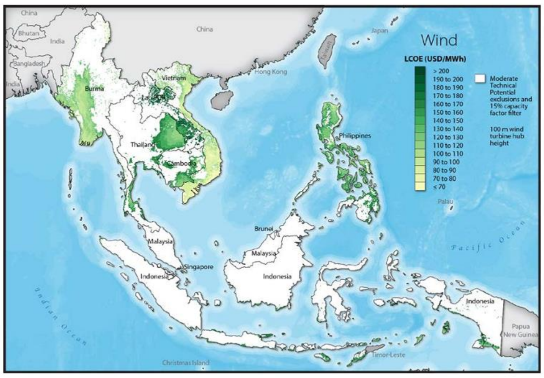
Wind resource potentials



Solar photovoltaic levelised cost of energy



Wind levelised cost of energy



ASEAN = Association of Southeast Asian Nations, kWh = kilowatt hour, LCOE = levelized cost of energy, m/s = metres per second, MWh = megawatt hour, PV = photovoltaic.

Source: Lee et al. (2020).

Table 2.2: Opportunities and Barriers for Renewables Development in Selected ASEAN Member States

Country	Potential Opportunities*		Potential Barriers
	Solar PV Capacity (GW) (suitable land area [km^2])	**Wind Capacity (GW)** (suitable land area [km^2])	
Malaysia	1,965 GW (54,575 km^2)	2 GW (526 km^2)	• Lower-quality wind resources given currently available technologies (and data) • Potentially high installed wind costs • Limited or non-existing utility-scale wind development
Philippines	1,910 GW (53,062 km^2)	217 GW (72,337 km^2)	• High installed solar PV and wind costs
Thailand	10,538 GW (292,713 km^2)	239 GW (79,718 km^2)	• High installed wind costs

*Note: LCOE of less than USD150/MWh.

ASEAN = Association of Southeast Asian Nations, GW = gigawatt, km^2 = square kilometres, LCOE = levelized cost of energy, MWh= megawatt hour, PV = photovoltaic.

Source: Lee et al. (2020).

3. ASEAN and the Paris Agreement

3.1. Intended Nationally Determined Contributions (NDCs)

As noted, all AMS have participated in the Paris Agreement and submitted Intended NDCs (Table 2.3). In addition, Singapore, Viet Nam, Thailand, Cambodia, Brunei Darussalam, and the Philippines have submitted updated NDCs (as of 15 April 2021) (Yumaidi, 2021).[3]

Although ASEAN countries are historically not blamed for greenhouse gas (GHG) emissions, which contribute to climate change, they rely on fossil fuels and are expected to continue this trend in the future. Moreover, per the Long-Term Climate Risk Index, four out of 10 most affected countries from 1999 to 2018 are ASEAN countries: Myanmar, the Philippines, Viet Nam, and Thailand (Germanwatch, 2019; Greenpeace Southeast Asia, 2020). ASEAN countries are vulnerable to climate change, and hence, it must be addressed with a sense of emergency. Nevertheless, although ASEAN countries already play a role in combating climate change via their commitment to NDCs, some studies note the paradox between their energy policies and climate ambitions, indicating that more efforts are needed to progress towards a more sustainable, low-carbon future (Overland et al., 2021; Shi, 2016).

Table 2.3: ASEAN Countries' Individual (Intended) Nationally Determined Contributions

Brunei Darussalam	• Brunei Darussalam commits to reducing 63% of its total energy consumption by 2035 • Updated NDC: 20% reduction of GHG emissions by 2030 relative to its BAU
Cambodia	• Cambodia commits to reducing 27% of its GHG emissions conditionally, taken from aggregate reductions from sectors such as energy, transport, and manufacturing, and an additional contribution from the land use, land-use change, and forestry (LULUCF) sector • Updated NDC: GHG targets (1) 27% GHG reduction by 2030 relative to BAU or equivalent to 3.1 MtCO2e, (2) LULUCF contribution of 4.7 MtCO2e/ha/year; 41.7% GHG reduction (of which 59.1% is from food and land use) by 2030 relative to BAU or equivalent to 64.6 MtCO2e

[3] UNFCCC NDC Registry: https://www4.unfccc.int/sites/NDCStaging/Pages/All.aspx

Indonesia	• Indonesia commits to unconditionally reducing 26% of its GHG emissions by 2020 and 29% by 2030 relative to its BAU scenario. The reduction target will increase to 41% by 2030 with international cooperation
Lao People's Democratic Republic (Lao PDR)	• Lao PDR has set policies and measures to reduce GHG emissions in multiple sectors to be implemented by 2030
Malaysia	• Malaysia intends to reduce its GHG emissions intensity in GDP by 45% by 2030 relative to the emissions intensity in 2005; This reduction comprises 35% on an unconditional basis and a further 10% upon receipt of climate finance, technology transfer, and capacity building from developed countries
Myanmar	• Myanmar has set policies and measures to reduce GHG emissions in multiple sectors to be implemented by 2030
Philippines	• The Philippines commits to reducing 70% of its GHG emissions by 2030 relative to its BAU scenario; the mitigation contribution is conditioned on the extent of financial resources, including technology development and transfer and capacity building • Updated NDC: Philippines commits to a projected GHG emissions reduction and avoidance of 75%, of which 2.71% is unconditional, and 72.29% is conditional, representing the country's ambition for the 2020–2030 GHG mitigation in agriculture, waste, industry, transport, and energy. This commitment is referenced against a projected BAU cumulative economy-wide emissions of 3,340.3 MtCO2e for the same period
Singapore	• Relative to the 2005 base year, Singapore intends to reduce its emissions intensity by 36% by 2030 and stabilise its emissions to peak around 2030 • Updated NDC: Peak emissions at 65 MtCO2e around 2030 to achieve a 36% reduction in emissions intensity from 2005 levels
Thailand	• Thailand commits to reducing its GHG emissions by 20% from the BAU level by 2030. The target could increase by up to 25%, subject to adequate and enhanced access to technology development and transfer, financial resources, and capacity-building support through a

	balanced and ambitious global agreement under the UNFCCC • Updated NDC: 20% (unconditional) up to 25% (conditional) GHG reduction by 2030 relative to BAU
Viet Nam	• Viet Nam intends to reduce its GHG emissions by 8% unconditionally by 2030. The target could be increased to 25% if international support is received through bilateral and multilateral cooperation and the implementation of new mechanisms under the Global Climate Agreement, in which emission intensity per unit of GDP will be reduced by 30% relative to 2010 levels • Updated NDC: 7.3% (unconditional) GHG reduction by 2025, 9% (unconditional) up to 27% (conditional) GHG reduction by 2030 relative to BAU

ASEAN = Association of Southeast Asian Nations, BAU = business-as-usual, GHG = greenhouse gas, MtCO2e = metric tons of carbon dioxide equivalent, NDC = naturally determined contributions, UNVCCC = United Nations Framework Convention on Climate Change.

Sources: ERIA (2021, p. 313), with the authors' updates based on (Yumaidi, 2021) and the UNFCCC website (NDC Registry: https://www4.unfccc.int/sites/NDCStaging/Pages/All.aspx)

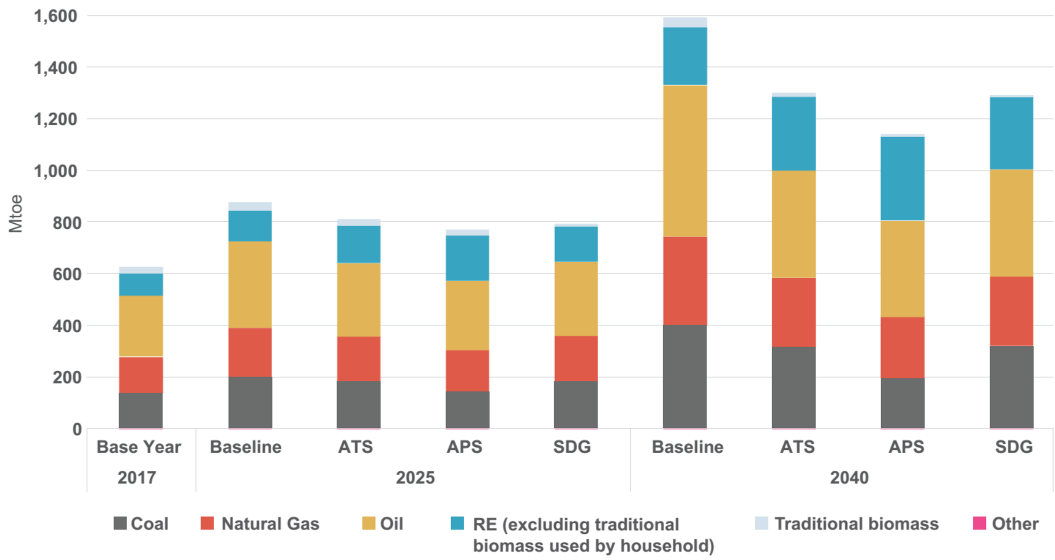
3.2. Energy Scenarios

Several organisations have conducted energy scenario analyses for ASEAN countries, such as ACE (ACE, 2020a), IEA (Southeast Asia Energy Outlook 2019), IRENA (Global Renewables Outlook: Energy Transformation 2050, 2020), and Greenpeace (Southeast Asia Power Sector Scorecard, 2020). This section considers the results from the ACE scenarios (ACE, 2020a).

ACE's sixth ASEAN Energy Outlook explored four scenarios: (1) the baseline scenario assumes AMS continue to develop along with historical trends, which present the business-as-usual (BAU) case as the reference for other scenarios. (2) AMS targets scenario (ATS) projects the future development if AMS do what is needed to fully achieve their national energy efficiency and RE targets and their climate commitments. (3) APAEC targets scenario (APS) projects what it would take to achieve the regional targets announced in APAEC 2016–2025, achieve 23% of TPES from RE, and reduce the energy intensity by 30% from 2005 levels in 2025. (4) Sustainable Development Goals (SDG) scenario builds on the ATS to explore what the AMS would have to do to achieve the three targets of SDG7 by 2030: 'to ensure universal access to affordable, reliable, and modern energy services; increase substantially the share of renewable energy in the global energy mix; and double the global rate of improvement in energy efficiency (from 2015 levels)' (ACE, 2020a).

The results (Figure 2.8) show that only the most ambitious scenario (APS) can achieve a 23% RE target by 2025, whilst the current national targets of ASEAN countries (ATS) would attain 17.7% (22.1%) RE in TPES by 2025 (2040), far behind the ASEAN regional target. Moreover, even under the APS, fossil fuels are projected to possess a 71% share of TPES in 2040, showing how the AMS would depend on fossil fuels and the importance of reducing this dependency. Regarding GHG emissions, the baseline scenario shows 2.4 times the current level of emissions if the AMS follow their current pattern to support economic development (Figure 2.9). If AMS follow their national policies and commitments (ATS), emissions will grow by 78% from more than the current level (2017) in 2040. Even the ambitious APS projects a 34% growth in 2040, relative to 2017.

Figure 2.8: ASEAN Total Primary Energy Supply across Scenarios

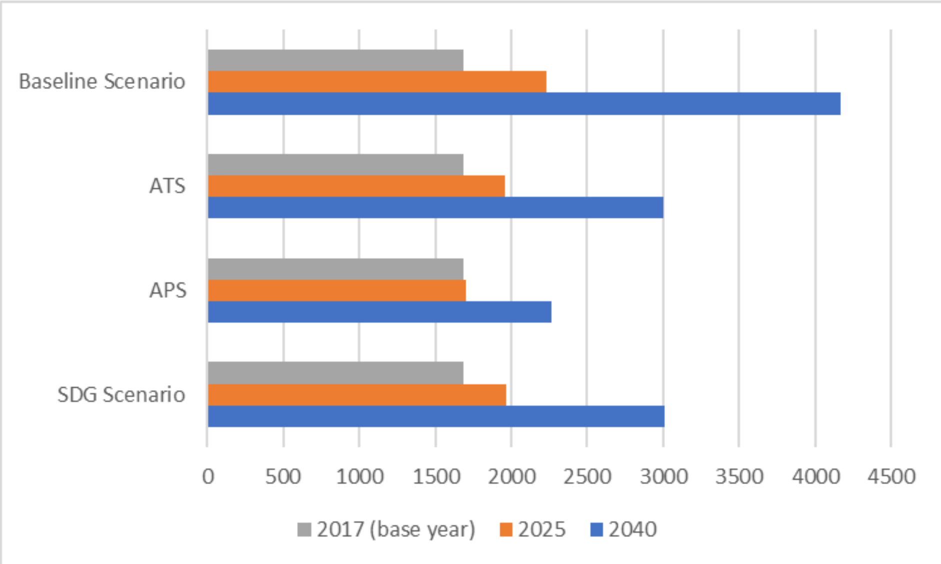


APS = APAEC targets scenario, ASEAN = Association of Southeast Asian Nations, ATS = AMS targets scenario, Mtoe = million tons of oil equivalent, RE = renewable energy, SDG = Sustainable Development Goal.

Source: ACE (2020a).

Figure 2.9: ASEAN GHG Emissions across Scenarios

($Mt\ CO_2$-eq)



APS = APAEC targets scenario, ASEAN = Association of Southeast Asian Nations, ATS = AMS targets scenario, GHG = greenhouse gas, SDG = Sustainable Development Goal.
Source: Charted by the authors based on data from ACE (2020a).

4. Energy Situation and Related Policies in Selected Countries

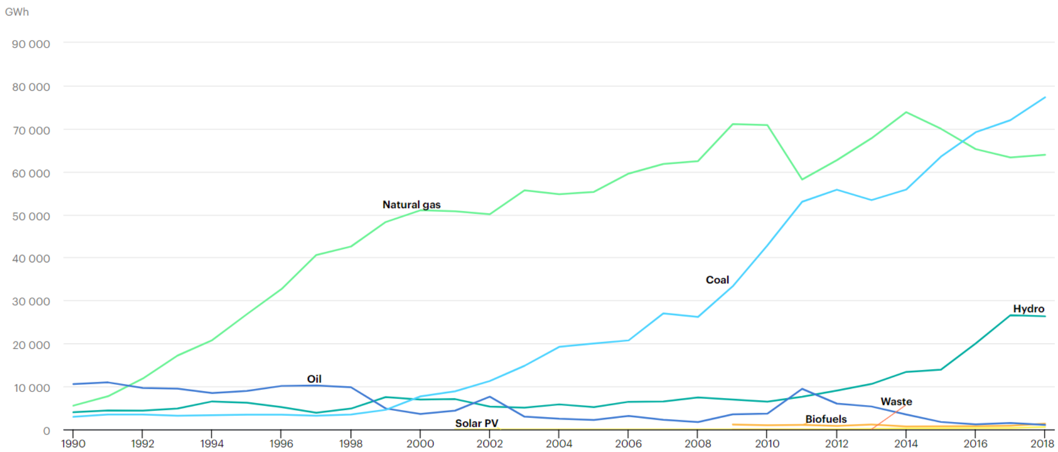
4.1. Malaysia

Malaysia is rich in fossil fuels such as oil, coal, and especially natural gas, where it ranks as the largest in Southeast Asia and the 12th largest worldwide in reserves (ERIA, 2021; Malahayati, 2020). Malaysia has relied on natural gas for power generation. Recently, coal has played a more important role in its power mix and now surpasses gas as the main source for power generation (Figure 2.10, Figure 2.11).

The Malaysian government started to realise the importance of RE, incorporating it into its energy mix in the Five Fuel Diversification Policy (2001) (the other four fuels are oil, coal, gas, and hydro) (Khor and Lalchand, 2014; Malahayati, 2020). The Five Fuel Diversification Policy is amongst the components of its national five-year development programme: the Eighth Malaysia Plan (2001–2005) (Umar, Jennings, and Urmee, 2014). The following Malaysia Plans included RE policies (Table 2.4). The announcement of the Twelfth Malaysia Plan (2021–2025) was delayed because of the COVID-19 pandemic, but it was finally tabled on 27 September 2021, setting the target of 31% RE of the total installed capacity by 2025.[4]

Malaysia set the target of 20% RE in the power capacity mix by 2025 (excluding large-scale hydro) in its Renewable Energy Transition Roadmap 2035 (ACE, 2020a; UNESCAP, 2020);[5] and the latest targets announced are 31% RE by 2025 and 40% by 2035.[6] Several RE targets have been indicated in documents on Malaysia's energy policies, compiled in Table 2.5. Moreover, biomass (biofuels extracted from oil palm) is also regarded as a potential RE source in Malaysia (Hamzah, Tokimatsu, and Yoshikawa, 2019; UNESCAP, 2020).

Figure 2.10: Electricity Generation by Source, Malaysia (1990–2019)



PV = photovoltaic.

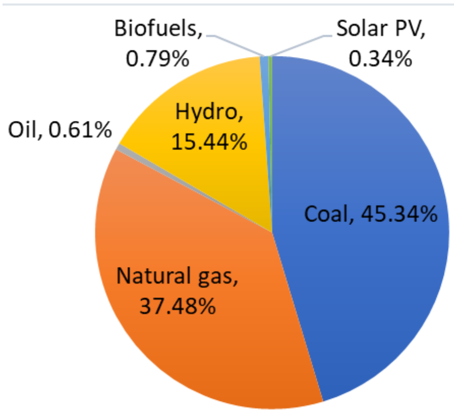
Source: IEA electricity data browser: https://www.iea.org/fuels-and-technologies/electricity (accessed 4 May 2021).

[4] Refer to https://www.mida.gov.my/mida-news/special-report-on-the-12th-malaysia-plan-2021-2025-12mp-success-needs-high-quality-investments-greater-public-accountability-whole-nation-participation/ For Twelfth Malaysia Plan (2021–2025), refer to https://rmke12.epu.gov.my/en

[5] Moreover, refer to www.seda.gov.my/2020/01/seda-malaysia-a-report-card-2019-strengthens-the-growth-of-renewable-energy-and-its-industry-in-malaysia/

[6] Refer to https://www.irena.org/newsroom/articles/2021/Jan/IRENA11ALiveDay1 Also see Twelfth Malaysia Plan (2021–2025). https://rmke12.epu.gov.my/en

Figure 2.11: Electricity Generation Mix in Malaysia (2018)



PV = photovoltaic.

Source: charted by the authors based on the data from IEA electricity data browser: https://www.iea.org/fuels-and-technologies/electricity (accessed 4 May 2021).

Table 2.4: Renewable Energy Policy Deployment and Development in Malaysia

Plans	Policies, Measures, Targets
Eighth Malaysia Plan (2001–2005)	• The fifth Fuel Diversification Policy 2001 • Small Renewable Energy Program • Renewable Share of 500 MW or 5% in Energy Mix 2005
Ninth Malaysia Plan (2006–2010)	• Renewable Share of 350 MW or 1.8% in Energy Mix 2010
Tenth Malaysia Plan (2010–2015)	• National Renewable Energy Policies and Action Plan 2010 • Renewable Energy Act 2011 • Sustainable Energy Development Authority 2011 • Feed-in Tariff • Renewable Share of 985 MW or 5.5% in Energy Mix 2015
Eleventh Malaysia Plan (2016–2020)	• Renewable Share of 2,080 MW or 7.8% from Peninsular Malaysia and Sabah Energy Mix 2020
Twelfth Malaysia Plan (2021–2025)	• 31% RE of the total installed capacity

MW = megawatt, RE = renewable energy.

Sources: Hamzah, Tokimatsu, and Yoshikawa (2019); Umar, Jennings, and Urmee (2014). For Twelfth Malaysia Plan (2021–2025), refer to https://rmke12.epu.gov.my/en.

Table 2.5: Energy Policies in Malaysia

Policy Area	Targets	References, Sources
Efficiency	Promote energy efficiency in the industry, buildings, and residential sectors via standard-setting, labelling, energy audits, and building design	(IEA, 2019b)
Renewables	Increase capacity of renewables to 2,080 MW by 2020 and 4,000 MW by 2030	(IEA, 2019b)
	20% RE in the power capacity mix by 2025 (excluding large-scale hydro)	• Malaysia National Renewable Energy Policy and Action Plan (NREPAP) 2011 (ACE, 2020a) • Renewable Energy Transition Roadmap 2035 (UNESCAP, 2020)
Transport	Introduce 100,000 electric vehicles by 2020 with 125,000 charging stations	(IEA, 2019b)
Climate change	Reduce GHG intensity in GDP by 35% by 2030 from the 2005 level, thereby inducing a 45% reduction with enhanced international support	(IEA, 2019b)

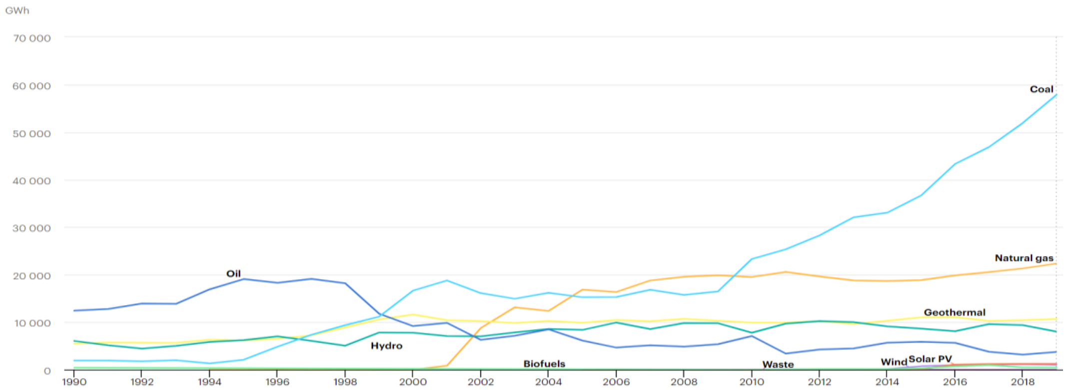
GHG = greenhouse gas, GDP = gross domestic product, MW = megawatt.

Sources: IEA (2019b), ACE (2020a) and UNESCAP (2020); compiled and edited by the authors.

4.2. The Philippines

The Philippines is rich in geothermal resources, utilising this advantage in power generation (Figure 2.12). Relative to other AMS, although the Philippines seems to have a relatively high RE share in its power generation at approximately 20% as of 2019, it has increasingly relied on fossil fuels, especially on coal, covering more than half the power generation (Figure 2.12,Figure 2.13). The import of fossil fuels has become a reason the rate of electricity in the Philippines is the most expensive in Asia (Overland et al., 2021).

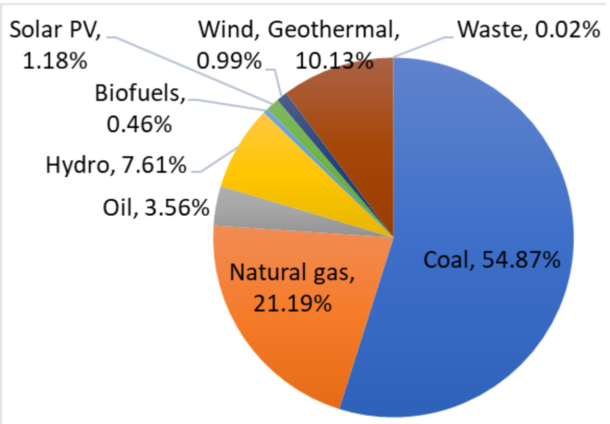
Figure 2.12: Electricity Generation by Source, The Philippines (1990–2019)



GWh = gigawatt hour, PV = photovoltaic.

Source: IEA electricity data browser: https://www.iea.org/fuels-and-technologies/electricity (accessed 4 May 2021).

Figure 2.13: Electricity Generation Mix in the Philippines, 2019



PV = photovoltaic.

Source: Charted by the authors based on the data from IEA electricity data browser: https://www.iea.org/fuels-and-technologies/electricity (accessed 4 May 2021).

The government of the Philippines promoted RE to reduce its vulnerability in depending on imported fossil fuels. Accordingly, the Renewable Energy Act was enacted in 2008 to provide incentives for the private sector's participation in RE investment (Malahayati, 2020). The National Renewable Energy Program (NREP) policy framework targets to increase the renewable-energy-based capacity to an estimated 15,304 MW by 2030, almost triple its 2010 level. Thus, the NREP planned installation targets and development goals, including the aim to 'increase geothermal capacity by 75.0%; increase hydropower capacity by 160%; deliver additional 277 MW biomass power capacities; attain wind power grid parity with the commissioning of 2,345 MW additional capacities; mainstream an additional 284 MW solar power capacities and work towards achieving the aspirational target of 1,528 MW; develop the first ocean energy facility for the country' (DOE, 2011).Tables 2.6, 2.7, 2.8, and Figure 2.14 highlight the detailed targets for developing RE and related energy policies.

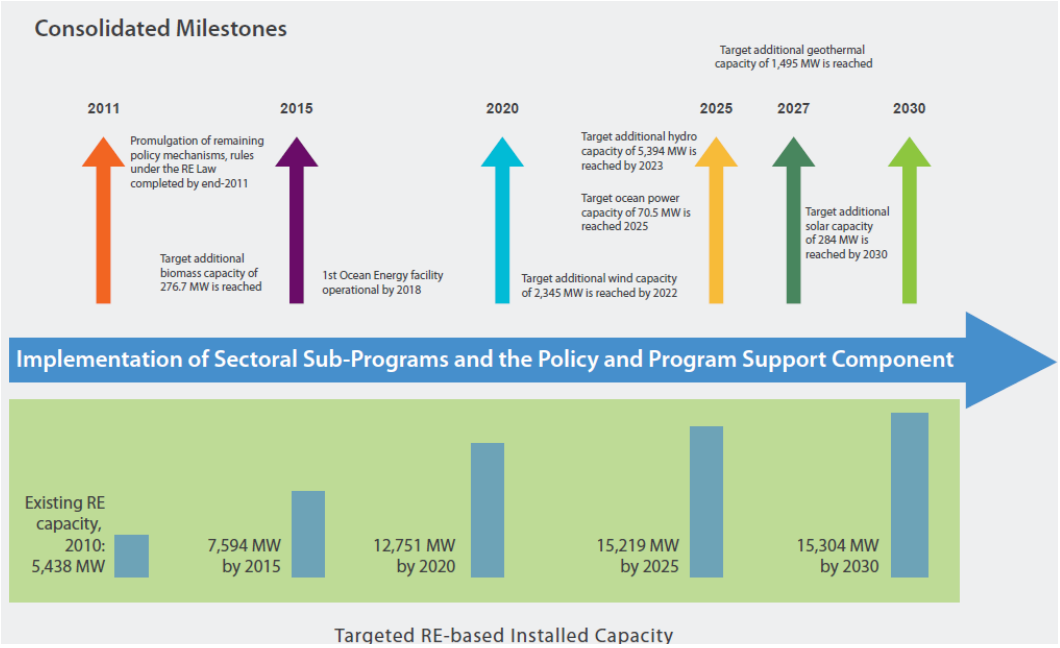
Table 2.6: Renewable-energy-based Capacity Installation Targets in the Philippines

Sector	Installed Capacity (MW) as of 2010	Target Capacity Addition By				Total Capacity Addition (MW) 2011–2030	Total Installed Capacity by 2030
		2015	2020	2025	2030		
Geothermal	1,966.0	220.0	1,100.0	95.0	80.0	1,495.0	3,461.0
Hydro	3,400.0	341.3	3,161.0	1,891.8	0.0	5,394.1	8,724.1
Biomass	39.0	276.7	0.0	0.0	0.0	276.7	315.7
Wind	33.0	1,048	855.0	442.0	0.0	2,345.0	2,378.0
Solar	1.0	269.0	5.0	5.0	5.0	284 .0	285.0
Ocean	0.0	0.0	35.5	35.0	0.0	70.5	70.5
Total	**5,438.0**	**2,155.0**	**5,156.5**	**2,468.8**	**85.0**	**9,865.3**	**15,304.3**

MW = megawatt.

Source: DOE (2011).

Figure 2.14: Roadmap for Renewable Energy Development in the Philippines



MW = megawatt, RE = renewable energy.

Source: DOE (2011).

Table 2.7: Projected Milestones (2011–2030) (the Philippines)

Sector	Target Indicative Capacity Addition Achieved by	Others
Geothermal	2027	Low-enthalpy geothermal resource assessment completed by 2015
Hydro	2023	Construction of sea water pumped storage demo facility by 2030
Biomass	2015	Mandatory E10 blend for all gasoline vehicles by 2012
Wind	2022	Grid parity by 2025
Solar	2030	Smart grid and concentrated solar thermal power demo completed by 2015: Grid parity 2020
Ocean	2025	First ocean energy facility operational by 2018

Source: DOE (2011).

Table 2.8: Energy Policies in the Philippines

Policy Area	Targets	References, Sources
Electrification	Achieve 100% electrification by 2022	IEA (2019b)
Efficiency	Reduce energy intensity by 40% by 2030 from the 2010 level Decrease energy consumption by 1.6% per year by 2030 from baseline forecasts	IEA (2019b)
Renewables	Triple the installed capacity of renewables-based power generation from 2010 level to 15 GW by 2030	IEA (2019b)
	Triple RE installed capacity by 2030 from the 2010 level to 15.3 GW from 5.4 GW	NREP 2011 Sectoral Plans and Roadmap (ACE, 2020a)
	Biofuel blending ratio around 2% for biodiesel and 10% of bioethanol	Biofuels Roadmap Short Term: 2017–2018 — Sectoral Plans and Roadmap (ACE, 2020a)
Climate change	Reduce GHG emissions by 70% from the BAU level by 2030 with the condition of international support	IEA (2019b)

BAU = business as usual, GHG = greenhouse gas, GW = gigawatt, NREP = National Renewable Energy Program, RE = renewable energy.

Sources: compiled and edited by the authors from IEA (2019b) and ACE (2020).

Despite the ambitious RE goals, the Philippines has historically lagged some of its targets (UNESCAP, 2020). Thus, it is essential to monitor and check renewable practices for practicable ways to fulfil goals. The financing issue in RE projects where there is no transmission is amongst the challenges the Philippines face (UNESCAP, 2020). Further, given the geographic characteristics of an archipelagic state, off-grid areas could be a challenge and an opportunity in promoting RE.

4.3. Thailand

Relative to other AMS, Thailand is the frontrunner in RE development (UNESCAP, 2020). Thailand is amongst the first Asian countries to introduce a feed-in tariff (FIT) mechanism (Tongsopit and Greacen, 2013; UNESCAP, 2020). In 2002, set at an avoided-cost tariff, purchasing RE and cogeneration electricity by very small power producers was allowed.[7] The feed-in premium, called the Adder Programme, came into effect in 2007 (endorsed in 2006), where premium rates are added on top of wholesale electricity prices. This scheme then shifted to fixed FIT in 2013 (IRENA, 2017; Tongsopit and Greacen, 2012, 2013; UNESCAP, 2020). With well-balanced and responsive policies, a steady RE growth in its power mix has been witnessed during the past years (UNESCAP, 2020) (Figure 2.15).

Coal possesses and maintains a share of around 20% in Thailand's power generation during the past decades, and only 18% in 2019 (Figure 2.15, Figure 2.16), which is much less than in the Philippines and Malaysia. However, Thailand heavily relies on natural gas. The Thai government tried to correct this trend through the Alternative Energy Development Plan (AEDP) to increase RE and the 20 Years Power Development Plan 2010–2030 (PDP 2010–2030) to reduce approximately 12.6% of natural gas by 2030, introducing more RE and nuclear power (Malahayati, 2020).[8] The later revised PDP 2015–2036 set the target of 20% RE in electricity generation by 2036; PDP 2018–2037 updated the contents, which include reducing coal and imported hydro shares and increasing RE to 20% of the total power capacity by 2037 (UNESCAP, 2020). Table 2.9 compiles the energy-related targets.

Thailand's community-based solar PV promotion brought it to the country with the highest per-capita solar installation rate in ASEAN countries (UNESCAP, 2020). Biofuels, including agricultural outputs such as rice, oil palm, sugarcane, and rubber, are the largest renewable electricity output sources in Thailand (Malahayati, 2020; UNESCAP, 2020).

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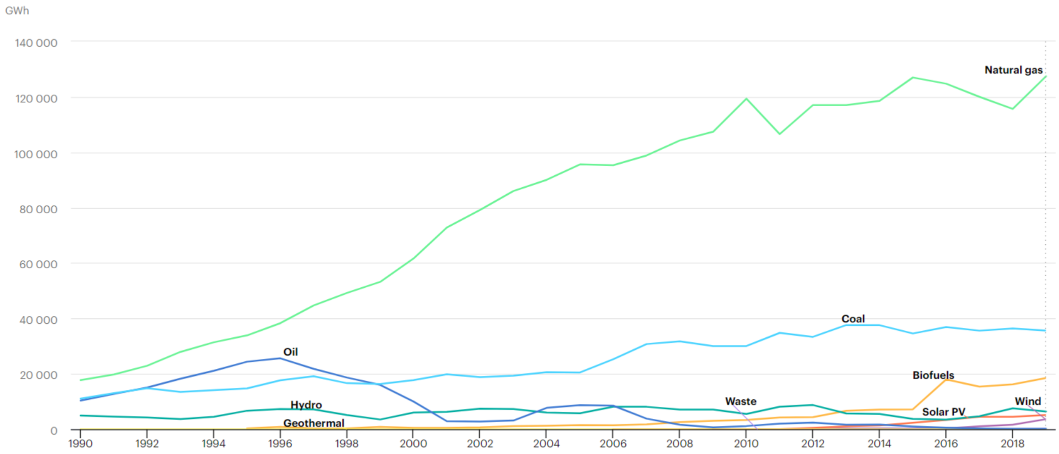
[7] Even earlier, the purchase of power from small power producers using non-conventional energy (RE and cogeneration) was allowed in 1992 to facilitate the use of alternative energies and reduce the government burden to invest in power plant infrastructure (ERIA, 2019; Tongsopit and Greacen, 2012).

[8] Given the impact of the Fukushima Daiichi nuclear disaster, the Thai government has postponed the nuclear power plant plan. Safety issues have been a concern for local people. Refer to https://asia.nikkei.com/Economy/Thailand-s-nuclear-plans-inch-forward-with-new-bill, https://www.bangkokpost.com/opinion/opinion/2122807/renewables-are-the-future, https://www.bangkokpost.com/thailand/special-reports/1072704/power-play-tackles-hearts-and-minds

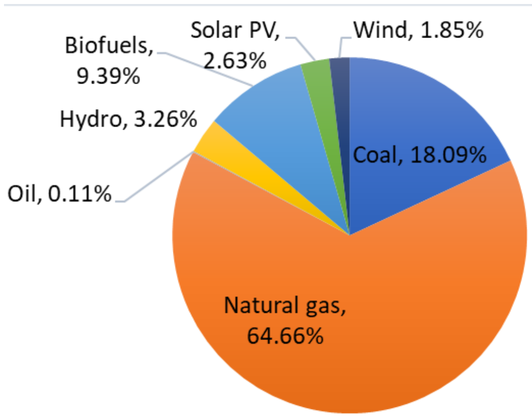
Figure 2.15: Electricity Generation by Source, Thailand (1990–2019)



GWh = gigawatt hour.

Source: IEA electricity data browser: https://www.iea.org/fuels-and-technologies/electricity (accessed 4 May 2021).

Figure 2.16: Electricity Generation Mix in Thailand, 2019



PV = photovoltaic.

Source: Charted by the authors based on the data from IEA electricity data browser: https://www.iea.org/fuels-and-technologies/electricity (accessed 4 May 2021).

Table 2.9: Energy Policies in Thailand

Policy Area	Targets	References, Sources
Efficiency	Reduce energy intensity by 30% by 2036 from the 2010 level	IEA (2019b)
Renewables	30% RE share in total final energy consumption (TFEC) by 2036, including 15% to 20% renewable electricity in total generation; 30% to 35% of consumed heat from renewables; and a 20% to 25% biofuel share in TFEC	Alternative Energy Development Plan (AEDP) 2015 (ACE, 2020a)
	The target for solar capacity increased from 6 GW to 17 GW by 2036 (under the Remap 2036)	(UNESCAP, 2020)
Transport	Increase to 1.2 million electric vehicles and 690 charging stations by 2036	(IEA, 2019b)
Climate change	Reduce CO_2 emissions from the power sector to 0.283 kg CO_2 in 2037 from 0.413 kg CO_2 in 2018 Reduce GHG emissions by 20% from the BAU level by 2030, inducing a 25% reduction with enhanced international support	(IEA, 2019b)

BAU = business-as-usual, GHG = greenhouse gas, GW = gigawatt,

Sources: Compiled and edited by the authors from IEA (2019b), ACE, (2020a) and UNESCAP, (2020).

5. Discussion and Conclusion

The above review on energy and climate policies of the overall ASEAN region and the selected three countries (Malaysia, the Philippines, and Thailand) show the willingness of the AMS to participate in the global fight against climate change and deploy sustainable RE. However, satisfying the rapidly growing energy demand driven by economic and industrial development whilst maintaining sustainability has become the main and common challenge for ASEAN countries. Whilst some analyses argued for the insufficiency in AMS' efforts on climate change and noted the paradox between their climate and energy policy and their global warming vulnerability (Overland et al., 2021), such a struggle, which may lead to a discrepancy between climate and energy policy, is not that rare and has also been observed in developed countries (e.g. Hattori and Chen, 2020).

Moreover, the ASEAN diversity requires more sophisticated policy designs in each country to meet their respective needs. The case of Thailand demonstrates that with a good policy lead, the fulfilment of RE targets can be achieved.

There is no doubt that deploying clean energy is vital and urgent for ASEAN countries. Beyond the climate risk, air pollution from fossil fuel combustion has caused public health issues, such as lung cancer, which is 'the leading and second leading cause of cancer-related death in men and women,' respectively, in Southeast Asian countries, inducing an economic burden in the long run, whilst the increase in RE and healthcare expenditure tend to reduce this health risk (Taghizadeh-Hesary and Taghizadeh-Hesary, 2020). Regarding the economy, although some countries have coal and natural gas resources, only Indonesia has comparatively rich reserves to avoid imports in the long run (Overland et al., 2021), resulting in an outflow of national wealth. Further, government investment in RE has been shown to bring more jobs than fossil fuels (Garrett-Peltier, 2017; Greenpeace Southeast Asia, 2020; McKinsey & Company, 2020) in the case of developed countries and Southeast Asia (IRENA, 2020a).

Environmental leapfrogging (Goldemberg, 1998; Watson and Sauter, 2011) is not a cliché; rather, it should be practicable more than ever for ASEAN countries at the crossroad of choosing an alternative pathway. The energy ladder is not a robust claim; more complicated models which consider more factors can shed more light on the energy use in emerging countries (Van Der Kroon et al., 2013).

There are at least four reasons and merits for which AMS should work on leapfrogging pathways.

First, good environmental practices address global climate change and regional and local AMS needs.

Second, the current competitiveness of RE technologies makes cleaner production technologies more attractive than end-of-pipe ones.

Third, AMS should feel fortunate that they can, to some extent, relative to advanced countries, avoid the stranded assets dilemma caused by the move towards a low-, zero-carbon society.

Finally, the global community, including international organisations and early-mover countries, engage in energy-related issues in Southeast Asia, which the AMS can leverage. Besides the inputs from the Economic Research Institute for ASEAN and East Asia (ERIA), some academic and policy-oriented documents are prepared with contributions from foreign and international units, which can serve as references for the AMS. Such documents include academic papers, such as (Overland et al., 2021) and 'Policy Brief' on the ACE website, issued by the ASEAN Climate Change and Energy Project (ACCEPT), both of which are funded by the Norwegian Government under the Norwegian–ASEAN Regional Integration Programme with joint implementation by ACE and the Norwegian

Institute of International Affairs; and the 'ASEAN Energy Outlook,' prepared by ACE with support from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH through the ASEAN–German Energy Programme.

The policy review and analysis in this chapter, together with the following chapters that present the real attitudes and WTP to energies amongst the AMS citizens, can serve as a reference for policy design or discourse shaping to guide society in support of sustainable energy transition.

Chapter 3

Methodology: Survey Design

1. Survey Overview

A series of household surveys were conducted in three cities in three countries to explore the willingness to pay (WTP) for renewables in the Association of Southeast Asian Nations (ASEAN) countries. A discrete choice experiment (DCE) was conducted in Bangkok (Thailand), Kuala Terengganu and Kuala Nerus (Malaysia), and Manila (the Philippines), and a contingent valuation method (CVM) was employed in Manila to investigate methodological influences.

Local researchers, in collaboration with the author, conducted each survey. Table 3.1 describes the survey period for each city. The survey instrument for the Philippines is presented in the Appendix as an illustration. The survey was influenced by the COVID-19 pandemic.

Table 3.1: Survey Period

City	Period
Bangkok	December 2020 to March 2021
Manila	December 2020 to April 2021
Kuala Terengganu and Kuala Nerus	February to March 2021

Source: Authors.

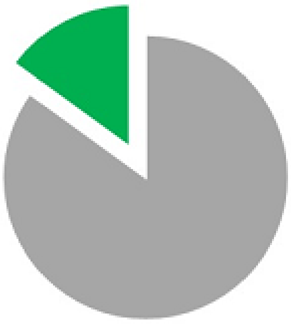
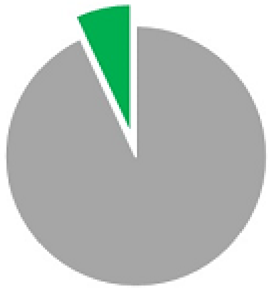
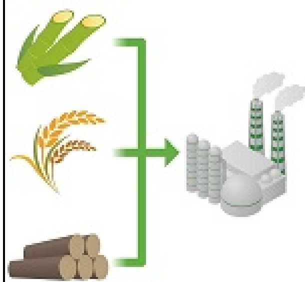
2. Discrete Choice Experiment

2.1. Theoretical Background

DCE and CVM are stated preference methodologies to measure the WTP of respondents. The stated preference method is appropriate for a hypothetical choice scenario with a smaller number of samples. Please see more details of theoretical backgrounds in Yoshikawa (2020).

The DCE asks respondents to choose from choice sets to elicit preferences. There are three alternatives (scenarios) in each choice set, and each set has a collection of attributes with defined levels (Table 3.1) Respondents are required to select the most preferred alternatives amongst the choice set.

Table 0.1: Sample Questions from the DCE Survey

Choice Set 1	**Alternative A**	**Alternative B**	**Alternative C (Status Quo)**
Renewable Energy (%)	25 % Renewable Energy 	15 % Renewable Energy 	7 % Renewable Energy 
Main Type of Renewable Energy	 Solar	 Biomass	 Solar
% Increase in Monthly Electricity Bill	Your monthly electricity bill will **increase** by **5%**	Your monthly electricity bill will **increase** by **5%**	No change

DCE = discrete choice experiment.

Source: Authors.

2.2. Attributes and Levels

Two common characteristics regarding the renewable energy (RE) policy were selected for the experiment—the RE share in future total generation capacity and the RE type with a higher share. For an easier understanding of the respondent, only one of these renewable sources will increase RE, even if the current share is collective. These attributes were designed at three to four levels depending on the circumstances of each country.

The price attribute was defined as the percentage increase in residents' monthly electricity bills. The increase in the monthly electricity tariff levels was determined per the results from the last phase (Yoshikawa, 2020). Table 3.3 displays the three attributes along with their corresponding levels.

Table 3.3: Attributes and Their Levels by Country

	Future Share of RE*	**Type of RE**	**Increase in Monthly Electricity Tariff**	**Status**
Thailand	15%/25%/35% in 2036 (current 9%)	Solar/Wind Biomass and waste/Small-scale hydropower	2%/5%/10%/15%/25%	9% by solar power
Philippines	35%/40%/45%/50% in 2030	Solar/Wind Biomass/ Small-scale hydropower	5%/10%/15%/20%/30%	30% by Large-scale hydropower and geothermal power
Malaysia	10%/15%/25%/35% in 2030	Solar/ Biomass/ Small-scale hydropower	2%/5%/10%/15%/25%	current 6% by solar power

RE = renewable energy.

* The target year of each country was set according to each government's plan, as explained below.

Source: Authors.

Thailand

The renewable share levels in Thailand were set at 15%, 25%, and 35%, unlike other countries. Given that the share of RE in 2014 was calculated as 9% of the total of solar, wind, small hydropower, geothermal, biomass, biogas, municipal solid waste, and energy crops, it seemed challenging for respondents to imagine only a percentage point increase. Based on the Thailand Power Development Plan 2015–2036 (PDP2015) (Ministry of Energy, 2015), the target share of the government in 2036 is projected as 33%. Further, RE definitions in PDP2015 vary from those used in this report and include large-scale and imported hydropower. Therefore, the RE share was fixed between the status quo and marginally above the government target. For simplicity, the survey combined various types of renewables such as biomass, biogas, municipal solid waste, and energy crops as 'biomass/waste.'

Philippines

The RE share in installed capacity is 29%, which is 4%, 2%, 1%, 8%, and 15% solar, wind, biomass, geothermal, and large-scale hydropower, respectively (DOE, 2019). We excluded large-scale hydropower when counting the RE share; however, for the Philippines, we include large-scale hydropower to calculate the current RE share for easier understanding. In the questionnaire, the current RE share is estimated as 30% rather than 29% for ease of comprehension. The target RE share is calculated based on RE-based capacity installation targets by 2030 (15,304.3 MW) DOE, 2011) and the total capacity of all sources in 2030 (31,215 MW) as a sum of capacity addition of all sources (17,338 MW) and existing capacity (13,877 MW) (Table 3.4) because there is no target RE share available. In the survey, the calculated target RE share (49%) was rounded to 50% for ease of comprehension. It includes large-scale hydropower in total RE share; however, in the questionnaire, respondents are asked to assume that the increase in RE share will be achieved via solar, wind, biomass, or small-scale hydropower.

Table 3.4: Capacity Installation Targets of the Philippines

	Total Installed Capacity by 2030		-	Source
Geothermal	3,461.0 MW	28.2%[4]		Department of Energy (2011)
Hydro	8,724.1 MW	11.1%		
Biomass	315.7 MW	0.9%		
wind	2,378.0 MW	7.6%		
solar	285.0 MW	1.0%		
Ocean	70.5 MW	0.2%		
Capacity addition of RE by 2030	15,304.3 MW	49.0%		
Capacity addition of all sources by 2030			17,338[1] MW	Department of Energy (2016)
Existing capacity of all sources			13,877[2] MW	
Total capacity in 2030			31,215[3] MW	

MW = megawatt, RE = renewable energy.

[1] Total of baseload capacity addition (1,150 MW), mid-merit addition (7,800 MW), and peaking (8,388 MW)

[2] Total of existing peaking and baseload power source

[3] Total of capacity addition of all sources (17,338 MW) and existing capacity (13,877 MW)

[4] 3,461 MW of geothermal capacity in 2030 divided by 31,215 MW of total capacity in 2030

Source: Collected by authors.

Malaysia

Currently, the installed RE capacity is 985 MW, which is 6% of the share in Malaysia, and the government targets to increase it by 4,000 MW (17%) in 2030 and 21.4 GW (73%) in 2050 (Chen, 2012). However, considering the recent surge in momentum to climate change, the target seems slow. Thus, we set the maximum level of share of RE in 2030 to 35%.

Blocks and Choice Sets

We produced the necessary combinations of choice sets using the numerical analysis software, MATLAB. We set seven to eight choice sets per respondent, as the response quality degrades when eight to 16 comparisons are made (Pearmain and Kroes, 1990). Choice sets assigned to each respondent comprise a block. A block is configured such that the number of occurrences of alternatives is equal. Table 0.2 shows the number of alternatives, choice sets, and blocks.

Table 0.2: Number of Choice Sets and Blocks for Each Country

	Blocks	Choice Sets
Malaysia	11	86
Thailand	12	91
Philippines	11	87

Source: Authors.

Sample size

A certain number of sample sizes are needed to evaluate the WTP in DCEs. Kuriyama, Tsuge, and Shoko (2013) reported that 200 samples are sufficient for statistical analysis in DCEs. We followed the formula (3–1) provided by de Bekker-Grob et al. (2015).

$$\frac{nta}{c} > 500, \quad (3-1)$$

where *n* is the number of respondents, *t* is the number of tasks, *a* is the number of alternatives, and *c* is the largest number of attribute levels.

For our design, *c* = 5, *t* = 7 (minimum), and a = 2 because the status quo alternative should not be counted. Therefore, we determined that the number of respondents should be *n* > 178.6, and we collected 250 to 300 samples for each country.

2.3. Contingent Valuation Method

In addition to DCE, a survey based on contingent valuation method was conducted in the Philippines to check the robustness of the results to the survey method. We employed a double-bounded dichotomous choice approach as in the previous year. The sample size was taken to be 250.

In the survey, a scenario of renewable expansion from the current level of 30% to 50% was presented to respondents, and respondents were invited to answer two bidding questions. The bid levels were chosen as follows:

- For the first WTP question: 5, 10, 15, 20, 30 (% increase in monthly electricity bill); and
- For the second WTP question: 2, 5, 10, 15, 20, 30, 40 (% increase in monthly electricity bill).

See the Appendix for the details of the survey.

Chapter 4

Sampling Strategy

1. Introduction

This chapter summarises the sampling strategies adopted for each city examined in this research. Therefore, it describes the approaches adopted to identify the respondents to avoid sampling bias, which would compromise the validity of generalising the WTP results to the entire population surveyed (the cities for this research). The sampling strategy depends on the available data to the researchers. Hence, differences exist between cities. The design was such that all households would have the closest possible probability to be identified as respondents for the survey, hence avoiding sampling bias as much as possible. The preferable method was to count with a comprehensive sampling frame from which direct random sampling can be realised. However, this was only possible for Ho Chi Minh City. The research teams in each of the three cities adopted a multi-stage stratified sampling. It is a common approach in WTP studies where an adequate sampling frame is not available. Table 4.1 summarises the sampling approaches adopted for each city and the different levels considered for the multi-stage stratified sampling.

Table 4.1: Summary of Sampling Strategies

City (Country)	Sampling approach	Stratification
Bangkok (Thailand)	Multi-stage stratified	Administrative zones -> District -> Sub-district
Ho Chi Minh City (Viet Nam)	Simple random	-
Manila (Philippines)	Multi-stage stratified	District -> City
Kuala Nerus, Kuala Terengganu (Malaysia)	Multi-stage stratified	District

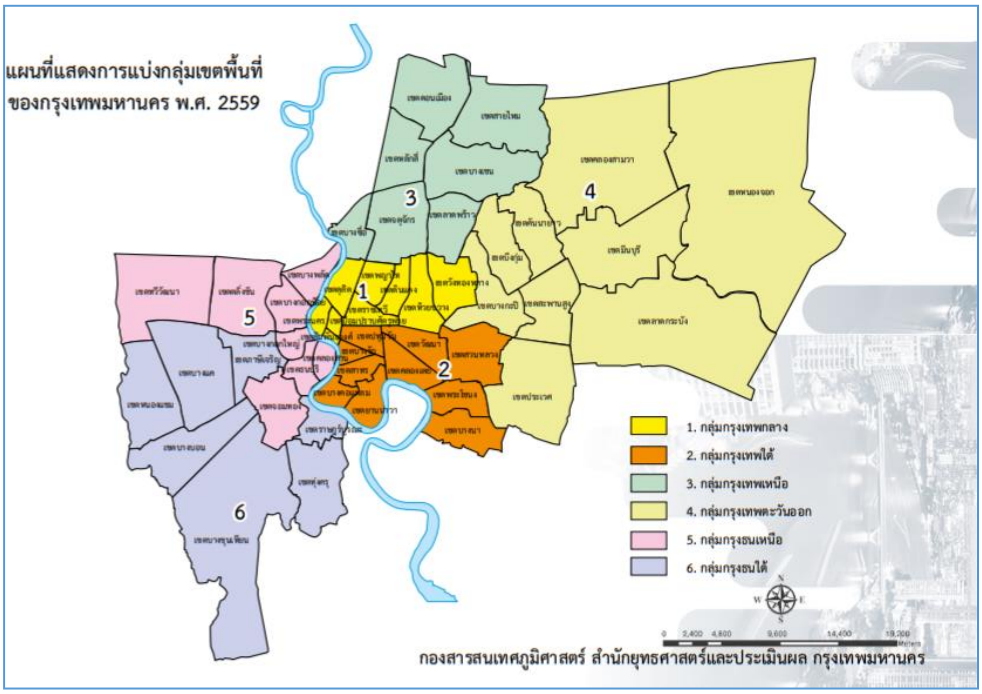
Source: Authors.

The rest of the chapter provides further details for each city and the sampling approaches from the research teams.

2. Thailand — Bangkok

The city of Bangkok has an area of 1,569 square kilometres (km[2]), a population of 5.6 million, and 2.8 million registered households. Bangkok has 50 districts; the Chao Phraya River divides Bangkok and Thonburi. The Bangkok Metropolitan Administration is organised per the Bangkok Metropolitan Administration Act 1985 and is responsible for managing Bangkok. The Bangkok Metropolitan Administration divides the city into six administrative zones: Central Bangkok, South Bangkok, North Bangkok, East Bangkok, North Thonburi, and South Thonburi (Figure 4.1).

Figure 0.1: Administrative Zones of the Bangkok Metropolitan Area



Notes: Central Bangkok (CB): yellow, comprises nine districts, South Bangkok (SB): orange, comprises 10 districts, North Bangkok (NB): light blue, comprises seven districts, East Bangkok (EB): light brown, comprises nine districts, North Thonburi (NT): pink, comprises eight districts, South Thonburi (ST): purple, comprises seven districts.

Source: Bangkok Metropolitan Administration (2020).

Multi-stage sampling was applied to the study to ensure the random selection of districts and sub-districts as follows (Table 4.1):

- Stage 1: Division into six administrative zones: Central Bangkok, South Bangkok, North Bangkok, East Bangkok, North Thonburi, and South Thonburi
- Stage 2: Random selection of two districts from each zone
- Stage 3: Random selection of two sub-districts from each district
- Stage 4: Random selection of two communities from each sub-district
- Stage 5: Simple random sampling and area-based sampling for households

Table 4.2: Overview of Randomly Selected Sub-districts

Zone	District	Sub-district	No. of Households	Character
Central Bangkok	Ratchathewi	Thanon Phyathai	11,621	CBD
		Thanon Petchaburi	11,607	CBD
	Din Daeng	Din Daeng	37,059	Residential
		Ratchadaphisek	24,151	CBD
South Bangkok	Wattana	Klong Toei Nue	17,301	CBD
		Klong Tan Nue	38,668	CBD
	Bang Na	Bang Na Nue	33,350	Residential
		Bang Na Tai	37,060	Residential
North Bangkok	Laksi	Tung Song Hong	39,641	Residential
		Talad Bangkhen	17,742	Residential
	Bangkhen	Anusawari	59,025	Residential
		Tha Reang	53,589	Residential
East Bangkok	Lad Krabang	Klong Songtonnoon	32,784	Industrial and residential
		Thab Yao	17,825	Industrial and residential
	Prawet	Prawet	35,922	Suburban and residential
		Nong Bon	23,813	Suburban and residential
North Thonburi	Thawee Wattana	Thawee Wattana	8,973	Suburban and agriculture
		Salathamm	24,922	Suburban new residential
	Taling Chan	Taling Chan	11,351	Suburban and agriculture
		Chim Plee	9,516	Suburban and agriculture
South Thonburi	Bang Khae	Bang Phai	14,597	Suburban and agriculture
		Lak Song	24,661	Suburban and agriculture
	Nong Khem	Nong Khem	30,333	Suburban and new residential
		Nong Khang Plu	31,549	Suburban and new residential

CBD = central business district.

Source: Authors.

Sampled households were randomly selected on the allocated target main road in each of the selected sub-districts (Table 4.3). The selection steps were as follows.

- Step 1: The enumerator goes to the designated main roads and randomly chooses the first household.
- Step 2: The enumerator introduces themselves to the respondent and invites the respondent to participate in the survey.
- Step 3: The enumerator provides the consent information in the questionnaire to the respondent.
- Step 4: The enumerator asks to look and take a photo of the latest electricity bill.
- Step 5: When the interview ends, the enumerator provides an incentive to the respondent, asks permission to take a photo, and goes to the next household randomly, which may be at least three houses away from the previous house.

If a respondent refused to respond at any steps mentioned earlier, the enumerator moved randomly to the next household.

Table 4.3: Multi-stage Stratified Sampling in Bangkok

Zone	District	Sub-district	No. of Households	No. of Samples	Main Road
Central Bangkok	Ratchathewi	Thanon Phyathai	11,621	9	Phyathai
		Thanon Petchaburi	11,607	9	Petchaburi
	Din Daeng	Din Daeng	37,059	12	Asoke-Din Daeng
		Ratchadaphisek	24,151	10	Ratchadaphisek
South Bangkok	Wattana	Klong Toei Nue	17,301	9	Asoke Montri
		Klong Tan Nue	38,668	12	Sukhumvit
	Bang Na	Bang Na Nue	33,350	11	Sukhumvit
		Bang Na Tai	37,060	12	Bang Na Trad
North Bangkok	Laksi	Tung song hong	39,641	12	Ngam Wong Wan
		Talad Bangkhen	17,742	9	Chaeng Wattana
	Bangkhen	Anusawari	59,025	14	Ram Indra
		Tha Reang	53,589	14	Ram Indra
East Bangkok	Lad Krabang	Klong Songtonnoon	32,784	11	Sri-Nakharin Romklao
		Thab Yao	17,825	9	Pracha Pattana
	Prawet	Prawet	35,922	11	Pattanakarn
		Nong Bon	23,813	10	Sri-Nakharin

North Thonburi	Thawee Wattana	Thawee Wattana	8,973	8	Putthamonton sai 3
		Salathamm	24,922	10	Putthamonton sai 2
	Taling Chan	Taling Chan	11,351	9	Ratchapruk
		Chim Plee	9,516	8	Putthamonton sai 1
South Thonburi	Bang Khae	Bang Phai	14,597	9	Putthamonton sai 2
		Lak Song	24,661	10	Petchkasem 69
	Nong Khem	Nong Khem	30,333	11	Liab Klong Phasi Charoen
		Nong Khang Plu	31,549	11	Putthamonton sai 3

Source: Authors.

3. Malaysia – Kuala Nerus and Kuala Terengganu

In Malaysia, the sampling area included the districts of Kuala Nerus and Kuala Terengganu within the Terengganu State in West Malaysia. The distribution of respondents between the two districts was decided based on the number of households residing in each (Table 4.4). For ease of computation, the number of samples in Kuala Terengganu District was set at 60% of the total samples surveyed (180), and the number of samples in the Kuala Nerus District was 40% (120). The choice sets were grouped into blocks, and each block was equally allocated. Blocks 9 and 11 were the exception since there are only seven choice sets rather than eight (Table 4.5). Further, two households with business operations in each block were interviewed in each district. Respondents were convenient-sampled.

Table 4.4: Overview of the Sampling Area

District	Number of Households	Share of Total	Number of Samples
Kuala Terengganu	51,778	63	190
Kuala Nerus	30,397	37	110
Total	**82,175**	**100**	**300**

Source: Department of Statistics (2020).

Table 4.5: Number of Samples in Each District

Block	Choice Set	Choice Set Number	Kuala Terengannu District	Kuala Nerus District	Total
1	8	1, 2, ..., 8	16	10	26
2	8	1, 2, ..., 8	16	10	26
3	8	1, 2, ..., 8	16	10	26
4	8	1, 2, ..., 8	16	10	26
5	8	1, 2, ..., 8	16	10	26
6	8	1, 2, ..., 8	16	10	26
7	8	1, 2, ..., 8	16	10	26
8	8	1, 2, ..., 8	16	10	26
9	7	1, 2, ..., 7	18	15	33
10	8	1, 2, ..., 8	16	10	26
11	7	1, 2, ..., 7	18	15	33
		Total	**180**	**120**	**300**

Source: Authors.

4. The Philippines – Manila

Metropolitan Manila (MM), officially the National Capital Region in the Philippines, is one of 17 regions in the Philippines. MM is the political, economic, social, and cultural centre of the Philippines. It is one of the more modern metropolises in Southeast Asia and is amongst the world's 30 most populous metropolitan areas. Covering an area of 620 km^2, MM is the smallest of the country's 17 regions. It is, however, the second-most populous (12.9 million in 2015, 13% of the entire Philippine population) and the most densely populated (20,784 per km^2 in 2015). MM is composed of 16 highly urbanised cities and one municipality. It is divided into four geographic areas called districts: Capitol District, Eastern Manila District, Northern Manila District, and Southern Manila District. Table 4.6 shows the cities comprising the four districts. Only the Capitol District comprises just a city — Manila.

Table 0.1: Administrative Division of Metropolitan Manila

District/Cities	Area (km^2)	Population	Share in Metro Manila Population (%)	Population Density
Capitol District	**42.88**	**1,780,148**	**13.8**	**41,515**
Manila	42.88	1,780,148	13.8	41,515
Eastern District	**236.36**	**4,650,613**	**36.1**	**19,676**
Mandaluyong	11.06	386,276	3.0	34,925
Marikina	22.64	450,741	3.5	19,909
Pasig	31.46	755,300	5.9	24,008
Quezon City	165.33	2,936,116	22.8	17,759
San Juan	5.87	122,180	0.9	20,814
Northern District	**126.42**	**2,819,388**	**21.9**	**22,302**
Caloocan	53.33	1,583,978	12.3	29,701
Malabon	15.96	365,525	2.8	22,903
Navotas	11.51	249,463	1.9	21,674
Valenzuela	45.75	620,422	4.8	13,561
Southern District	**208.28**	**3,627,104**	**28.2**	**17,415**
Las Pinas	32.02	588,894	4.6	18,391
Makati	27.36	582,602	4.5	21,294
Muntinlupa	41.67	505,509	3.9	12,131
Paranaque	47.28	664,822	5.2	14,061
Pasay	18.64	416,522	3.2	22,346
Pateros	1.76	63,840	0.5	36,273
Taguig	45.18	804,915	6.3	17,816
Metro Manila	**619.57**	**12,877,253**	**100.0**	**20,784**

km^2 = square kilometre.

Sources: Philippine Statistics Authority (2015); Philippine Institute of Volcanology and Seismology (2013).

The Philippine survey employed a multi-staged stratified sampling procedure (Table 4.7). The four districts of Metro Manila comprise the first-stage stratification of the population. Each district (first-stage stratum) was then stratified into its cities (second-stage strata). For each district, a representative city was selected from which the district sample is drawn. For the Capitol District, it was Manila (the sole city in the district); for the Eastern District, Quezon City; for the Northern District, Caloocan City; and for the Southern District, Makati City. All four cities are the principal cities in their respective districts, with mixed residential, commercial, and industrial areas. Except for Makati, all have the highest population in their respective districts. Quezon City, Manila, and Caloocan are also the three largest cities in Metro Manila regarding population and area. The number of respondents in each of the four cities is proportional to the share of the city in the region's population.

Table 4.7: Summary of Surveyed Districts and Distribution of Respondents

District	City	Population	Share	No. of respondents
Capitol	Manila	1,780,148	25.86	64
Eastern	Quezon City	2,936,116	42.66	107
Northern	Caloocan City	1,583,978	23.01	58
Southern	Makati	582,602	8.46	21
Total		**6,880,844**	**100**	**250**

Source: Authors.

Respondents for this survey were gathered from predominantly residential barangays in the cities, selecting only households with metered connections to the local power utility, Manila Electric Railroad and Light Company (MERALCO). Sample households were drawn from barangays, the smallest administrative units in the Philippines, that comprise a mix of low-, middle-, high-income household residents. Respondents from each barangay were chosen using systematic sampling (Palanca-Tan, 2017). The barangay's office provided support to conduct the survey. These provided maps that were employed to identify the starting points for the sampling. Enumerators were instructed to approach the first household encountered around the starting point. In the case that one potential refuse to participate, the nearest house was approached. Every succeeding respondent approached must be at least the 20th house from the last responding household. When required, the surveys were conducted via face-to-face online communication because of mobility restrictions (respondents could see the enumerator but in an online environment).

Chapter 5

Descriptive Results

1. Overview

This chapter provides an overview of the descriptive statistics of the responses. The number of respondents in each country is as follows: Thailand: n=250, Malaysia: n=300, and the Philippines: n=500.

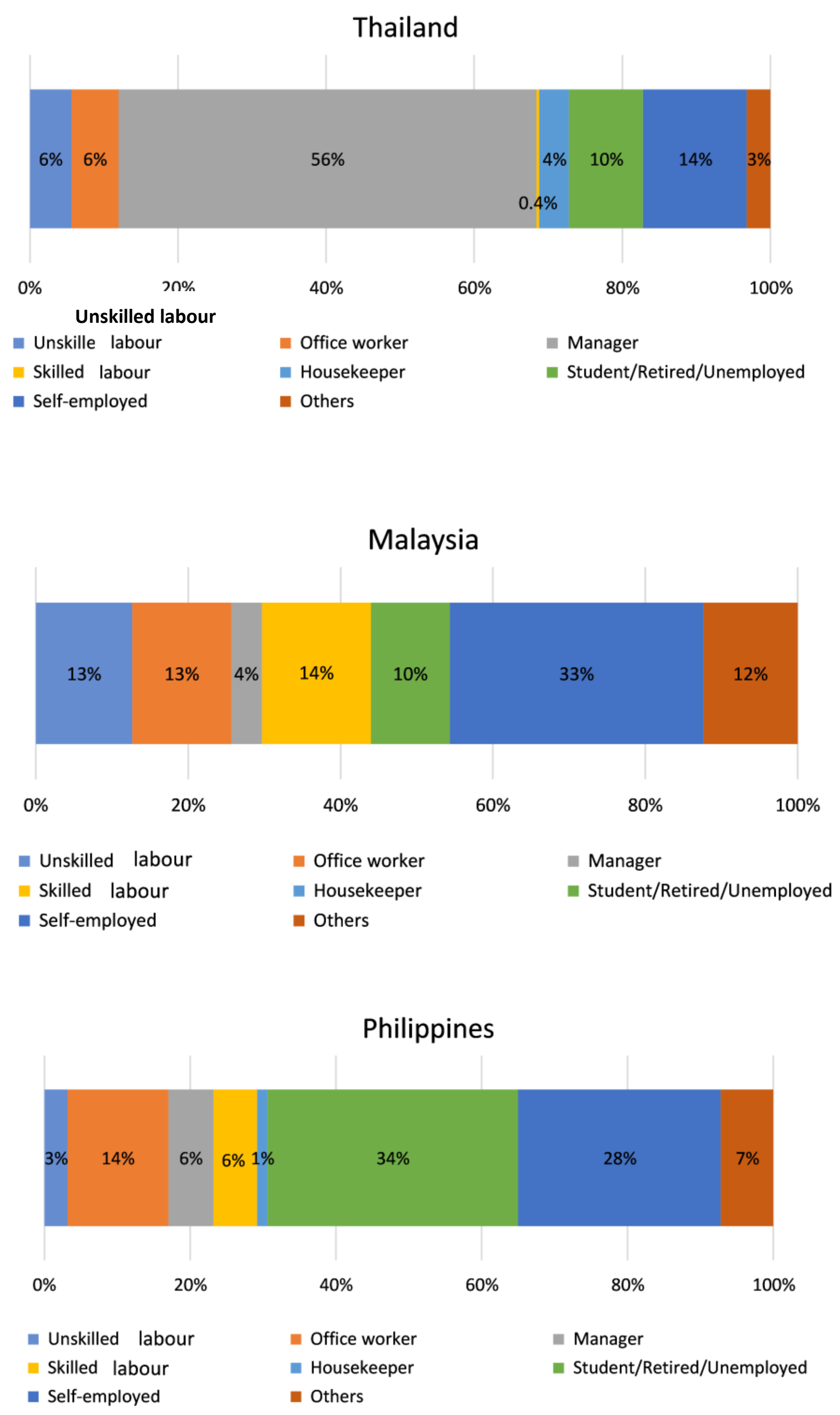
Table 5.1 and Figure 5.1 show the employment status of all respondents in all regions. Common occupation status differs by country. The most common occupations are as follows: manager (56%) in Thailand, self-employed (33%) in Malaysia, students, retired, or unemployed (34%) in the Philippines, followed by self-employed in Thailand and the Philippines (14% and 28%, respectively) and skilled labour (14%) in Malaysia.

Table 5.1: Occupation of Respondents in all Regions

Country	**Thailand (n=250)**		**Malaysia (n=300)**		**Philippines (n=500)**	
Country-specific question No.	Q34		p4Q39		PART4 Q7	
	Number of respondents	%	Number of respondents	%	Number of respondents	%
1. Unskilled labour	14	6%	38	13%	16	3%
2. Office worker	16	6%	39	13%	69	14%
3. Manager	141	56%	12	4%	31	6%
4. Skilled labour	1	0.4%	43	14%	30	6%
5. Housekeeper	10	4%	0	0%	7	1%
6. Student/Retired/ Unemployed	25	10%	31	10%	172	34%
7. Self-employed	35	14%	100	33%	139	28%
8. Others	8	3%	37	12%	36	7%
Blank	0	0%	0	0%	0	0%
SUM	250	100%	300	100%	500	100%

Source: Authors' calculation.

Figure 5.1: Respondent Occupation Percentages

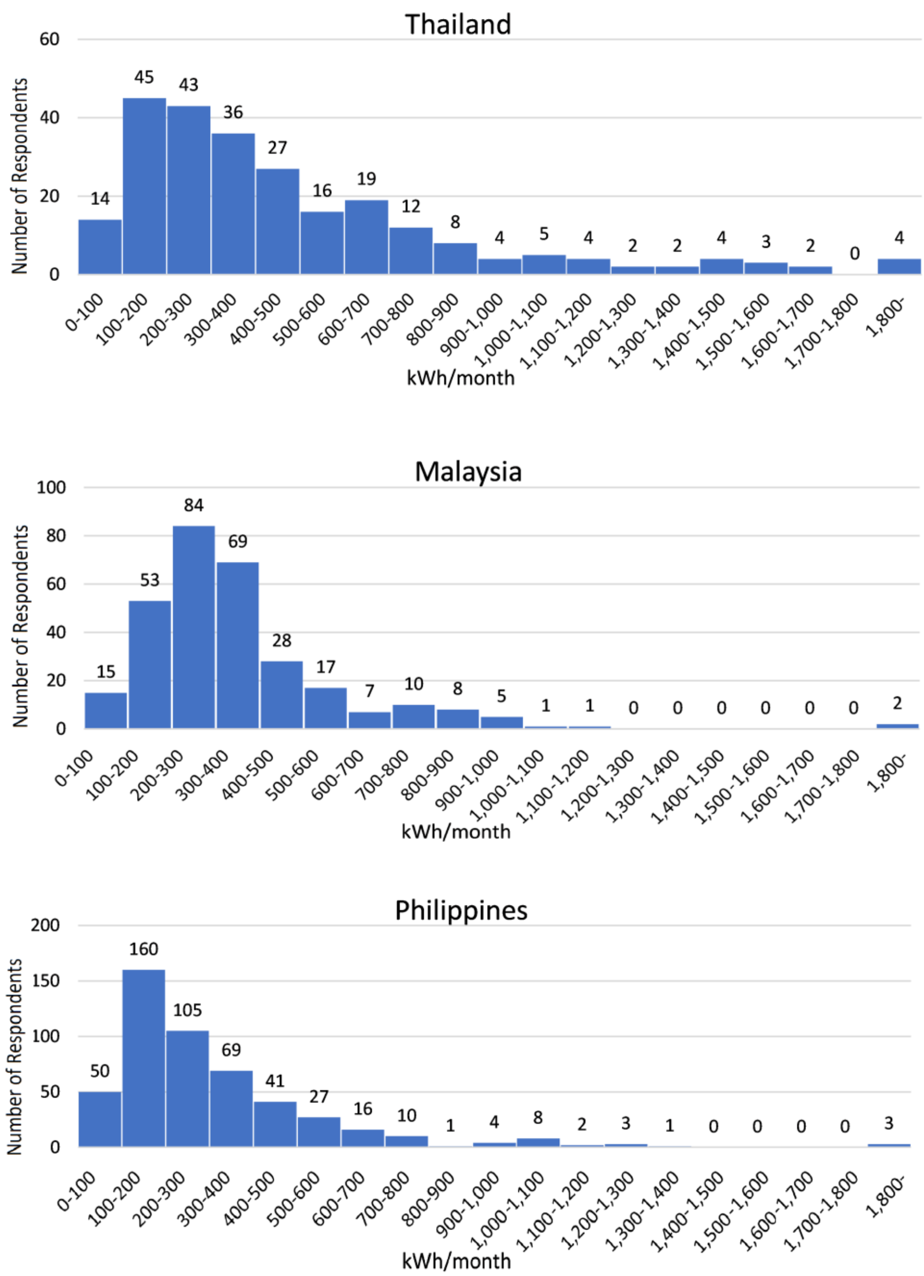


Source: Authors’ calculation.

2. Monthly Electricity Consumption

Figure 5.2 shows the electricity consumption per month in each country. The highest concentration of monthly electricity consumption ranged from 100–200 kilowatt hour (kWh)/month in Thailand and the Philippines and 200–300 kWh/month in Malaysia.

Figure 5.2: Electricity Consumption



kWh = kilowatt hour.

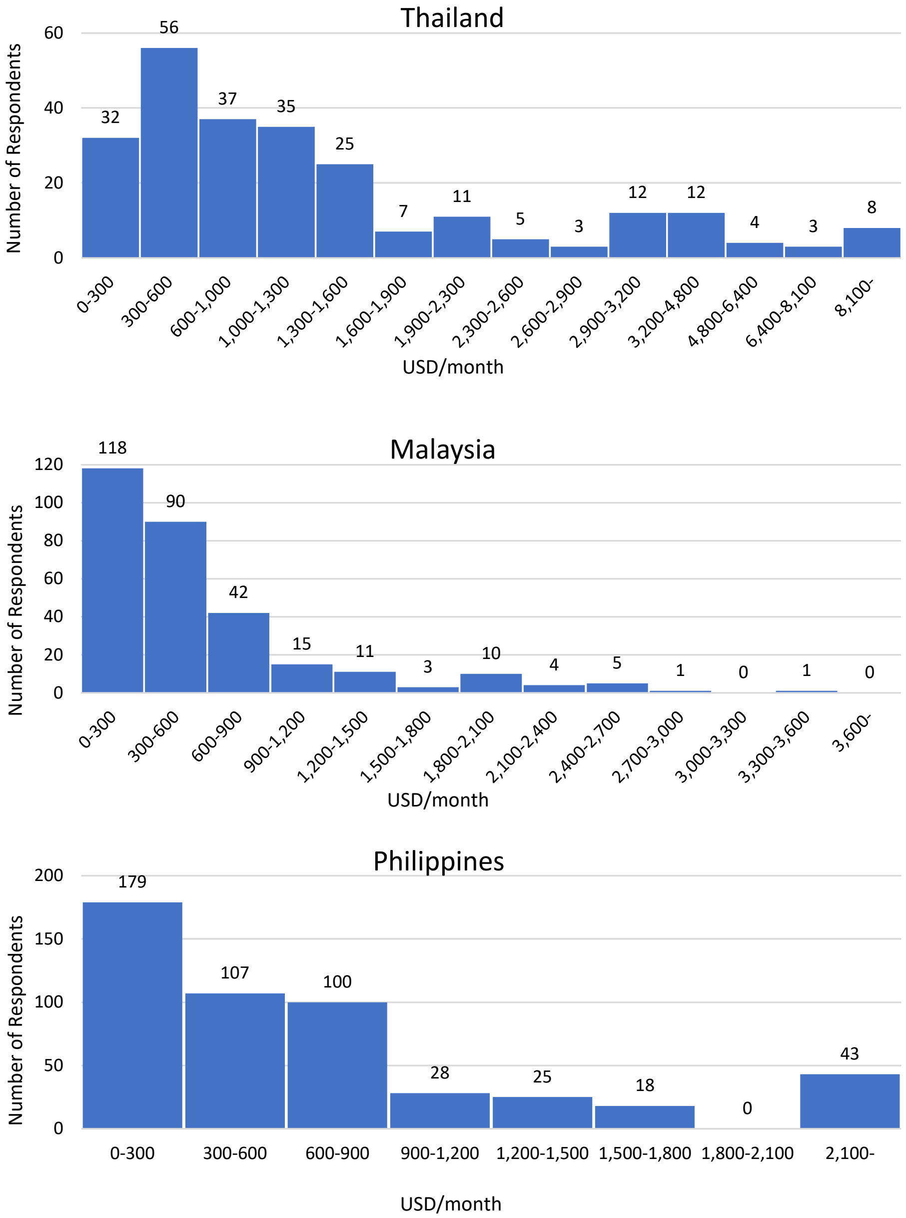
Source: Authors' calculation.

3. Monthly income

Figure 5.3 shows the monthly income in each country. The highest concentration of income ranged from USD300–600/month in Thailand and USD0–300/month in Malaysia and the Philippines. The gap between high- and low-income populations is greatest in Thailand.

The distribution of monthly electricity consumption does not follow a similar pattern as the monthly income distribution in the three examined regions.

Figure 5.3: Distribution of Monthly Income

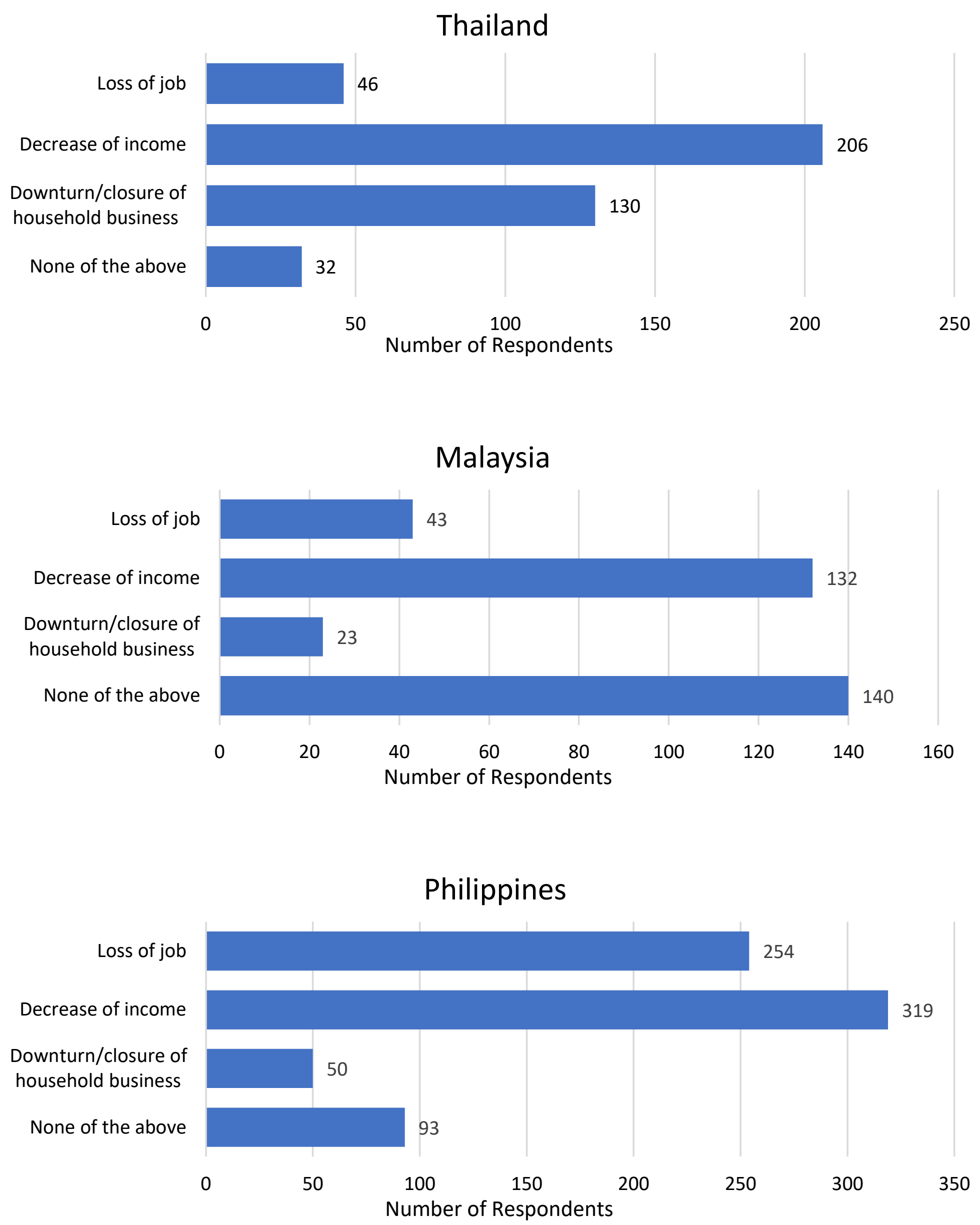


Source: Authors' calculation.

4. Effects of COVID-19

As noted, the survey was conducted during the COVID-19 pandemic. Figure 5.4 shows the results on the effects of COVID-19 on the respondents. In all countries, many respondents selected 'Decrease of income.' In the Philippines, the number of respondents who selected 'Loss of job' was also high. In Malaysia, about half of the respondents did not select 'Decrease of income' or 'Loss of job.'

Figure 5.4: Effects of the COVID-19 Pandemic

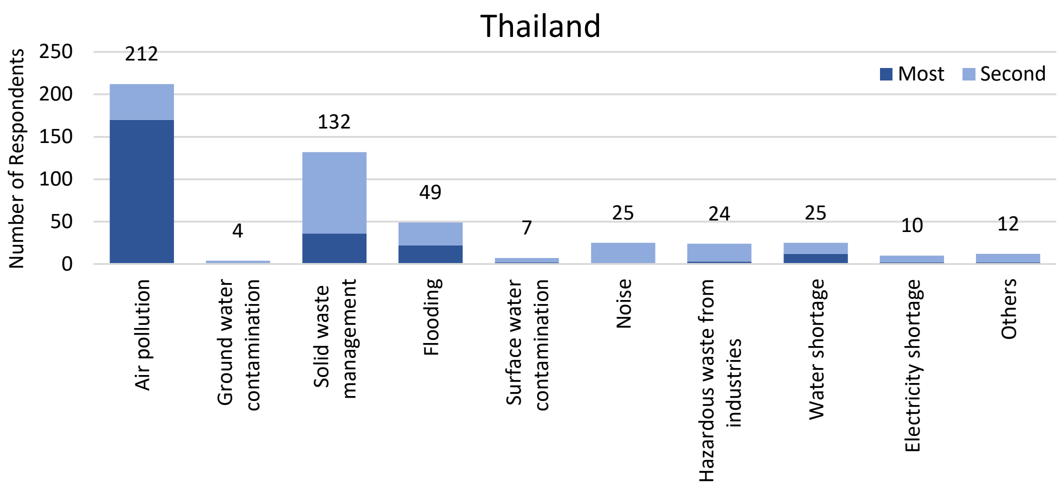


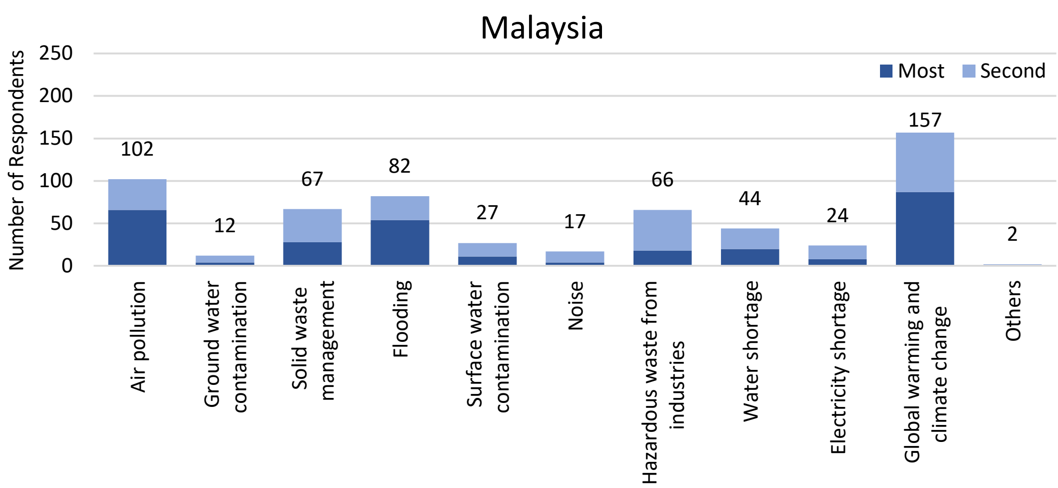
Source: Authors' calculation.

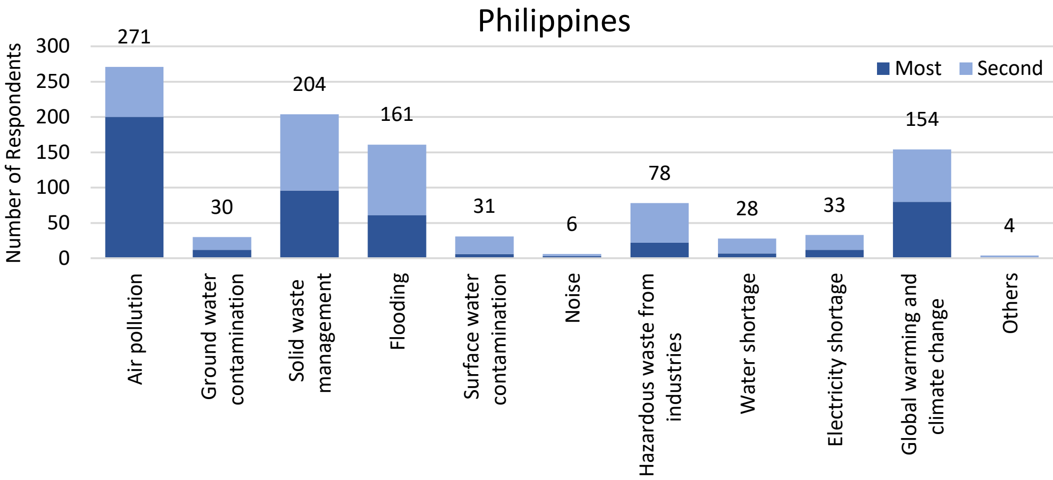
5. Attitudes Towards Environmental Issues

Figure 5.5 shows the environmental issues considered most and second-most important by respondents. Air pollution was a serious environmental problem in Thailand and the Philippines. In Thailand, most respondents selected 'Air pollution' as the most important. This trend follows the 2020 results in the country. In Malaysia, the largest number of respondents selected 'Global warming and climate change' as the most and second-most important. In the 2020 survey in Viet Nam, Thailand, Myanmar, and Lao People's Democratic Republic, this trend was not observed; thus, people seem to pay more attention to global warming and climate change.

Figure 0.1: Perceived Importance of Environmental Issues





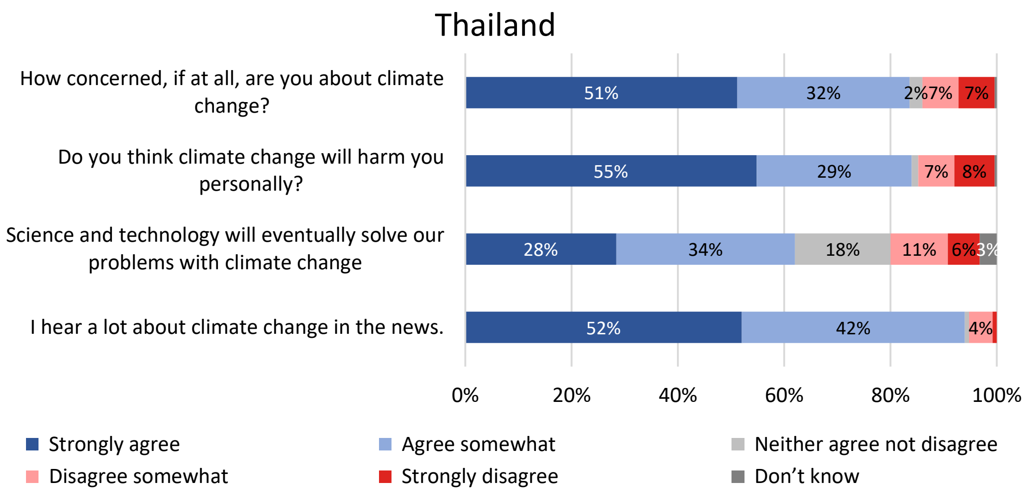


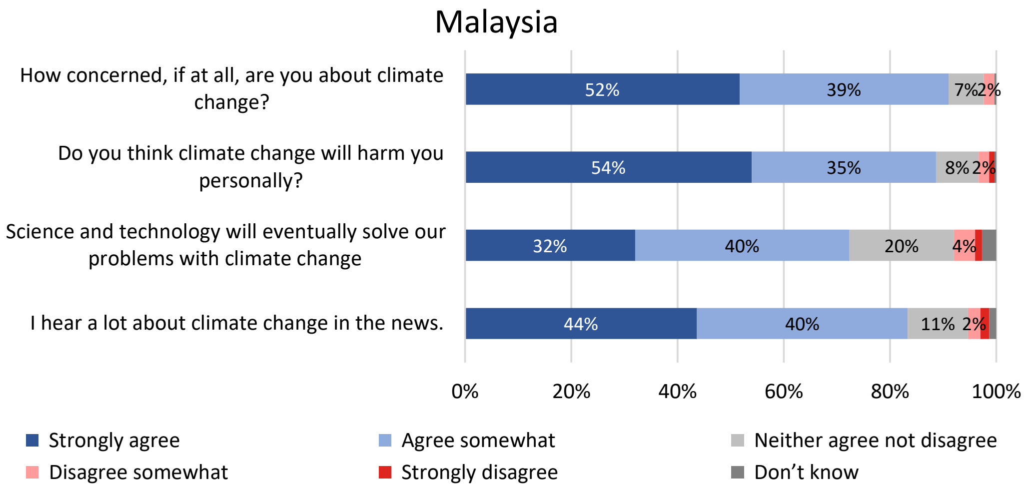
Note: 'Global warming and climate change' was not included in Thailand's questionnaire.

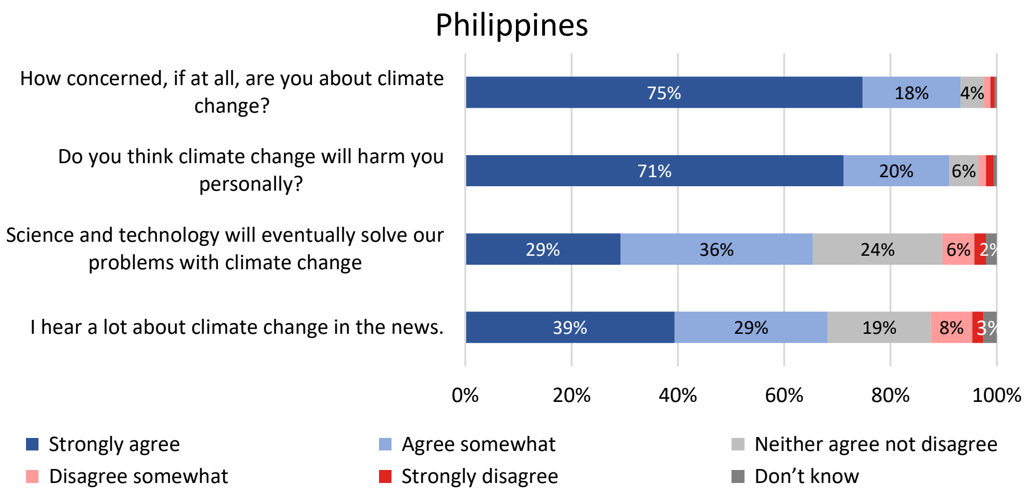
Source: Authors' calculation.

Figure 5.6 shows the attitudes towards climate change in the three countries. In the Philippines, respondents were more strongly concerned about the effects of climate change than Thailand and Malaysia. Respondents who answered 'Strongly agreed' to the first and second questions were 75% and 71%, respectively. In Thailand and Malaysia, a similar pattern was observed in the answers for the first and second questions. For the third question, respondents in the three countries showed identical patterns.

Figure 5.6: Attitudes Towards Climate Change Issue





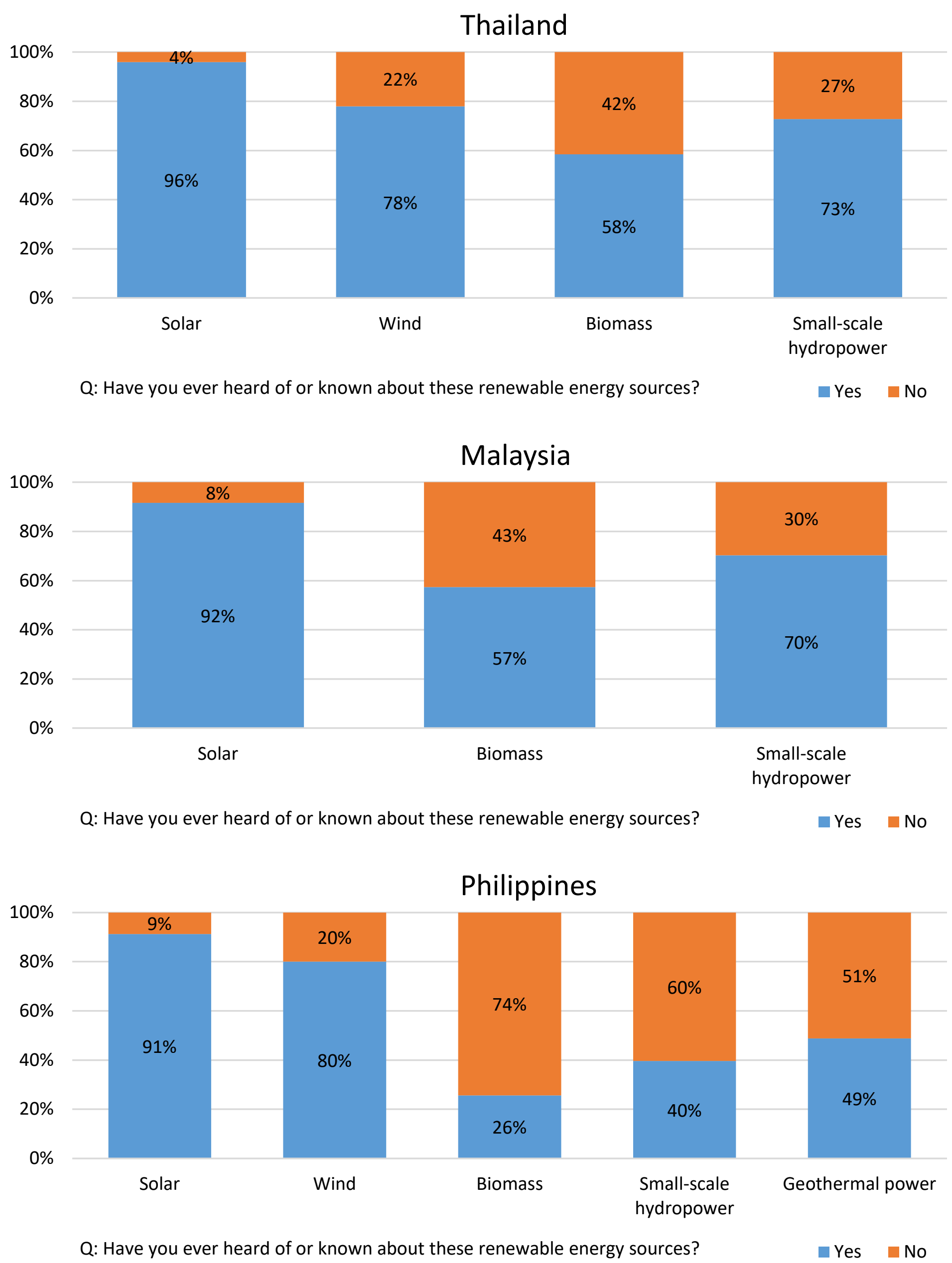


Source: Authors' calculation.

6. Attitudes Towards Types of Renewable Energy

Figure 5.7 shows people’s knowledge about renewable energy sources. Solar was the most popular, with over 90% answering ‘Yes’ in all countries. Biomass was least well known in all countries, especially in the Philippines, where only 26% of respondents answered ‘Yes.’

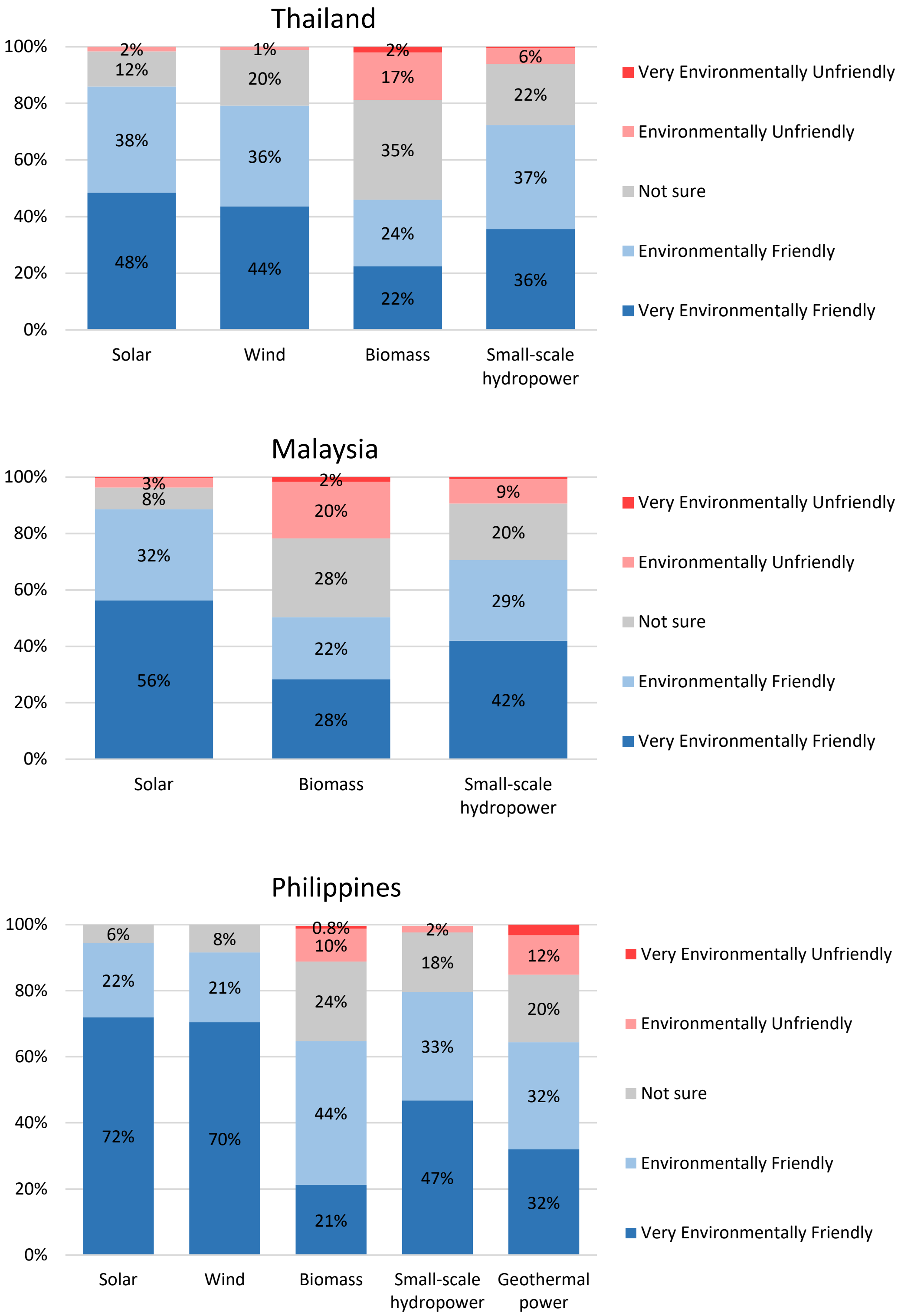
Figure 5.7: Knowledge About Renewable Energy Sources



Source: Authors’ calculation.

Figure 5.8 shows the proportions of respondent evaluations regarding RE types. In all regions, solar energy was considered most environmentally friendly, with solar considered as more environmentally friendly in Thailand (48% responded ‘very environmentally friendly’), Malaysia (56% responded ‘very environmentally friendly’), and the Philippines (72% responded ‘very environmentally friendly’). Wind power was also considered environmentally friendly in both Thailand and the Philippines. Respondents expressed more concerns regarding biomass in Thailand (17% responded ‘environmentally unfriendly’), Malaysia (20% responded ‘environmentally unfriendly’), and the Philippines (10% responded ‘environmentally unfriendly’). The same pattern was observed in the last year’s survey, where solar and wind were considered more environmentally friendly, and biomass was considered less environmentally friendly in all regions.

Figure 5.8: Attitudes Towards Renewable Energy

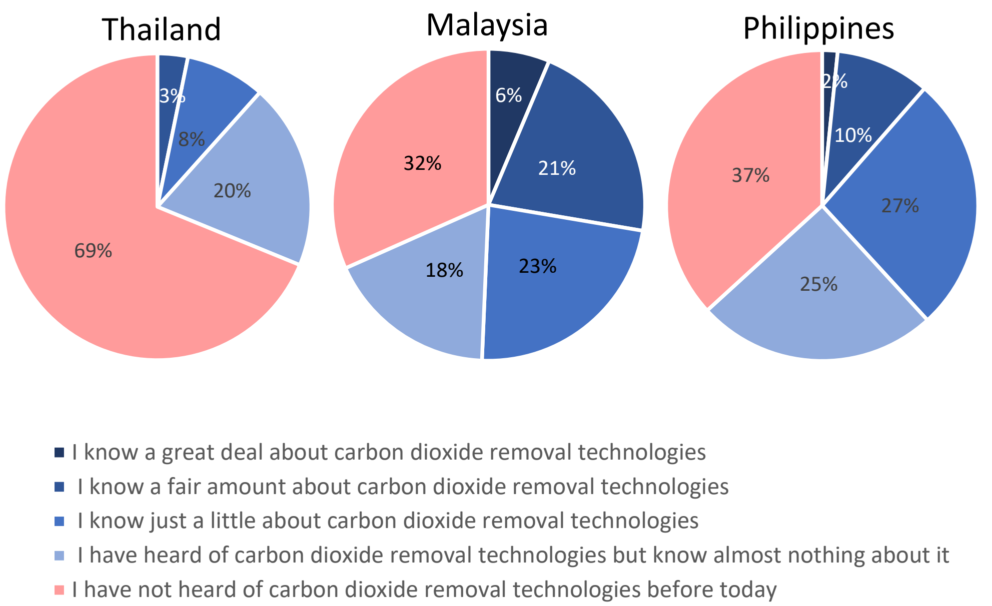


Source: Authors' calculation.

7. Attitudes Towards Carbon Dioxide Removal Technologies

Figure 5.9 shows people's knowledge about carbon dioxide removal (CDR) technologies. In Malaysia and the Philippines, 27% and 12%, respectively, answered 'I know a great deal about [CDR] technologies' and 'I know a fair amount about [such] technologies,' with over 60% of respondents saying they have at least heard of them. However, in Thailand, the largest share of respondents (69%) answered 'I have not heard of them,' which was the largest share amongst the three countries.

Figure 5.9: Knowledge of CDR Technologies

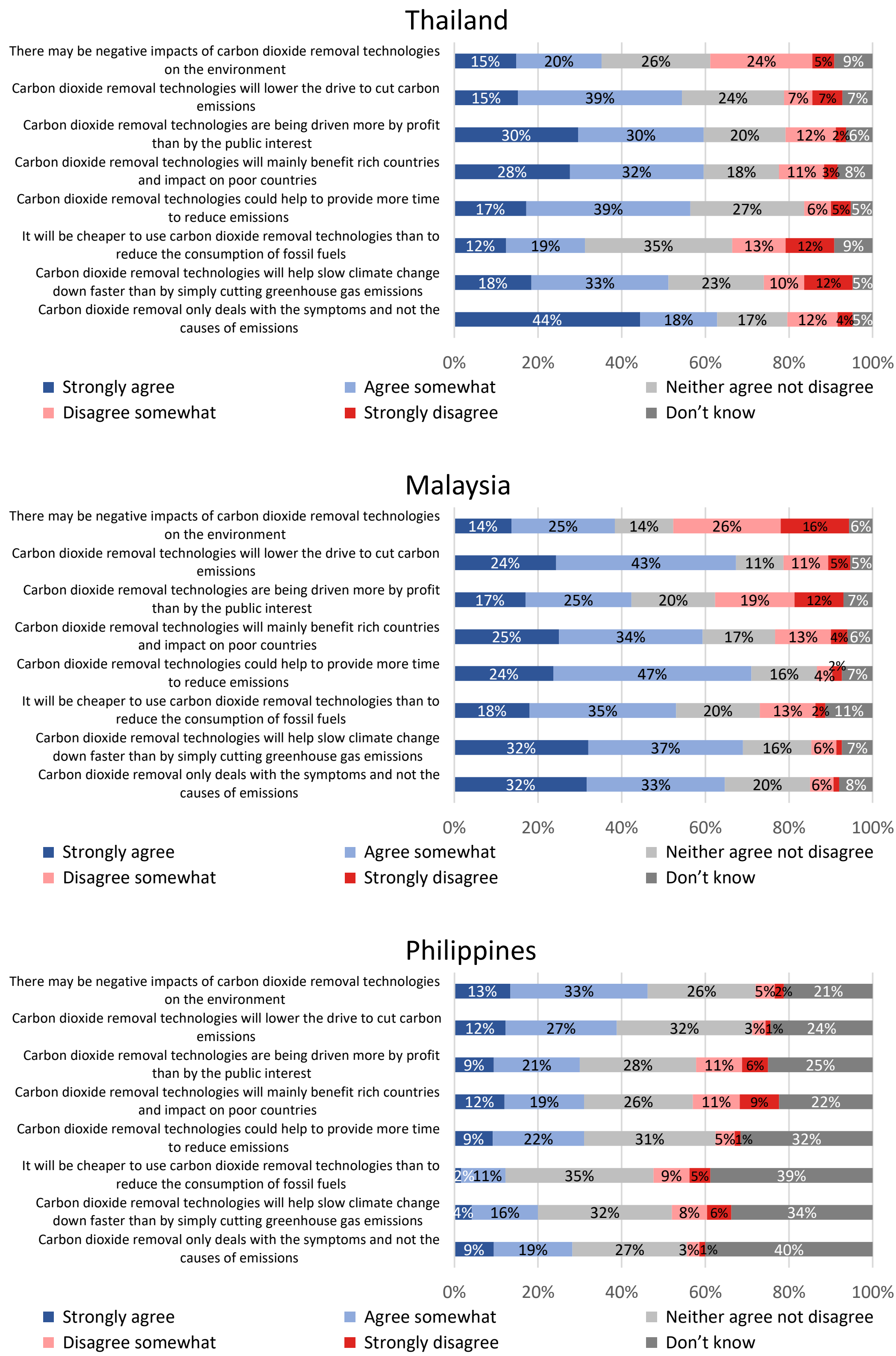


CDR = carbon dioxide removal.

Source: Authors' calculation.

Figure 5.10 shows the attitudes towards the risks and benefits of CDRs in the three countries. In the Philippines, the proportion of respondents who answered 'Neither agree nor disagree' to all questions was about 30%, more neutral than in other countries. The highest support came from Malaysia, where 71% of respondents answered either 'Strongly agree' or 'Agree somewhat' to the statement of '[CDR] technologies could help […] provide more time to reduce emissions.'

Figure 5.10: Attitudes Towards CDR Technologies

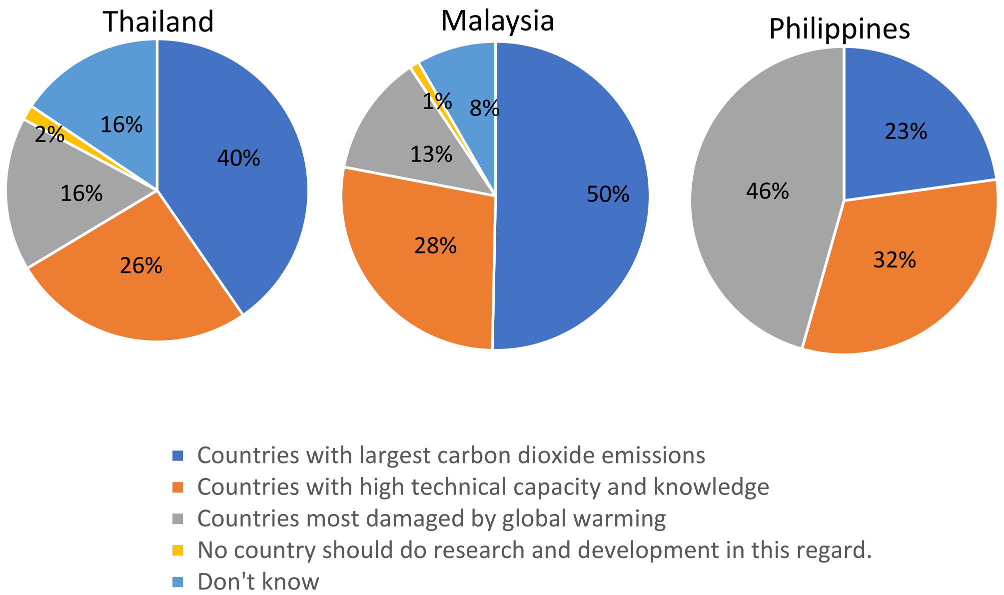


CDR = carbon dioxide removal.

Source: Authors' calculation.

Finally, Figure 5.11 shows the attitudes towards the future of CDR research and development in the three countries. In Thailand and Malaysia, the highest share of respondents answered that the countries with the largest carbon dioxide emissions should be foremost in developing carbon removal technologies, with 40% and 50% respectively. In the Philippines, the highest share of respondents (46%) answered that the countries most damaged by global warming should be foremost in developing such technologies.

Figure 5.11: Answer to 'In your Opinion, what Countries Should be at the Foremost in the Development of Carbon Removal Technology?'



Note: 'No country should do research and development in this regard' and 'Don't know' was not included in the questionnaire for the Philippines.

Source: Authors' calculation.

Chapter 6

Analysis of Survey Results on the Willingness to Pay for Renewable Energy in Five ASEAN Cities

This chapter analyses the results of the willingness to pay (WTP) survey for renewable energy (RE) in five ASEAN cities.

1. Discrete Choice Model Results

1.1. Regression Analysis

As shown in the previous chapter, the sample covered 800 households (Thailand: 250, Malaysia: 300, Philippines: 250). From this sample, households with outlier values of the monthly electricity bill have been excluded for the purpose of the following regression analysis.

We estimated household the WTP using the conditional logit. The utility was assumed to be a linear function of attributes of RE share and price. RE types, including solar, biomass, hydropower, wind, mini-hydro, and small-scale hydro, were represented by dummy variables. Solar (Thailand and Malaysia) and hydro and geothermal (Philippines) were considered the status quo type in the model. Mathematically, for respondent *i*, the utility of choosing an alternative *j* is a function of the characteristics of the alternative *j*, and the utility function (U_{ij}) contains two parts: a deterministic part V_{ij} for observed characteristics and a stochastic error part ε_{ij} for unobserved variables.

$$\boldsymbol{U_{ij} = V_{ij} + \varepsilon_{ij}} \quad (6\text{-}1)$$

The deterministic part V_{ij} represents the observable portion of the utility that can be measured and is related to both attributes of alternatives and characteristics of the respondent. It is expressed as a linear-in-parameter function:

$$\boldsymbol{V_{ij} = \alpha_j + \sum_k X_{jk}\beta_k} \qquad (6\text{-}2)$$

where α_j is an alternative specific constant, X_{jk} is the *k* attribute value of the alternative *j* , and β_k is the coefficient associated with the *k*th attribute.

Table 6.1 presents the results of our utility model.

Table 6.1: Utility Function Estimates

Variables	**Cities**		
	Thailand	Malaysia	Philippines
Price	−0.118***	−0.061***	−0.062***
(% of the monthly bill)	(0.007)	(0.005)	(0.005)
RE share (%)	0.015***	0.009***	0.017**
	(0.005)	(0.003)	(0.006)
Renewable energy types			
Base type	Solar	Solar	Hydro and Geothermal
Solar	-	-	0.902***
			(0.121)
Biomass	−0.361***	−0.183**	0.437***
	(0.114)	(0.078)	(0.123)
Hydropower	−0.337***	-0.065	0.361**
	(0.114)	(0.077)	(0.126)
Wind	−0.272**	-	0.407**
	(0.112)		(0.125)
ASC (SQ)	0.174	0.145	
	(0.126)	(0.089)	
Obs	5691	6978	5907
Number of households	250	298	249
Log-likelihood	−1645	−2402	−2025

ASC = alternative-specific constant, RE = renewable energy.

Note: Robust standard errors are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The ASC for the Philippines would be perfectly correlated with the dummy variable for the base type and has thus been dropped.

Source: Authors' calculation.

The results can be summarised as follows:

- Respondents prefer higher RE shares, and the RE share coefficients in all three cities were positive and significant.
- The increased price reduces the utility of households.

1.2. WTP Estimations

Estimates of WTP for different RE share levels and different RE types were calculated using the results of the conditional logit. We converted both significant and insignificant parameters into marginal WTP by dividing the marginal utility of attributes by the marginal utility of price. The utility function of the household can be expressed as follows:

$$\boldsymbol{V_j = ASC_j + \beta_1 REshare_j + \beta_2 Solar_j + \beta_3 Wind_j + \beta_4 Hydro_j + \beta_5 Price_j,} \tag{6-3}$$

where V_j is the utility of choice set j; $REshare_j$ is the RE share amongst total electricity production of choice set j; $Solar_j$, $Wind_j$, and $Hydro_j$ are dummy variables representing RE types of choice set j; and $Price_j$ represents the percentage of increasing monthly electricity tariffs. Here we have taken biomass as the base for the RE type dummy variable.

To examine $Price_j$ at different $REshare$ levels, we specified $REshare_j$ and determined the changes in WTP_j using the following function:

$$\boldsymbol{WTP_j = Price_j = \frac{\beta_1(REshare_j - REshare_{sq}) + \beta_2 Solar_j + \beta_3 Wind_j + \beta_4 Hydro_j}{-\beta_5}} \tag{6-4}$$

As expected, the RE share is an influential attribute when households evaluate RE types. Households prefer a higher renewable proportion in the electricity mix.

	RE Share	**Solar** % of monthly electricity bill (USD)	**Biomass** % of monthly electricity bill (USD)	**Hydropower** % of monthly electricity bill (USD)	**Wind** % of monthly electricity bill (USD)
Thailand (status quo = 9%)	20%	2.92%	−0.14%	0.06%	0.61%
		(2.33)	(−0.12)	(0.05)	(0.49)
	30%	4.23%	1.17%	1.37%	1.92%
		(3.38)	(0.93)	(1.10)	(1.54)
	40%	5.54%	2.48%	2.68%	3.24%

		(4.43)	(1.98)	(2.15)	(2.59)
Malaysia (status quo = 6%)	10%	2.97% (0.81)	−0.04% (−0.01)	1.90% (0.52)	-
	20%	4.52% (1.22)	1.50% (0.41)	3.44% (0.93)	-
	30%	6.06% (1.64)	3.04% (0.83)	4.99% (1.35)	-
Philippines (status quo = 30%)	40%	17.31% (8.74)	9.82% (4.96)	8.60% (4.35)	9.34% (4.71)
	50%	20.11% (10.16)	12.63% (6.38)	11.41% (5.76)	12.14% (6.13)
	60%	22.91% (11.57)	15.43% (7.79)	14.21% (7.18)	14.95% (7.55)

shows the estimation of the mean WTP in the percentage of monthly electricity bills in United States dollars (USD) when increasing the RE share. The average WTP values for solar are highest in the three ASEAN cities. It follows the same pattern as the results of last year. In Thailand and Malaysia, biomass energy was valued lowest.

Table 6.2: Willingness to Pay Estimates for Renewable Energy Types in % of Monthly Electricity Bill

	RE Share	Solar % of monthly electricity bill (USD)	Biomass % of monthly electricity bill (USD)	Hydropower % of monthly electricity bill (USD)	Wind % of monthly electricity bill (USD)
Thailand (status quo = 9%)	20%	2.92% (2.33)	−0.14% (−0.12)	0.06% (0.05)	0.61% (0.49)
	30%	4.23% (3.38)	1.17% (0.93)	1.37% (1.10)	1.92% (1.54)
	40%	5.54% (4.43)	2.48% (1.98)	2.68% (2.15)	3.24% (2.59)
Malaysia (status quo = 6%)	10%	2.97% (0.81)	−0.04% (−0.01)	1.90% (0.52)	-
	20%	4.52% (1.22)	1.50% (0.41)	3.44% (0.93)	-
	30%	6.06% (1.64)	3.04% (0.83)	4.99% (1.35)	-
Philippines (status quo = 30%)	40%	17.31% (8.74)	9.82% (4.96)	8.60% (4.35)	9.34% (4.71)
	50%	20.11% (10.16)	12.63% (6.38)	11.41% (5.76)	12.14% (6.13)
	60%	22.91% (11.57)	15.43% (7.79)	14.21% (7.18)	14.95% (7.55)

Note 1: The official exchange rate by the World Bank in 2019 was used for the conversions (USD1 = THB31.1 = RM4.1 = PHP51.8). https://data.worldbank.org/indicator/PA.NUS.FCRF

Note 2: The mean monthly electricity bills are as follows: Thailand, USD79.0/month; Malaysia, USD27.1 /month; Philippines, USD50.5/month.

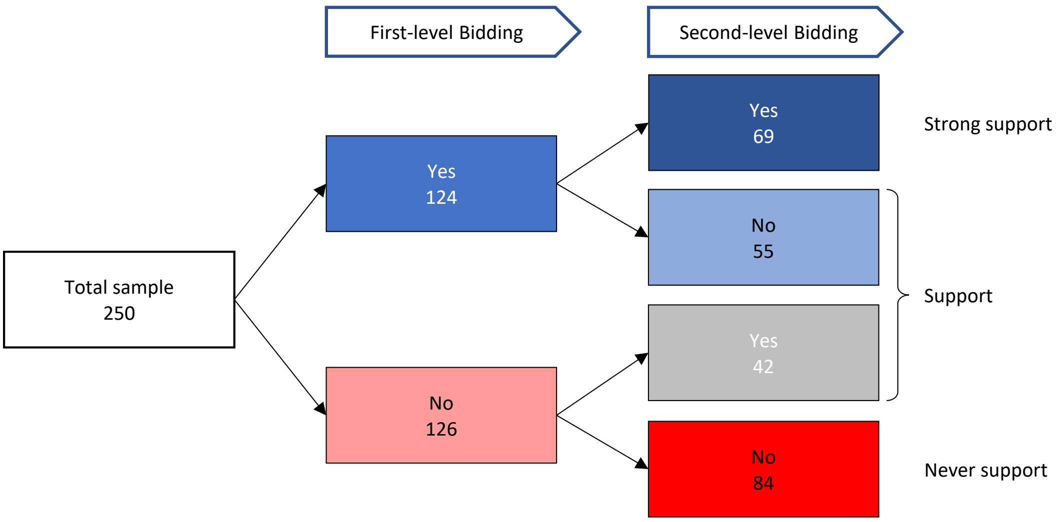
Note 3: The status quo of renewable share is different in cities (Thailand, 9%; Malaysia, 6%; the Philippines, 30%).

Source: Authors' calculation.

1.3. Contingent Valuation

Figure 6.1 illustrates the bidding process of contingent valuation. At the first bidding level, 124 of 250 participants responded 'Yes,' whereas 126 rejected the bid. At the second bidding level, 69 respondents (27.6%) supported the plan to increase the renewables share to 50%. The results are as follows: 55 respondents (22.0%) responded affirmatively to the first bid level but negatively at the second bid level; 42 respondents (16.8%) responded negatively at the first bid level but affirmatively at the second bid level. Finally, 84 respondents (33.6%) responded negatively at both bid levels.

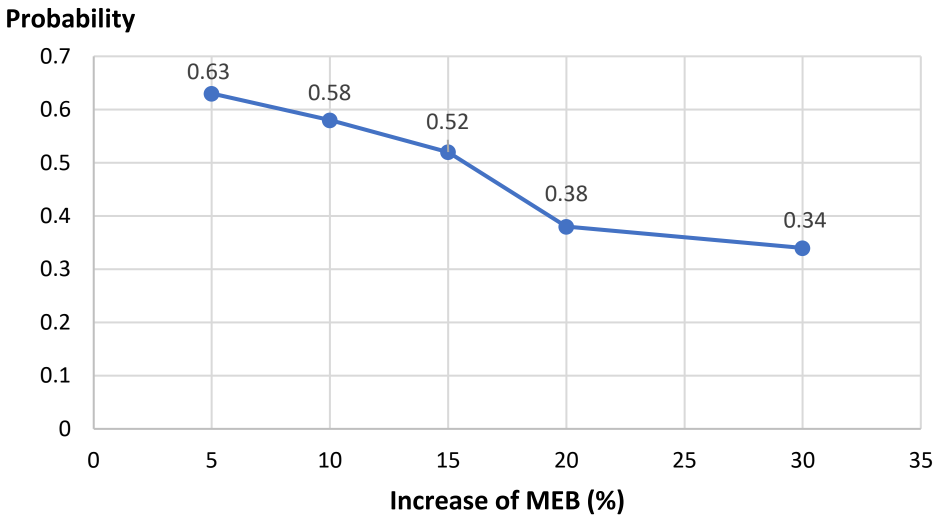
Figure 6.1: Bidding Process Based on the Contingent Valuation Model



Source: Authors' calculation.

The results (Figure 6.2) show that respondents were willing to support the 50% RE capacity target by paying extra through higher electricity prices. As expected, more than 63% of all respondents who answered the contingent valuation question stated that they were willing to pay 5% more on their current monthly electricity bill to support the target. Approximately 58% of respondents were willing to pay 10% more, 52% were willing to pay 15% more, and 34% were willing to pay 30% more to support the Plan. Less than half of the respondents were willing to pay 20% more.

Figure 6.2: Willingness to Support the Philippines Power Development Plan: 'The share of Renewable Energy will be Increased from only 30% in 2019 to 50% in 2030.'



MEB = monthly electricity bill.

Source: Authors' calculation.

Logistic regression models were used to estimate the WTP to support the government RE target (Table 6.3). The model includes socio-demographic household variables in addition to the price increase in the electricity bill. The results of the regression indicate that higher education level can lead to higher WTP to government RE target.

Table 6.3: Results of the Logistic Regression Model for Contingent Valuation

	Model (SBDC)		Model (DBDC)	
	Coefficient	**SE**	**Coefficient**	**SE**
Sigma (Cons)	−3.532*	1.429	−2.405	1.271
Ln (Average electricity price, Philippine pesos)	0.267	0.181	0.217	0.165
Gender	0.209	0.314	0.272	0.285
Age	0.016	0.011	0.015	0.009
Education level	0.475***	0.138	0.494***	0.124
Extra electricity price	−0.058***	0.017	−0.118***	0.010
Obs	250		250	
Log-likelihood	−156		−350	

DBDC = double-bounded dichotomous choice model, SBDC = single-bounded dichotomous choice model.

Note: ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Source: Authors' calculation.

Table 6.4 shows that the mean WTP (logistic regression) is a 21.1 % increase in monthly electricity bills in SBDC Model and a 15.2% increase in DBDC Model. The mean monthly electricity bill of the sample is 3,010 PHP; therefore, the mean WTP is PHP634/month (USD12.2/month) in SBDC and PHP458/month (USD8.8/month) in DBDC.

Table 6.4: Estimated Willingness to Pay Values (% of monthly electricity bill)

Model	Mean WTP	95% Confidence Intervals
SBDC	21.078	16.175−35.382
DBDC	15.228	13.153−17.485

DBDC = double-bounded dichotomous choice model, SBDC = single-bounded dichotomous choice model.

Source: Authors' calculation.

Chapter 7

Sustainable Mobility in Viet Nam: A Study on the Willingness to Pay for Electric Motorbikes

1. Introduction

This chapter explores the consumers' perspectives on the use of electric versus internal combustion motorbikes in Ho Chi Minh City. In that regard, this chapter complements the previous work on the households' perceptions towards the use of renewable energy for electricity generation. Indeed, whilst there is widespread recognition for the need to promote decarbonisation of the power systems, transportation is also one of the main sources of greenhouse gases emissions. On a global scale, transportation accounts for 24% of all the emissions and, out of these, three quarters are due to road transportation (IEA, 2020). As the climate emergency becomes more pressing (IPCC, 2021) (IPCC, 2021), there is also an increasing need to accelerate the shift from internal combustion engine vehicles to other technologies, such as hydrogen and electricity. Particularly, electrification of road transportation is currently one of the mains strategies to increase its sustainability (Weiss et al., 2015). However, policy support is still needed to make the purchase economically reasonable from the consumer's point of view. For that, several governments (both national and sub-national) have adopted is to set a timeline for phasing out the sales of the internal combustion engine passenger cars. So far, this option is still limited to several European countries (European Union [EU] and non-EU members), North America (Canada and California), and few other countries (Costa Rica, Cape Verde, and Singapore) (Wappelhorst, 2021). Other countries are following, even though without official commitments for full phasing out. China has announced that from 2035, the only new cars for sale will be 'new-energy' (electric, fuel cell, or plug-in hybrid). Similarly, Japan is planning to allow only the sale of electric and hybrid vehicles by 2035 (Davis, 2020). Nevertheless, electrification of transportation alone cannot reduce the overall emissions, and need to be combined with a decarbonisation of the power mix (Zhang and Fujimori, 2020).

In ASEAN, transportation is considered as one of the key elements of the *6th Energy Outlook* for the period 2017–2040 (AO6) (ACE, 2020a). The AO6 outlines two key approaches to realise greener transport: the adoption of electric vehicles and the replacement of oil products with biofuels. Electric vehicles are still in their infancy in ASEAN, although several countries are setting targets. In contrast, there is more experience with biofuels, but to secure their sustainability, more efforts are needed to develop second-generation biofuels that use waste and other non-food feedstock. Furthermore, Improvements in fuel economy are also essential. These are also included in the ASEAN Transport Strategic Plan 2016–2025 (also known as the Kuala Lumpur Transport Strategic Plan), approved in 2015, as a successor of the Brunei Action Plan (ASEAN, 2015). The Kuala Lumpur Transport Strategic Plan outline several strategic goals for air, land, maritime, and sustainable transport and transport facilitation. The need for a fuel economy roadmap for the transport sector was then incorporated as one of the key steps towards a more sustainable transportation system.

- Goal 1: Average fuel consumption per 100 kilometres of new light-duty vehicles sold in ASEAN is reduced by 26% between 2015 and 2025.
- Goal 2: Common indicators and methodologies, as well as baseline data for fuel economy, are defined.
- Goal 3: Regional cooperation, national action, and fuel economy policy leadership are established.
- Goal 4: Fuel economy label information is regionally aligned.
- Goal 5: Introduction or enhancement of fuel consumption or CO_2 emissions-based fiscal policies.
- Goal 6: Adoption of national fuel consumption standards for light-duty vehicles in all markets, striving towards a regional standard in the long term.

In terms of fuel efficiency, ASEAN countries follow the EU classification for emissions standards (Table 7.1). Currently, there is a six reference level, and stricter emissions standards are expected to be adopted by the EU Commission during the fourth quarter of 2021.[9] The implementation of these standards is still at very different levels in each country but has been improved gradually. (Tongsopit et al., 2016) notes that Euro IV standards have been implemented only in Malaysia and Thailand, and in Singapore only for diesel vehicles; Malaysia, Indonesia, and Viet Nam have Euro II; whilst, there are no emissions standards in Brunei Darussalam, Cambodia, Lao People's Democratic Republic, and Myanmar. (Li and Chang, 2019) point out that Singapore has already implemented Euro 5 for all cars, which Thailand is also introducing gradually, and Malaysia and Indonesia have plans to introduce Euro 4. In Viet Nam, Euro 4 standards apply for vehicles,

[9] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12313-European-vehicle-emissions-standards-Euro-7-for-cars-vans-lorries-and-buses_en

whilst two and three-wheelers must follow Euro 3.[10] ASEAN has adopted a regional approach to ensure a harmonised improvement of the fuel economy standards building upon the agreements outlined in the ASEAN Transport Strategic Plan 2016–2025, and further extended in the ASEAN Fuel Economy Roadmap for Transport Sector 2018–2025 with the goals previously mentioned. In this effort, several initiatives for sustainable transport are being implemented in the region. In 2019, the International Transport Forum and the ASEAN Secretariat established the International Transport Forum–ASEAN Transport Research Proposal to support the development of the roadmap and supported by the Global Fuel Economy Initiative (2021a).

Table 7.1: European Emissions Standards

		Unit	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6
Implementation	New approvals	Date	1 July 1992	1 Jan 1996	1 Jan 2000	1 Jan 2005	1 Sep 2009	1 Sep 2014
	All new registrations	Date	31 Dec 1992	1 Jan 1997	1 Jan 2001	1 Jan 2006	1 Jan 2011	1 Sep 2015
Petrol standards	CO	g/km	2.72	2.2	2.3	1.0	1.0	1.0
	HC + NOx	g/km	0.97	0.5	-	-	-	-
	THC	g/km	-	-	0.20	0.10	0.10	0.10
	NMHC	g/km	-	-	-	-	0.068	0.068
	NOx	g/km	-	-	0.15	0.08	0.06	0.06
	PM	g/km	-	-	-	-	0.005	0.005
	PN	#/km	-	-	-	-	-	6.0 x10^11
Diesel standards	CO	g/km	2.72	1.0	0.66	0.50	0.50	0.50
	HC + NOx	g/km	0.97	0.7	0.56	0.30	0.23	0.17
	NOx	g/km	-	-	0.50	0.25	0.18	0.08
	PM	g/km	0.14	0.08	0.05	0.025	0.005	0.005
	PN	g/km	-	-	-	-	6.0x10^11	6.0x10^11

CO = carbon monoxide, g/km = gram per kilometre, HC = hydrocarbons, NOx = nitrogen oxides, THC = total hydro carbon, NMHC = non-methane hydrocarbons, PM = particulate matter, PN = particle number.

Source: Euro 1 to Euro 6 Guide – Find out your Vehicle's Emissions Standard.

https://www.rac.co.uk/drive/advice/emissions/euro-emissions-standards/

[10] https://www.transportpolicy.net/standard/vietnam-motorcycles-emissions/

Electric motorbikes can play an important role in developing countries, particularly in those with already high penetration. Electric motorbikes can become even more important if they can shift some users from private cars to electric mobility. As electric cars still remain too expensive for the average person, this can become critical in avoiding a continuous increase in private cars, and the pollution, congestion, and traffic accidents associated. Gasoline motorbikes already play a vital role in mobility in many ASEAN cities, occupying less space in the road than cars. Motorbikes are also important for equity to access. With a broader range of available options in the market, it is easier for all economic classes to access the purchase of a motorbike. However, the rapid increase of existing motorbikes in cities have brought other problems, such as air pollution, congestion, and traffic accidents (Van, 2009). A shift to electric motorbikes would reduce these impacts, particularly in air pollution, and the possibility of traffic accidents (due to lower average speed). However, the impact on congestion is difficult to assess. Electric motorbikes are in general simpler in their maintenance, and lighter and cleaner in the operation, reducing the barriers for new entrants. This could lead to a worsening of congestion due to an increase in the number of motorists).

Furthermore, electric motorbikes represent an alternative that fits current consumer preferences (i.e. private mobility), and urban mobility goals (i.e. reduced air and noise pollution). In any case, a shift towards electric motorbikes should be accompanied by the promotion and improvement of a city's public transportation system, such as more sustainable bus technologies (Büyüközkan, Feyzioğlu, and Göçer, 2018), and to look at the potential introduction of newer urban mobility systems, which could be public, private, or a combination of both. These include micro-mobility devices such as e-scooters and electric bicycles (Abduljabbar, Liyanage, and Dia, 2021), both in private ownership or shared business models (Christoforou et al., 2021). In addition, there is an increase in the adoption of shared-economy models for motorbikes and cars, well established in Southeast Asia through companies such as Singapore-based Grab and Indonesia-based GoJek (Lauria, 2020). Even more, it is needed to consider the integration of all the different urban mobility systems (Oeschger, Carroll, and Caulfield, 2020).

However, studies on the adoption of electric motorbikes are still lacking, particularly when comparing with those on private cars (electric and hybrid) (Jones et al., 2013). (Eccarius and Lu, 2020) reviewed studies on the adoption of electric motorbikes. In total, the authors analysed 11 studies finding that most of them considered similar attributes, such as purchase price, operating cost, and performance levels. Cultural differences are considered to play a role in certain inconsistencies between the studies, such as whether gender has any effect on the adoption of electric motorbikes. The symbolic meaning that motorbikes can have for many owners also play an important role. In that sense, the image of a specific model will have a notable effect on the decision, either positively or negatively. (Eccarius and Lu, 2020) also point out the necessity for futures studies on consumers' attitudes towards electric two-wheelers and how related infrastructure could influence consumers. Nonetheless, there is nascent literature on willingness to pay for electric two and three wheelers, including motorbikes but others such as auto rickshaws. Table 7.2 presents previous related studies.

Table 7.2: Overview of Studies on Willingness to Pay for Electric Motorbikes

Author(s) (Year)	Country	Method	Main Findings
Jones et al. (2013)	Viet Nam	Mixed logit model	Technological improvements and economic incentives (i.e. sales taxes) can have significant effects on adoption
Patil et al. (2021)	India	Multinomial logit, random parameter logit	Speed is most important, followed by acceleration and charging duration
Chiu and Tzeng (1999)	Taiwan	Multinomial logit	Sales taxes, technological improvements, and increases in gasoline prices could expand market share
Sung (2010)	Taiwan (28)	Four-stage stated preference experiment	Respondents have a higher quality perception of the electric motorbike than the gasoline motorbike
Zhu et al. (2019)	Macau	Double-boundary dichotomous contingent valuation method + binary logistic regression analysis	Actual cost (i.e. sale price, charging fee, repair fee, and tax incentives) are the main points of interest for respondents Product features (i.e. driving speed and load capacity) got very little attention
Guerra (2019)	Solo (Indonesia)	Mixed logit model	Charge time is particularly important

Scorrano and Danielis (2020)	Italy	Multinomial logit model + Random parameter logit model	Electric scooters adoption is Limited by non-monetary factors and still inadequate supply
Sun and Zhang (2013)	Lao PDR	Dogit model	Cruising range, charge distance operation cost, and diffusion rate are major influential factors
Patil et al. (2021)	India (Hyderabad)	Multinomial and Random parameter logit	Top speed is the most important attribute, followed by acceleration and charging duration
ADB (2009)	India (Ahmedabad) and Viet Nam (Ha Noi)	Conditional logit	A poor reputation for quality is a significant factor

Source: Collated by authors.

This chapter aims to contribute to this emerging literature with a survey and choice experiment for electric motorbikes in Viet Nam. The ownership ratio of motorbikes in Vietnam is one of the largest in the world. Indeed, currently, personal motorbikes are the default and preferred urban transportation mode (Le and Trinh, 2016). However, this has also created severe problems such as traffic congestion and air pollution. Indeed, Vietnamese large urban areas (Ha Noi and Ho Chi Minh City) are amongst those with lower air quality in the region. The transformation into sustainable transportation systems is therefore one of the priority areas for policymakers in the country. Indeed, in 2021, Viet Nam has adopted its 10-year climate-resilient urban development plan until 2030 (Vietnam+, 2021). A shift from gasoline to electric motorbikes has been pointed out as one of the suitable alternatives in this process (Huu and Ngoc, 2021). And as such, some pilot projects have been implemented in the country. The United Nations Environmental Programme (UNEP) under the eMob Programme is supporting developing countries, including Viet Nam, in their transition to electric mobility in a programme under the Global Environment Facility (Global Fuel Economy Initiative, 2021b; Fabian, 2020). The programme partnered with the Viet Nam University of Transport Technology under the project 'Mainstreaming Electric Mobility in Vietnam', which concluded at the end of 2020. The focus of these studies has been mostly on the potential for electric motorbikes to contribute to a transition towards sustainable transportation, as well as the possible limitation and shortcomings of such an approach. Nevertheless, it is also important to also consider the perceptions and preferences of residents (current owners or not of gasoline motorbikes) to better design policies to promote a shift from gasoline to electric motorbikes in the country.

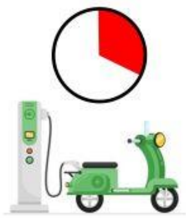
The remainder of the chapter provides further details for each of the cities and the sampling approaches from the research teams. The next section provides an overview of willingness to pay studies on electric motorbikes. This feeds into the design of the choice experiment described in the following section. After that, the results are presented including socio-demographics, an analysis of the current mobility patterns and insights into respondents' view on electric mobility, and the estimation of the willingness to pay for electric motorbikes. The final section provides a summary of the main findings and a discussion on policy implications and further research.

2. Survey Design

The survey was divided into five parts: (i) personal mobility, (ii) knowledge on electric motorbikes, (iii) choice experiment, (iv) attitude towards environmental problems, and (v) household respondents' information. The overall questionnaire was prepared in collaboration between the teams at the University of Tokyo and the Ho Chi Minh University of Economics based on the review of the literature and a pre-test conducted in the first trimester of 2021.

The choice experiment was designed so respondents are presented a hypothetical scenario to purchase a motorbike between three alternatives: (i) electric motorbike, (ii) gasoline motorbike, (iii) none of them. Figure 7.1 shows one of the actual choice sets employed (CSID 001) in Vietnamese. The choice sets were prepared with a D-optimal design (NIST/SEMATECH, 2012) combining the different levels for each of the attributes selected. Visual representations were prepared as an aid for the respondents. In total 110 different choice sets were prepared, and 486 interviews were conducted. Each of the respondents was expected to complete five-choice tasks, although the final registered responses were 2,406).

Figure 7.1: Sample Choice Set

	Option A [Phương án A] Electric Motorbike [XE MÁY ĐIỆN]	Option B [Phương án B] Gasoline Motorbike [XE MÁY XĂNG]
Fuel [Loại nhiên liệu]	 Điện Electricity	 Xăng Gasoline
Maximum speed (km/h) [Tốc độ tối đa (km/h)]	 100 km/h	 80 km/h
Range in single charge (km) [Quãng đường đi được sau 1 lần sạc đầy (km)]	 150 km	 100 km
Fuel/electricity cost (VND/100 km) [Tiền xăng/điện (đồng/100km)]	 5.000 đồng/100km	 50.000 đồng/100km
Maintenance cost (VND/month) [Chi phí bảo trì (đồng/tháng)]	 90.000 đồng/tháng	 100.000 đồng/tháng
Time for full charge (hour) [Thời gian sạc đầy pin (giờ)]	 4 giờ	 0 giờ

Country of origin [Xuất xứ thương hiệu]	 Châu Âu	 Việt Nam
Price (VND million) [Giá bán đã bao gồm thuế và phí (triệu đồng)]	 20 triệu đồng	 40 triệu đồng
He/she chooses [Ông/Bà chọn…]	☐ Electric motorbike [Xe máy điện]	☐ Gasoline motorbike [Xe máy xăng]
	☐ Not buy any [Không mua chiếc nào]	

Source: Authors.

The attributes for the choice sets were prepared including those that were found to be relevant for Vietnamese residents in their decision to purchase their motorbike but that would allow for the estimation of the willingness to pay for each of them. The levels were prepared after consultation of available resources to make them realistic in the present or a reasonable future. The sources included reports from industry such as (Terra Motor and Quantum Leaps, 2013) and (Mirai Asset Daewoo, 2020). The initial design was modified after the pre-test. In particular, the appearance of the motorbike was one attribute that was discarded after that; for others, the levels were adjusted when needed (maximum price was increased to fit an appreciation by some respondents of more expensive models). The final list of attributes and values are presented in Table 7.3.

Table 7.3: Attributes and Levels for the Choice Experiment

Attribute	Unit	Levels
Top speed	km/hour	40 – 60 – 80 – 100
Range	km	100 – 150 – 200 – 250 – 300
Fuel / electricity cost	VND/100 km	Electric: 3,000 – 4,000 – 5,000 Gasoline: 30,000 – 40,000 – 50,000
Maintenance cost	VND/month (over a period of 6 years)	Electric: 50,000 – 70,000 – 90,000 – 110,000 Gasoline: 100,000 – 150,000 –200,000 – 250,000 For electric need to replace the battery after 6 years For gasoline monthly maintenance For electric swap battery monthly service
Time to charge	Hours	Electric: 0 (swappable) – 1 – 4 – 7 Gasoline: 0
Country of origin	-	Viet Nam – China – Japan – Europe
Price	VND million	20 – 40 – 60 – 80 – 100

km = kilometre.

Source: Authors.

Top speed and range are common features of great importance for motorists. Electric motorbikes have traditionally counted with limited maximum speed to optimise the use of batteries. This has led them to be more focused on short travels within the boundaries of cities rather than for long-distance travel or use on roads with high-speed limits, such as highways. Nevertheless, new models are being brought to market with speed limits analogous to those of gasoline motorbikes. However, these faster models were out of scope for this study. The exploratory survey and the pre-test revealed that the main use for motorbikes in Ho Chi Minh City is still for travel within city boundaries. For these, the speed is limited due to the regulation, and by the common traffic jams. For that, the highest maximum speed was set at 100 kilometres per hour (km/h), and the minimum at 50 km/h, which is more adequate for the cheapest models. A range between 100 to 300 km was adopted for both electric and gasoline motorbikes. These are relatively high values for electric motorbikes, but it considered adequate for the development of hypothetical alternatives.

For the repetitive costs, only charging (fuel or electricity) and maintenance were included. Other costs such as taxes and parking fees were discarded. In general, drivers also count in the initial tax as part of the total cost of the motorbike and there are free of charge parking is commonly available. The charging cost for the gasoline motorbikes was estimated based on the responses during the pre-test. For the electric motorbikes, the value was estimated including the cost of electricity in Viet Nam (per kWh) and the range of benchmarking models (such as those from VinFast). This was also contrasted with those values considered by the industry (Mirai Asset Daewoo, 2020). For the maintenance cost, similarly, the value for gasoline was based on experience from motorists in Viet Nam and for electric motorbikes based on external sources. In general, electric motorbikes required less maintenance than conventional motorbikes (Publimotos, 2020). However, battery check-ups are required at 1,000 km and 5,000 km (Silence Valencia, 2020). Furthermore, batteries need to be replaced after 6 years, adding a large cost that was distributed across their period of service. Although not equal, this was assumed to be similar to the total expenses for contracting a swapping battery service during that time.[11]

Battery anxiety is a common concern for consumers to purchase electric vehicles. This is usually lower for electric motorbikes than for cars due to the possibility to charge them without installing additional infrastructure. In many cases, the batteries can be charged connected to electric home power outlets. Moreover, many companies already offer subscription models that allow swapping of batteries (Sholichah and Sutopo, 2020). In this case, the time required to charge the battery is virtually reduced to zero due to the availability of battery charging stations through the city from which to replace the used battery for one fully charged .

Country of origin is another important feature that is considered by drivers. Japanese manufactures have traditionally dominated the motorbike market in Viet Nam. Honda is consistently the most widespread brand, followed by Yamaha, and, in a minor position Suzuki. European brands have only been introduced with models such as Piaggio Vespa. American brands are less popular. Nevertheless, this market structure does not apply to electric motorbikes. The first models were introduced by Chinese manufacturers. However, bad experiences from customers at that time limited their initial expansion. Large Japanese manufacturers, such as Honda, have not introduced their electric models until recently. Although some other smaller companies have looked at this as a niche market with sufficient potential (Terra Motor and Quantum Leaps, 2013). The market for

[11] As a reference VinFast's battery rental service is available at https://shop.vinfastauto.com/vn_vi/vinfast-bike.html

electric motorbikes in Viet Nam has started to see an increase in newer models with higher quality and that is capturing attention from consumers. In 2018, VinFast, a Vietnamese brand, started to sell only electric motorbikes with a rapid increase in their sales (Bloomberg, 2020). In 2019, Yadea, a Chinese brand and one of the major global brands in electric motorbikes opened a factory in Viet Nam to supply the market with local manufactured products.[12]

There is a wide range of prices for the motorbike models available in Viet Nam.[13] In general, electric motorbikes have specialised in lower price models, with some of them below VND20 million. Nevertheless, there is a trend for relatively higher-end models, with the popularity of the VinFast Klara. For gasoline motorbikes, Honda is the leading brand, and the Wave and SH are the most popular models in Viet Nam. However, consumers tend to automatically include the purchase and registration taxes as part of the purchase cost. Furthermore, the pre-test revealed that respondents also consider higher price models.

3. Results

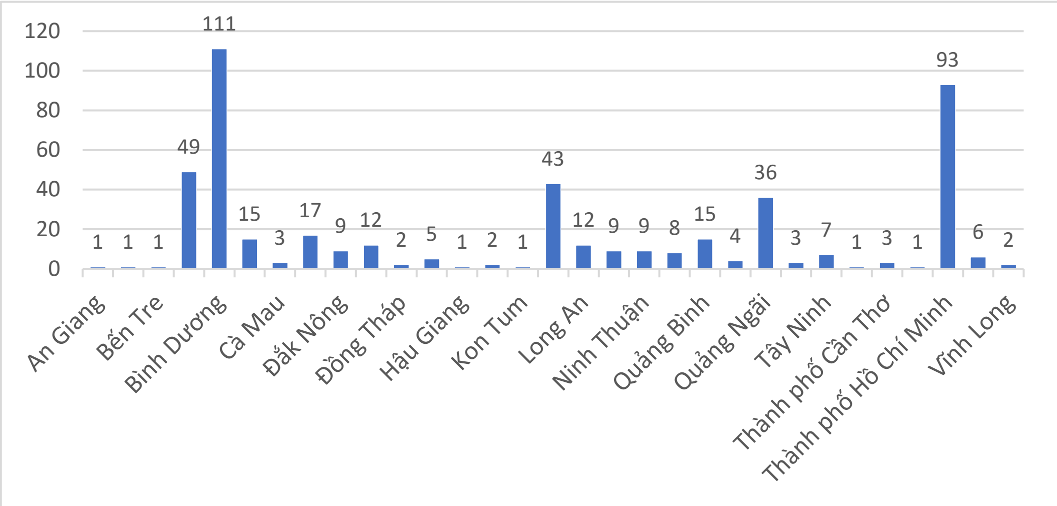
3.1. Socio-demographics

Initially, the target surveyed area was Ho Chi Minh City, but this needed to be modified due to the mobility restrictions put in place by the government to prevent the spread of COVID-19 in the city. To overcome such limitations, the surveyors' team was expanded to include economics students from the University of Economics of Ho Chi Minh City, Binh Duong University, and Quy Nhon University. Furthermore, some of the interviews were conducted via video conferences. As a result, the respondents were scattered across the country (Figure 7.2 and Figure 7.3), but most of them were located in the provinces of the three universities. In total, 486 interviews were conducted, nearly half split by gender (Figure 7.4) and distributed between unskilled labour, office workers, and self-employed (Figure 7.5) with a monthly income between VND6 to VND40 million (Figure 7.6).

[12] http://www.globalyadea.com/newsdetails-68.html

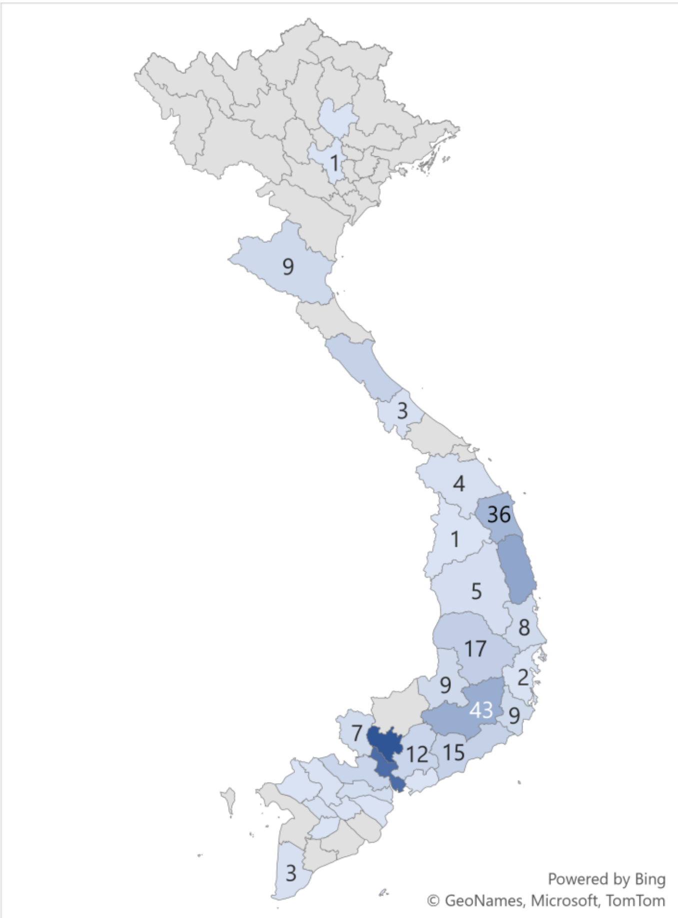
[13] Reference models from Honda (market leader in motorbikes in Viet Nam) and VinFast (emerging manufacturer specialised on electric motorbikes) were used for benchmarking. https://www.honda.com.vn/xe-may/san-pham and https://shop.vinfastauto.com/vn_vi/vinfast-bike.html

Figure 7.2: Respondents per Province



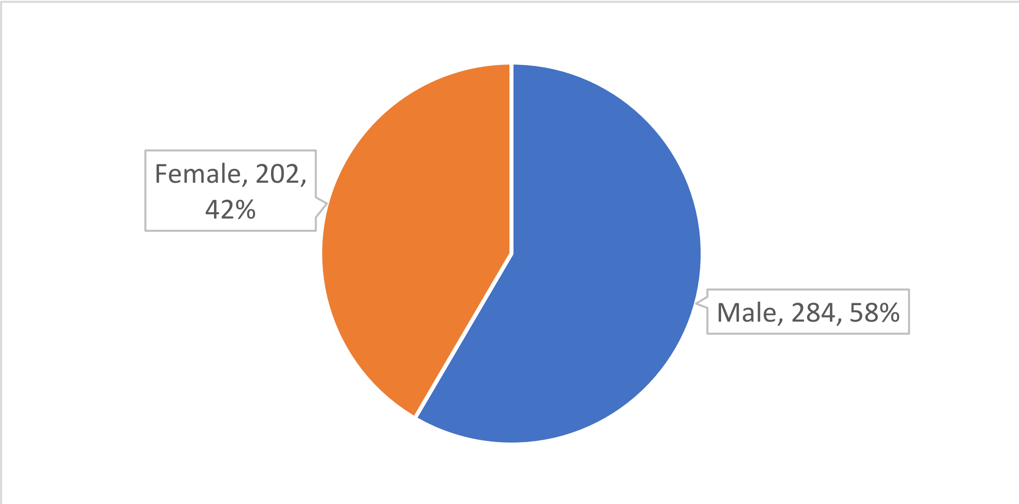
Source: Authors' calculation.

Figure 7.3: Map with the Distribution of Respondents by Province



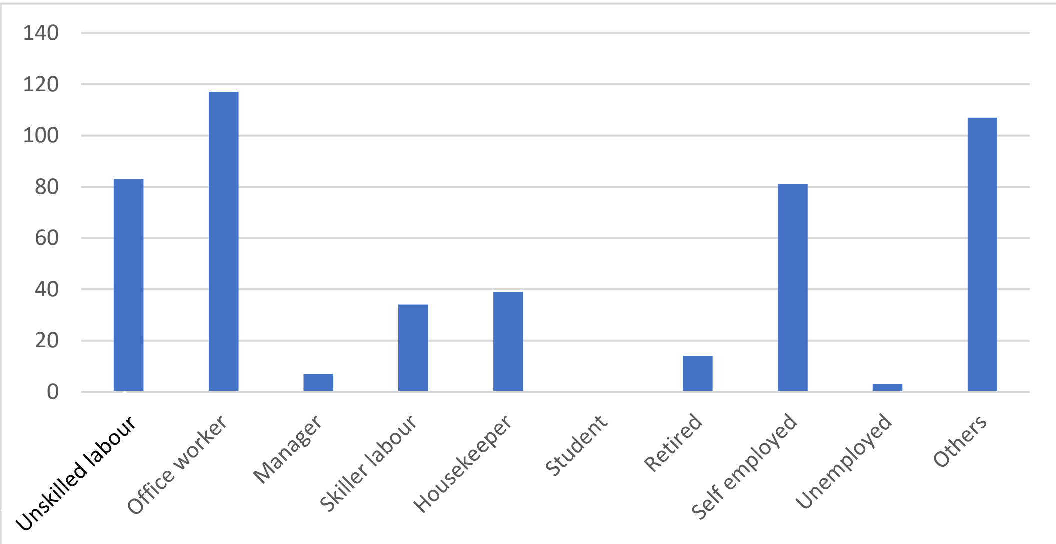
Source: Authors' calculation.

Figure 7.4: Respondents' Gender



Source: Authors' calculation.

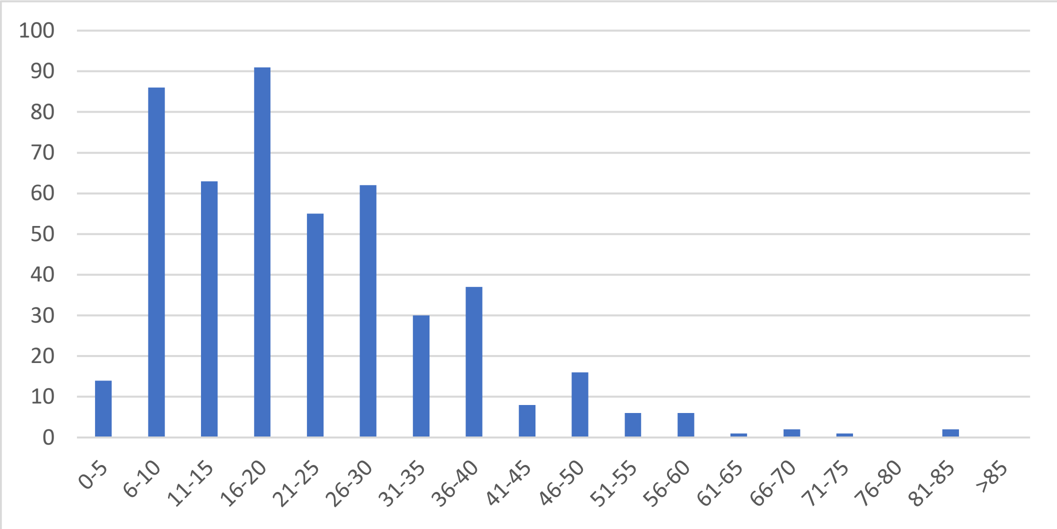
Figure 7.5: Respondents' Occupation



Source: Authors' calculation.

Figure 7.6: Respondents' Monthly Income

(VND)

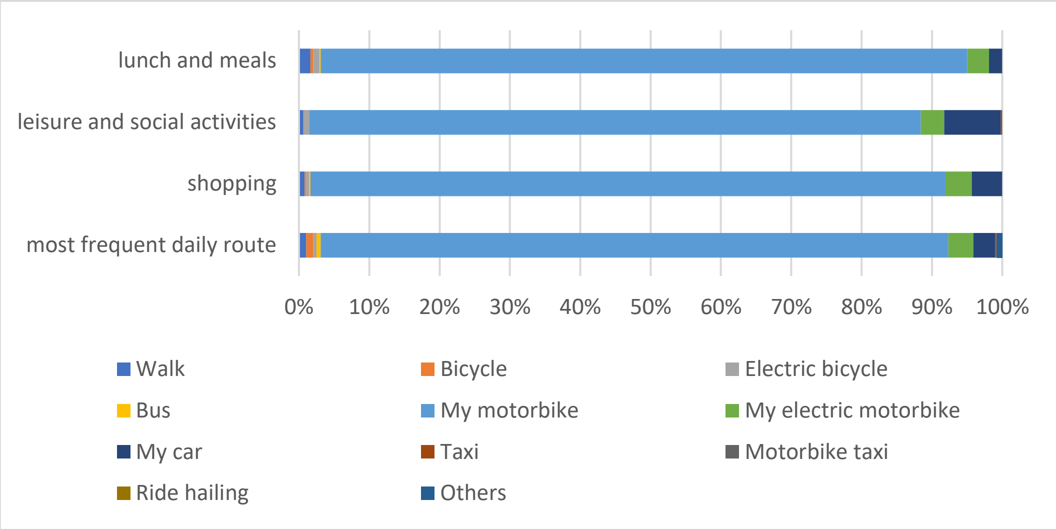


Source: Authors' calculation.

3.2. Personal Mobility

Personal motorbikes are the de-facto choice for urban mobility for the responses for each of the activities considered (Figure 7.7). During the pre-test, ride-hailing was one of the transportation modes for respondents. However, during the full survey, no respondent mentioned it for any of the activities. This was probably because of the lower popularity of ride-hailing services outside of big cities and the stopping of these services in major cities due to the COVID-19. This can also explain the low number of respondents that walk or use a bus for their trips.

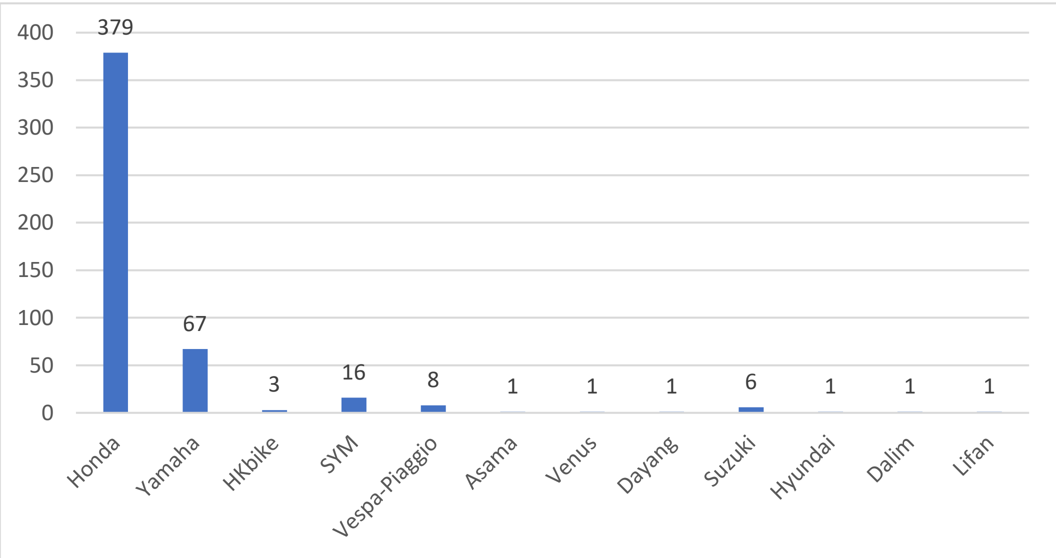
Figure 7.7: Main Transportation Mode by Activity



Source: Authors' calculation.

Most of these motorbikes (480) are gasoline, with only six respondents owning an electric motorbike (HKbike, Asama, Venus, or Hyundai). Also, most respondents own one of the models offered by Honda, followed by Yamaha (Figure 7.8). This is in line with the current market trends in Viet Nam.

Figure 7.8: Respondents' Motorbikes by Brand

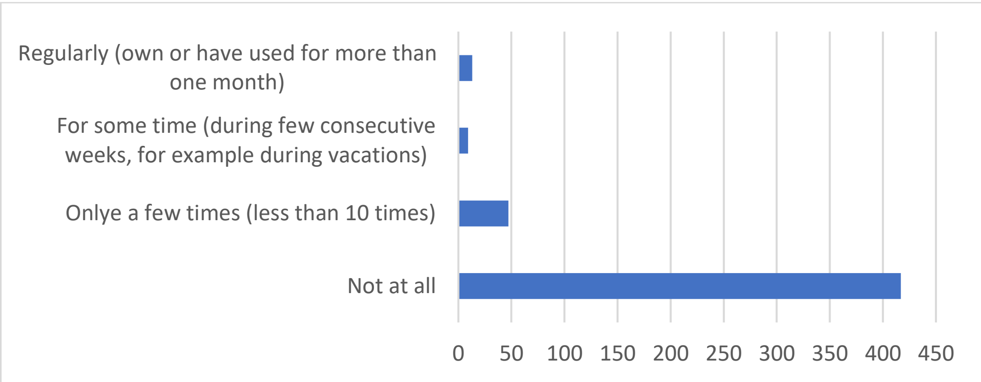


Source: Authors' calculation.

3.3. Knowledge of Electric Motorbikes

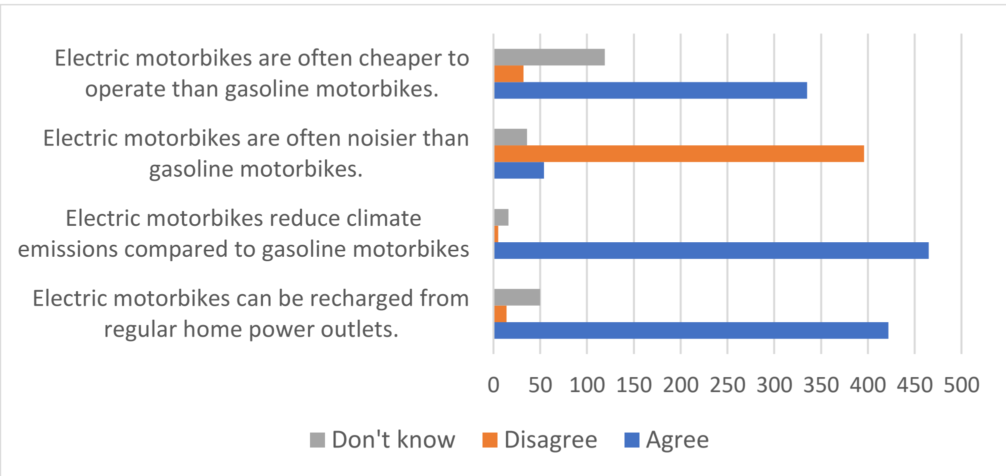
In addition to the lower ownership of electric motorbikes, very few respondents have ever experience riding one (Figure 7.9). Only 13 respondents use an electric motorbike regularly, nine sometimes, and 47 for a few times. In contrast, 417 reported having never ridden one. However, respondents appeared to be aware of electric motorbikes. The questionnaire survey included a short quiz on basic knowledge including four questions on comparing electric and gasoline motorbikes (Figure 7.10). The majority could correctly answer these. Only the question of the cost of operation of the electric motorbike got several 'do not know' responses. This might be due to the lack of ownership or experience for a long period.

Figure 7.9: Experience in Riding an Electric Motorbike



Source: Authors' calculation.

Figure 7.10: Quiz on Basic Knowledge on Electric Motorbikes



Source: Authors' calculation.

3.4. Estimation of the Willingness to Pay

The regression analysis (Table 7.4) shows that all the attributes, except the charging time, are significant. As it would be expected, those related to cost (price, fuel, and maintenance cost) are negatively correlated, whilst those on performance (speed and range) are positive. The charging time was not significant, indicating a possible lower relevance in the purchasing behaviour for the battery capacity or easiness to charge (in contrast to the situation with electric cars). The country of origin was also significant, with the highest preference for electric motorbikes from Japan and Viet Nam. It is important to note that Japanese brands (particularly Honda and, at a lower rate, Yamaha) are the current dominant manufacturers in the country. The emergence of Vietnamese brands and the good reputation they are gaining amongst residents shows the potential of a shift to electric motorbikes also as an industrial policy. Table 7.5 includes the calculation of the marginal willingness to pay for each of the attributes. From, this, the WTP for each of the attributes is estimated. The results are that a WTP of VND400,000 for improving 1 km/h in top speed, VND620,000 to improve a range in 10 km, VND50,000 to reduce VND1,000/km in fuel cost, and VND170,000 to reduce VND1,000 /month in maintenance cost.

Table 7.4: Attributes and Levels for the Choice Experiment

	Model 1
Price	–0.0204***
	(0.0011)
Speed	0.00818***
	(0.0014)
Range	0.00127***
	(0.0004)
Fuel cost	–0.0000119***
	(0.00000265)
Maintenance cost	–0.00000353***
	(0.00000075)
Charging time	–0.0230
	(0.0161)
Country/region of origin	
China	1.248***
European Union	2.152***
Japan	2.169***
Viet Nam	2.163***
R2	0.11
Observations	7218
Log-likelihood	-3418

Note: Robust standard errors are in parentheses. ***, ** and * indicate statistical significance at 1%, 5% and 10% respectively.
Source: Authors' calculation.

Table 0.1: Marginal Willingness to Pay for Each of the Attributes

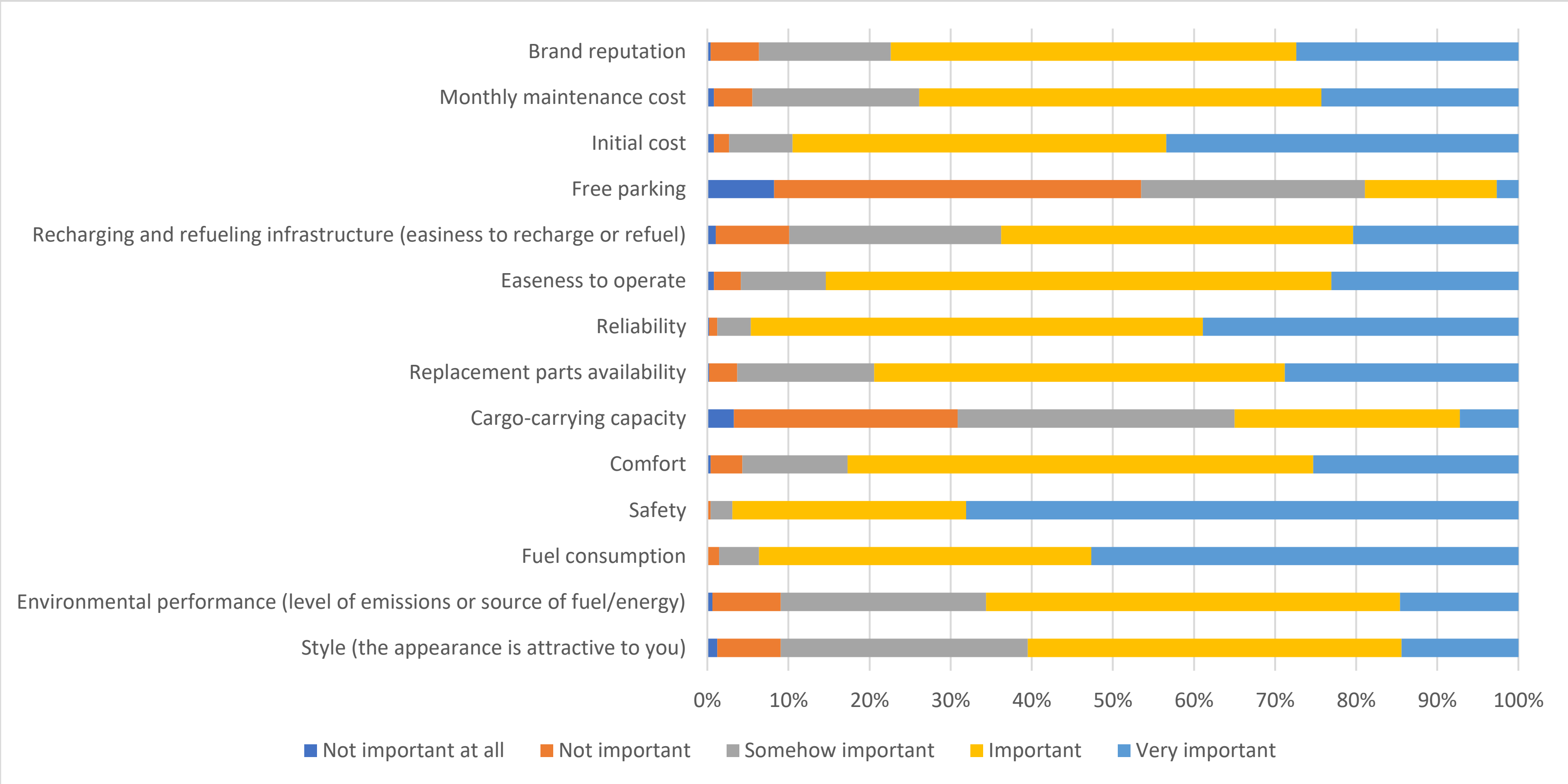
Variable	Marginal Willingness to Pay (95% CI)	Willingness to Pay
Speed	0.4 (0.26~0.54)	Improve 1 km/hour speed: VND400,000 (USD17.6)
Range	0.062 (0.021~0.11)	Improve 10 km range: VND620,000 (USD27.3)
Fuel cost	–0.00058 (–0.00084~-0.00032)	Reduce VND1,000/km (4.4 cents/km) fuel cost: VND580,000 (USD25.5)
Maintenance cost	–0.00017 (–0.00025~-0.0001)	Reduce VND1,000/month (4.4 cents/month) maintenance cost: VND170,000 (USD7.5)
Charging time (Insignificant)	–1.12 (–2.65~0.45)	Reduce charge time –

CI = confidence interval, km = kilometre.

Source: Authors' calculation.

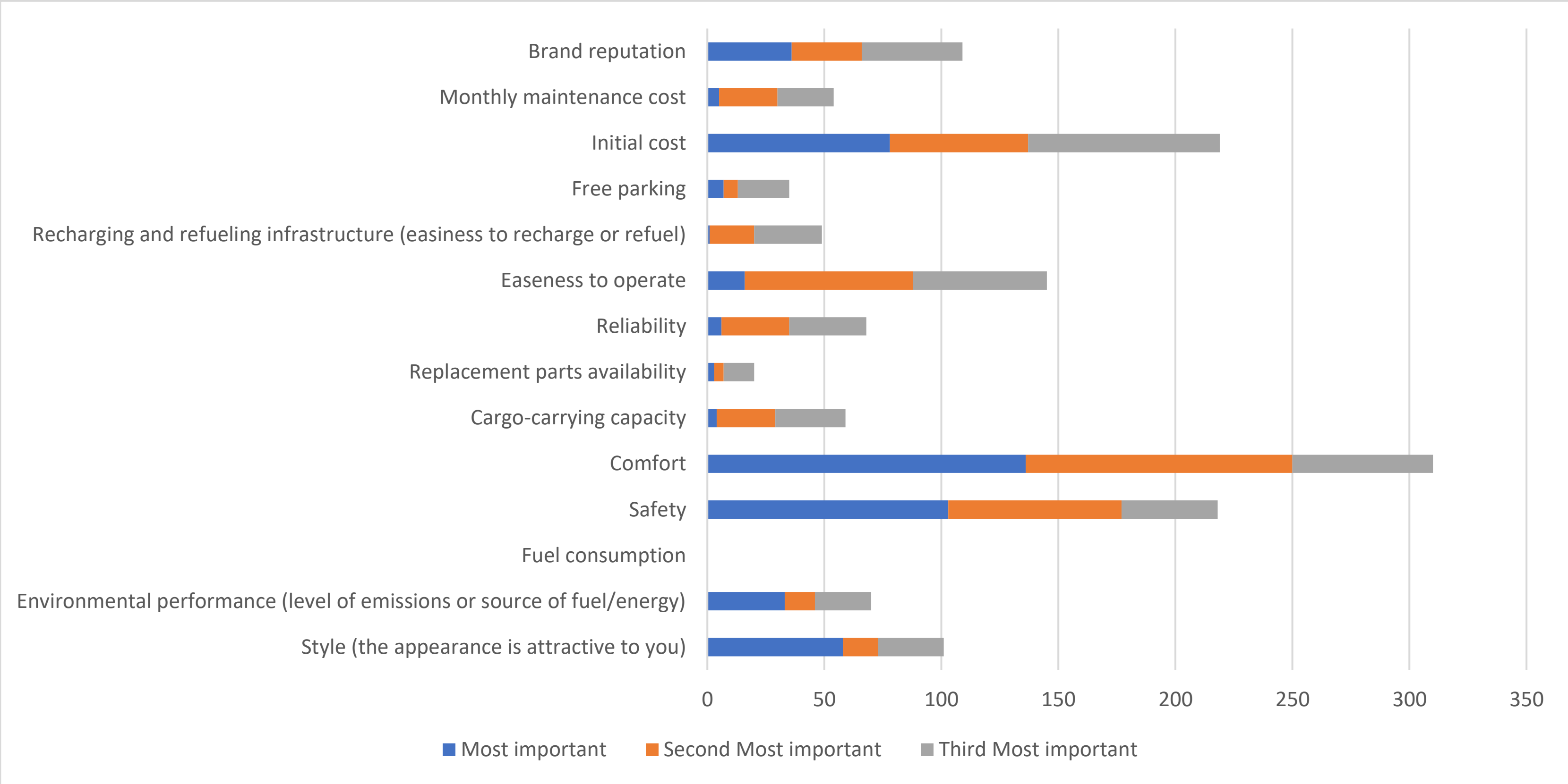
In addition to the choice experiment, the questionnaire survey included follow up questions to further investigate the factors that respondents consider at the time of purchasing a new motorbike (Figure 7.11). Safety is the overall most important factor, followed by the fuel consumption and the initial cost. However, comfort is the most commonly cited factor when respondents are questioned only for the three most important factors (Figure 7.12). Ease of operation is also highlighted as one of the three commonly mentioned important decision criteria. In contrast, availability of replacement parts and free parking are two of the least important factors (Figure 7.13). Style and brand reputation are two of the most divisive elements, these are very relevant for many, but also some of the least important for other respondents. Environmental performance is also in a similar situation, in which it highlights both in the list of three most and the three least considered factors. However, there is consensus amongst respondents on a negative perception of air quality and traffic congestion (Figure 7.14).

Figure 7.11: Factors to Consider When Purchasing a New Motorbike



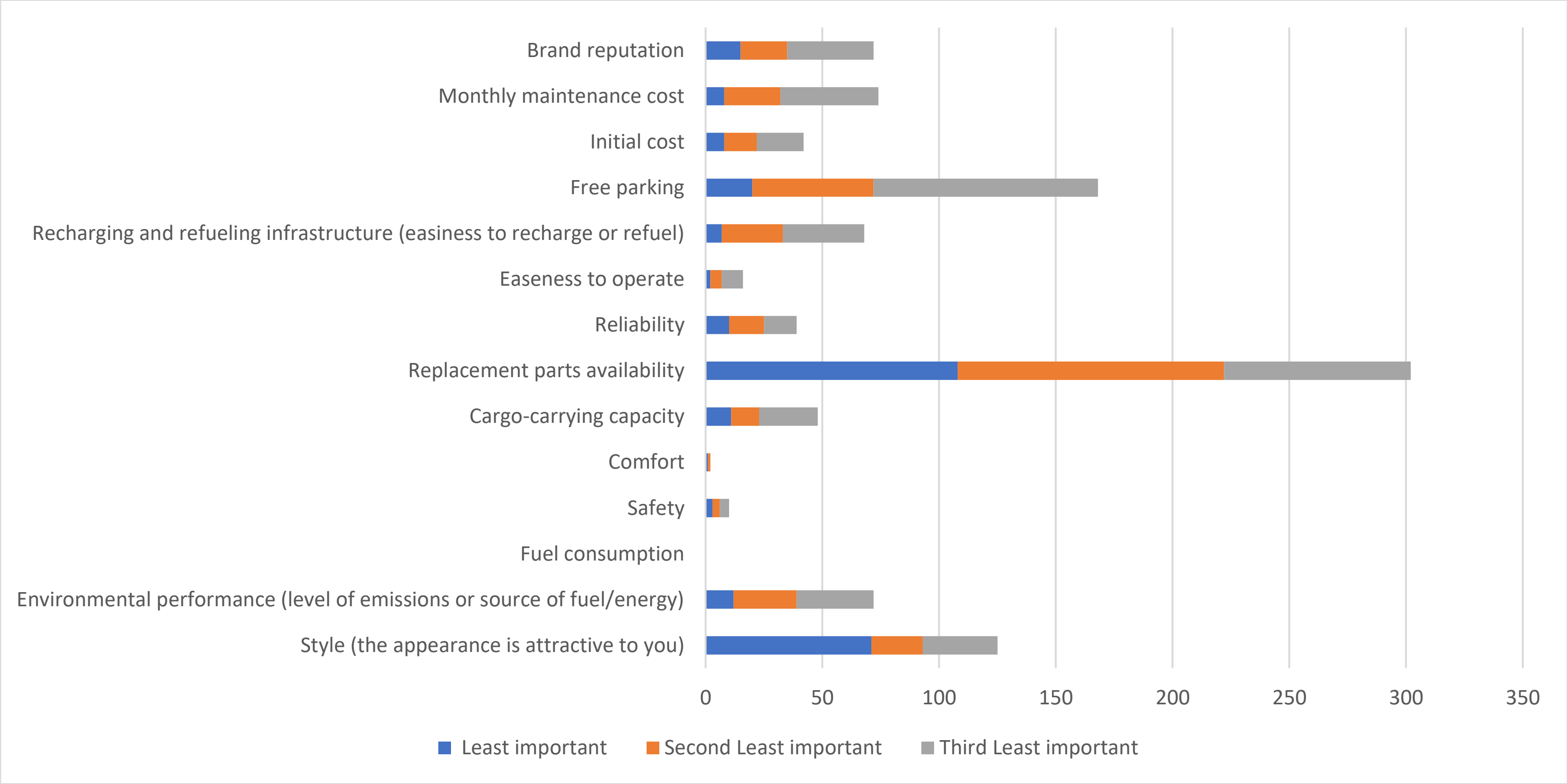
Source: Authors' calculation.

Figure 7.12: Three Most Important Factors to Consider when Purchasing a New Motorbike



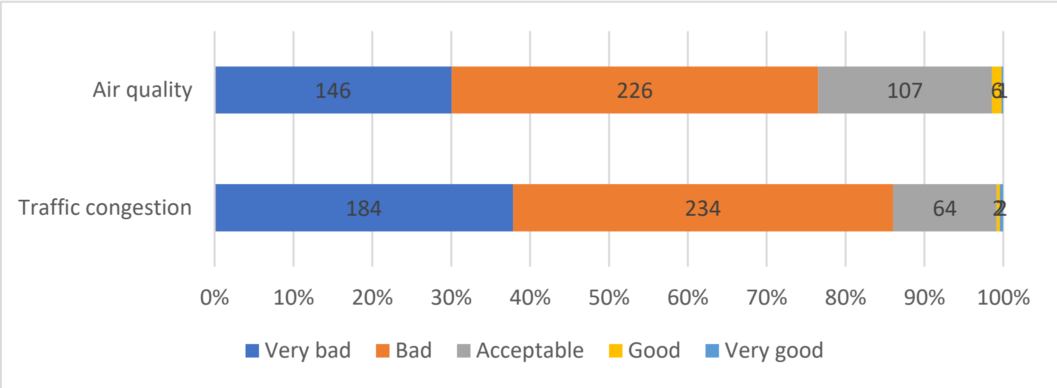
Source: Authors' calculation.

Figure 0.1: Three Least Important Factors to Consider when Purchasing a New Motorbike



Source: Authors' calculation.

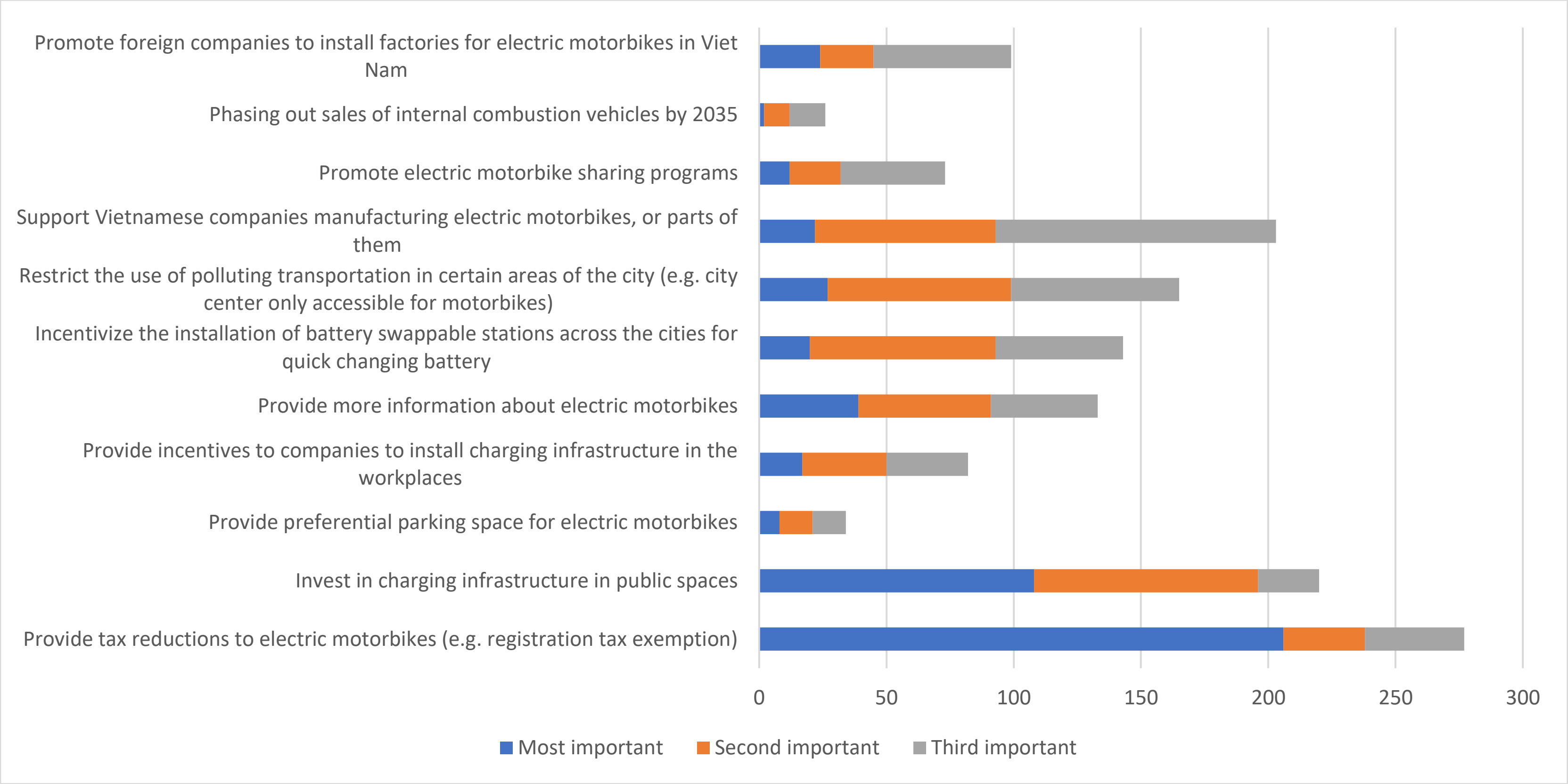
Figure 0.2: Respondents’ Perception of the Air Quality and Traffic Congestion



Source: Authors’ calculation.

For the promotion of the use of electric motorbikes, respondents favoured policy measures such as tax reductions and investments in charging infrastructure in public spaces (Figure 7.15). The support to Vietnamese companies to involve in the manufacturing of motorbikes was also a commonly expressed action that the government could take, notably more than the support for installation of manufacturing centres from foreign companies. Other restrictive measures such as phasing out the sale of internal combustion engine motorbikes or the creation of preferential areas parking space for electric motorbikes were the least preferred. Nevertheless, a great number of respondents expressed their support for the restriction of access to the city centres to the most polluting transportation modes. Other measures to support the installation of charging points and stations for swapping batteries are broadly supported, as well as increasing the diffusion of information about electric motorbikes.

Figure 7.15: Top Three Actions the Government Could Take to Promote Electric Motorbikes



Source: Authors' calculation.

3.5. Conclusion

A sustainable transportation model in Viet Nam must consider the decarbonisation of the current mobility patterns compatible with the needs of residents. Currently, motorbikes are the preferred transportation mode for any purpose. The COVID-19 pandemic has exacerbated this pattern. The number of motorbikes is already at unsustainable levels leading to high congestion and air and noise pollution. As residents increase their available income, drivers may shift from motorbikes to private cars, which would worsen the conditions. In contrast, a replacement of the gasoline motorbikes by electric would help to reduce the negative environmental impacts with an acceptable solution. To understand the attributes that could trigger or hinder this shift, this chapter presents the results of a survey and choice experiment in Viet Nam.

Most of the respondents to the survey use their motorbikes for their trips. This result is probably biased due to the mobility restrictions imposed due to COVID-19. However, it shows the importance that motorbikes play in the country. Most of them are gasoline motorbikes from large manufacturers, particularly Honda and Yamaha. Respondents also had very little experience with riding electric motorbikes, with most of them not having any experience at all. Nevertheless, respondents showed good knowledge of the characteristics of electric motorbikes and the available models in the market.

All the attributes considered are significant except for charging time, which may indicate that batteries for electric motorbikes are not a major barrier, such as for electric cars. This can be due also to the ease of charging, the lower range of usual trips, and the possibility of contracting battery-swapping services. The estimation of the WTP for each of the attributes is USD25.5 for improving 1 km/h in top speed, USD27.3 to improve range in 10 km, USD25.5 to reduce 4.4 cents/km in fuel cost, and USD7.5 to reduce 4.4 cents/month in maintenance cost. The country of origin is also significant and shows a lower preference for motorbikes manufactured in China. This may be due to bad experiences with early models. However, since China is the largest market for electric motorbikes, these companies might be able to bring models that fit the needs and expectations of consumers. Also, brands from Viet Nam are regarded similarly to those from Japan (the main country of origin of available gasoline motorbikes) and Europe (which are regarded as high cost and performance).

The survey also allowed the respondents to express their preferences amongst a set of policy incentives. Amongst those, tax reductions and investments in charging infrastructure in public spaces were the most preferred. Indeed, the provision of incentives for the installation of charging points and stations for swappable batteries are in general supported by the respondents. In contrast, other measures more restrictive with gasoline motorbikes, such as banning their sale or restricting parking spaces are least preferred. However, there seems to be an understanding that certain restrictions would be required, and, for example, limiting the access to the city centre to the most polluting vehicles is broadly supported.

To sum up, there seems to be an interest in electric motorbikes despite not being widely available yet. Respondents have a good knowledge and a positive attitude towards them. As companies, national and foreign, are bringing to the market new models with a wider range of prices and characteristics, local and national governments have the opportunity to put in place policies to support a gradual replacement of polluting motorbikes for other more environmentally friendly. Nevertheless, this should not minimise the importance and need of improvements in other alternatives, such as public transportation. Widespread adoption of electric motorbikes would help to significantly reduce the air and noise pollution impacts from the traffic congestion, but this would continue with the transit travel time and total travel cost. For example, a study around the delayed metro line project Ho Chi Minh City, (Nguyen et al., 2019) found that a resident switching from a motorbike would obtain a monetary welfare increase of VND56,000.

Chapter 8

Policy Implications and Conclusions

The policy implications of this study are summarised below.

First, the respondents' environmental concerns can justify renewable expansion. The respondents in this research have many concerns about air pollution and global warming issues, and renewables are found to be environmentally friendly.

Second, although the respondents are willing to pay extra money for renewables, the willingness to pay (WTP) is not high, necessitating the continued cost reduction of these technologies. The amount of WTP for renewable energy is only a few percent in Thailand and Malaysia for most cases, and around 10% in the Philippines, with the highest value being about 20% for solar in the Philippines (for an increase in renewable energy share to 60%). These figures are mostly consistent with those indicated for developing countries according to the literature review conducted in last year's report. This can be interpreted as that the consumers are willing to pay more money for renewable energy, but the amount is not significantly large. Renewable energy itself has been steadily decreasing in cost worldwide, but as more renewable energy is introduced, there will be increasing costs for grid measures such as transmission expansion and energy storage deployment. Innovation to lower the cost of system integration as well as to develop renewable energy technologies will be increasingly necessary in the future, and there is a need to strengthen innovation so that the total cost can be kept within this small figure.

Third, different perceptions of renewable technologies imply that different deployment strategies might be needed. Solar photovoltaic (PV) has the highest awareness amongst renewable energy sources and is regarded as the most environmentally friendly energy as shown in the surveys for all targets countries. Furthermore, in all of the countries investigated, biomass energy receives a consistently low value. The willingness to pay also basically corresponds to this tendency. The WTP for solar PV is consistently high and that for biomass energy tends to be low. It is a fact that biomass energy can cause air pollution if not used with end-of-pipe technologies. Also, air pollution ranks high on the list of environmental problems that people are concerned about, which may explain why people have a bad impression of biomass. However, since biomass is an important renewable energy that can be dispatched, it is necessary to properly regulate biomass energy and to dispel its bad image. As for solar power generation, the willingness to pay is high and the impression is good, so it may be prioritised for expanding deployment.

Compared to the results of the phase one, the percentage of people who have been economically affected by COVID-19 has generally increased. Therefore, this may have influenced the results of this year’s survey. Although we do not know how long the impact of COVID-19 will last, we need to be careful in interpreting the results from this year’s survey of willingness to pay.

In this study, we investigated the willingness to pay not only for renewable energy, but also for electric motorbikes. Although price is not necessarily an important factor in the decision to purchase a motorbike because of the aspect of consumption for status, we devised our research design and conducted the survey. We found that citizens have a good knowledge and positive attitude towards electric motorbikes, even though the current levels of adoption are still very low. We also found that initial cost, speed, range, fuel and maintenance costs, and country of origin have a significant influence on the decision to purchase. Interestingly, the image of Vietnamese brands on electric motorbikes (new, and therefore, with little experience) is similar to the predominant and premium brands (particularly Japanese). Also, it was found that charging time is not a significant concern to purchase an electric motorbike, as is the case for electric cars. When asked about preferred policy actions to promote electric motorbikes, tax reductions and investments in charging facilities in public spaces are the most commonly mentioned. In addition to these, respondents were also very positive about the support to local brands manufacturing electric motorbikes. The results show the potential of electric motorbikes to support a transition towards a more sustainable urban mobility (with reducing air and noise pollution and limiting the impact in traffic conditions from a shift towards private cars) as well as to incentivise the emergence of new (or upgrading of existing) industries in the country.

The results of this study on carbon dioxide removal (CDR) provide suggestions for the direction of international research and development. CDR was little known in the target countries and the awareness was low. When the respondents were given some simple information and asked to think about it, they gave ambivalent answers. That is, the respondents felt that CDR had some benefits, but also recognised that it could hinder mitigation measures such as reducing carbon dioxide emissions. Moreover, as CDR is still an immature technology, it will need to be developed. When asked which countries and regions should lead the way in its technological development, they responded those countries that are affected by global warming (Philippines) (the choice that received largest responses), and those that emit large amounts of carbon dioxide (Malaysia and Thailand). The importance of CDR is increasing day by day, as countries around the world are planning to achieve net zero emissions by 2050, and sooner or later ASEAN countries as well will need to consider such a drastic reduction.

In addition, it should be noted that the willingness-to-pay figures revealed in this study are limited to renewable energy and electric bikes, and not to carbon pricing applied to the entire economy.

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Appendix 1 Questionnaire for the Philippines

Appendix 1.1 Questionnaire for DCE and CVM survey

SURVEY ON ELECTRICITY CONSUMPTION
AND ATTITUDE TOWARDS CLEANER SOURCES OF ENERGY

Before starting, the enumerator visually checks or asks if the house has an electric metre. If none, the enumerator moves to the next house, until a household with a MERALCO connection is found.

INFORMATION SHEET

must be given to respondent

Dear Sir/Madam,

Good day. I am ____________________________ from REAP. We are conducting a research on households' electricity consumption and their attitudes towards cleaner sources of energy.

We would like to invite you to participate in the survey for our research. We will ask your opinions regarding renewable energy sources and protection for the environment, as well as questions about your household's electricity consumption and demographic and other basic questions about your household. The interview will take approximately 60 minutes.

All your answers will be kept confidential and will only be used for this research. Any personal identification, including your name, will not be entered into the computer. Your name will only appear on the consent form and/ your payment receipt.

If you decide to participate and complete the survey, you will receive PHP XXX as compensation.

The survey respondent must be the household head, or the spouse of the household head, or an adult member of the household (18 years old or older) who pays the monthly electricity bill. Your participation is completely voluntary. You are free to discontinue participation at any time during the interview.

If you agree to participate in this survey, please sign the consent form.

In the case you have any questions about the questionnaire, please contact the principal researcher:

SURVEY ON ELECTRICTY CONSUMPTION
AND ATTITUDES TOWARDS CLEANER SOURCES OF ENERGY

CONSENT FORM

enumerator keep this

I understand that I have been invited to participate in a research survey.	☐ **Yes**	☐ **No**
I have received and read a copy of the Information Sheet.	☐ **Yes**	☐ **No**
I understand the benefits and risks involved in participating in this survey.	☐ **Yes**	☐ **No**
I understand that I can quit taking part in this survey at any time.	☐ **Yes**	☐ **No**
The confidentiality been explained to me.	☐ **Yes**	☐ **No**
I understand how my answers will be used.	☐ **Yes**	☐ **No**
I understand what for my answers will be used.	☐ **Yes**	☐ **No**
I give my permission to use my data for the purposes specified.	☐ **Yes**	☐ **No**
I agree to participate in the survey.	☐ **Yes**	☐ **No**

[Enumerators are not allowed to interview if there is any answer of 'No' in the above questions]

I agree to participate in the survey.

______________________ ______________________

Name and Signature Date

Phone:

ID: CV20%-____

Version: CV20%-PT1

Enumerator

____

Date of interview

_____ _____ 2020

dd mm

SURVEY ON ELECTRICITY CONSUMPTION

AND ATTITUDES TOWARDS CLEANER SOURCES OF ENERGY

PART I: ELECTRICITY CONSUMPTION

1. What type of meter does your household have? [*Choose one only*]

☐ 1. Residential electricity meter only.

☐ 2. Business electricity meter only.

☐ 3. Both residential and business electricity meters.

FOR THOSE WHO ANSWERED (1) AND (3) TO A QUESTION 1:

*Enumerators ask for permission to see the **residential** electricity bills for the last three months and fill in the following information in **Questions 2** to **5 (How many kWh was your electricity consumption last month. Can I take a look at your electricity bills).***

2. Residential Electricity Bills

Month	Meter 1		Meter 2 (if household has a second residential meter)	
	kWh	Amount (tax & other fees included) PhP	kWh	Amount (tax & other fees included) PhP
______ 20____				
______ 20____				
______ 20____				

3. Customer name: ____

4. Address in the bill: *house number and street name*: ____________________

barangay: ______________________, *city*: ________________.

5. Voltage level class (indicated in the bill): ______________.

Enumerator asks for permission to take a photo of the recent bill among the electricity bills viewed.

6. Number of households sharing the meter and payment of the bill (include own household in the count):__________ households.

7. If answer to Question 6 is more than 1, ask why more than one household share their electricity meter.

□ 1. Has tenants/renters □ 2. Shares meter with neighbour/s

8. Out of the monthly electricity consumption of [*copy the response from Question 3 here*]_______ kWh/month, how much electricity is consumed by these neighbouring households, tenants and business renters who share electricity with your households?

______________ kWh/month OR PHP/month.

OR If respondent cannot give amount, proportion is acceptable.

□ 1. 1/5 (20%)	□ 4. 1/2 (50%)
□ 2. 1/4 (25%)	□ 5. 3/4 (75%)
□ 3. 1/3 (30%)	□ 6. Others. Please specify:

9. Does your household run a business at home? *(Note to enumerators: Do not include businesses run by tenant/renters. Having housing units for long-term rent **IS NOT** considered a business.)*

□ 1. Yes *Go to Question 10.*

□ 2. No *Go to Question 25.*

10. What kind of business?

□ 1. Grocery/convenience store
□ 2. Specialty store
□ 3. Restaurant
□ 4. Coffee shop
□ 5. Laundry services
□ 6. Barber/Beauty shop
□ 7. Tailor shop
□ 8. Hotel/inn
□ 9. Agriculture/livestock/poultry/landscaping
□ 10. Bike/car wash
□ 11. Bike/car repair shop
□ 12. Household manufacturing/cottage industry (manufacturing done at home)
□ 13. Others, specify: ____________

11. Do you have a private (internal) meter to measure the electricity consumption of your business?

□ 1. Yes. → What is the average monthly electricity consumption of your business? _______ kWh

□ 2. No. → Your best estimate, what proportion of the total monthly electricity volume is used for the business?

□ 1. ¼ (25%)	□ 3. ¾ (75%)
□ 2. ½ (50%)	□ 4. Almost all (90% or more)

Jump to Question 23.

FOR THOSE WHO ANSWERED (2) AND (3) TO QUESTION 1:

*Enumerators ask for permission to see the **business** electricity bills for the last three months and fill in the following information in **Questions 12** to **15**.*

12. Business Electricity Bills

Month	Meter 1		Meter 2 (if household has a second business meter)	
	kWh	Amount (tax & other fees included) PhP	kWh	Amount (tax & other fees included) PhP
______20____				
______20____				
______20____				

13. Customer name: ____

14. Address in the bill: *house number and street name*: ________________________

barangay: _________________________, *city*: ______________________________.

15. Voltage level class (indicated in the bill): ____________.

Enumerator asks for permission to take a photo of the recent bill among the electricity bills viewed.

16. Number of households sharing the meter and payment of the bill (include own household in the count):_________ households.

17. If answer to Question 6 is more than 1, ask why more than one household share their electricity meter.

□ 1. Has tenants/renters □ 2. Shares meter with neighbour/s

18. Out of the monthly electricity consumption of [*copy the response from Question 12 here*] ______ kWh/month, how much electricity is consumed by these neighbouring households, tenants and business renters who share electricity with your household? ____________ kWh/month OR PHP/month.

OR If respondent cannot give exact amount, proportion is acceptable

□ 1. 1/5 (20%)	□ 4. 1/2 (50%)

□ 2. 1/4 (25%)	□ 5. 3/4 (75%)
□ 3. 1/3 (30%)	□ 6. Others. Please specify:

19. Does your household run a business at home? *(Note to enumerators: Do not include businesses run by tenant/renters. Having housing units for long-term rent **IS NOT** considered a business.)*

□ 1. Yes *Go to Question 20.*

□ 2. No *Go to Question 22.*

20. What kind of business?

□ 1. Grocery/sari-sari/convenience store	□ 8. Hotel/inn
□ 2. Specialty store	□ 9. Agriculture/livestock/poultry/landscaping
□ 3. Restaurant	□ 10. Bike/car wash
□ 4. Coffee shop	□ 11. Bike/car repair shop
□ 5. Laundry services	□ 12. Household manufacturing/cottage industry (manufacturing done at home)
□ 6. Barber/Beauty shop	□ 13. Others, specify: ____________
□ 7. Tailor shop	

21. Do you have a private (internal) meter to determine the monthly electricity consumption of your business?

□ 1. Yes. What is the average monthly electricity consumption of your business? _______ kWh

□ 2. No. What proportion of your total electricity consumption is used by your business?

□ 1. ¼ (25%)	□ 3. ¾ (75%)
□ 2. ½ (50%)	□ 4. Halos lahat (90% or more)

22. Why do you have a business electricity meter when you are not running a business?

____.

23. Over the past 12 months, how much is the average monthly electricity bill of your household (best estimate)? __________________ **PHP/month.**

Enumerator fills up the blanks below based on the data from pictures of the electricity consumption (electricity bills have chart of consumption over the past 12 months). This can be done after the interview. 24. Over the past 12 months, what is the volume of your average monthly electricity consumption (best estimate)? ________________________ **kWh/month.**

25. In the past year, how many times has your households experienced a power outage?_______ times/year.

26. What is the average length of the power outages your household has experienced over the past year? ______ hours.

27. Have you been delayed in payment of your electricity bill? □ Yes □ No

28. Are you currently delayed in payment of your electricity bill?

□ Yes → How many months are you delayed?: _____ months

□ No

PART 2A: CONTINGENT VALUATION

The demand for electricity in Philippines has rapidly increased in the past decade. By 2030, electricity consumption in the country is expected to be more than double that of 2015, according to the Power Development Plan (Department of Energy Republic of the Philippines, 2016).

In 2019, the total installed capacity is 26 GW and the sources of this installed capacity are:

- Coal, oil and gas: 70%
- Renewable energy: 30%

Show visual aid 1a

The production of coal-, oil- and gas-fired thermal energy generates a great amount of greenhouse gases, which considerably contribute to the process of global warming. Greenhouse gasses emission from the production of renewable energy is much lower, and is thus considered to be an important measure of global warming mitigation.

The Department of Energy of the Philippine government has embarked on a program to increase the share of renewable energy in the total installed electricity capacity to reduce greenhouse gas emissions and hence contribute to global warming mitigation. In 2030, the required total installed capacity of 31 GW will be sourced from:

Coal, oil and gas	**50%**
Renewable energy	**50%**

Show visual aid 1b

This means that the share of renewable energy will be increased from only 30% in 2019 to 50% in 2030.

Show visual aid 1c

To increase the share of renewable energy, a large number of renewable power plants have to be built in the coming years. Renewable energy includes many types. Popular types of renewable energy in Philippines are geothermal power, solar energy, wind power, biomass power, and small-scale hydropower.

Hydroelectric energy is a form of energy that harnesses the power of water in motion (such as water flowing over a waterfall or stream/river) to generate electricity. There are large-scale as well as small-scale hydropower systems. Unlike large-scale hydropower systems, small-scale hydropower systems cause little or no environmental impacts.

Show visual aids 2a and 2b

Geothermal energy is the thermal energy generated and stored in the earth (mainly from volcanic activity). The steam generated by geothermal energy is used to generate electricity by turning a steam turbine connected to a generator.

Show visual aid 3

Solar energy refers to electricity converted from sunlight by using photovoltaic cells. Solar energy could be produced in large-scale plants, but it could also be produced by small-scale rooftop solar systems.

Show visual aids 4a & 4b

People can use wind to create electricity. When wind blows, the blades of wind turbines rotate and generate electricity.

Show visual aid 5

Biomass power is generated by burning organic wastes. It generates less greenhouse gases than fossil fuels.

Show visual aid 6

CV-Question 1: Have you heard or known of the above mentioned renewable energy before this survey?

a. Solar power	□ Yes	□ No
b. Wind power	□ Yes	□ No
c. Biomass power	□ Yes	□ No
d. Small-scale hydro power	□ Yes	□ No
e. Geothermal power	□ Yes	□ No

The switch to renewable energy from fossil fuel is in line with the commitment of the Philippines with international community, for example, the Nationally Determined Contribution in the Paris Agreement 2016. This commitment has been stipulated in sectoral laws (e.g., the Renewable Energy Act of 2008). The National Renewable Energy Program (the Program) sets the strategic building blocks to achieve the goals set forth in the Renewable

Energy Act of 2008. The Program seeks to increase the RE-based capacity of the country to an estimated 15 GW by the year 2030, which is about double the 2019 level to reduce greenhouse gases emission. This is to contribute to the mitigation of global warming and sea level rise.

Show again visual aid 1c, chart of comparable shares of energy sources

Measures have been specified in the Program in order to increase the share of renewable energy from 30% in 2019 to 50% (15 GW) in 2030. To achieve the desired target, two important institutions have been designated to be responsible for policy planning and implementation of the Program. One is the Renewable Energy Management Bureau in the Department of Energy, and the other is the National Renewable Energy Board that is composed of various stakeholders. To achieve the target of the Program, more renewable energy plants need to be installed.

All the electricity generation costs, together with the delivery costs, determine the retail prices for households. Future prices may vary, but for now the prices for renewable energy is 10–15 percent higher than that for electricity from coal- and gas-fired thermal power plants. Hence, as the share of renewable energy increases, the retail prices must increase as well.

However, so far there is no referendum to elicit the opinion of households about this issue.

We are conducting this survey to elicit people's opinion regarding the issue. We are doing this survey to find out if households in the Philippines would be willing to pay higher monthly electricity bills for the increase in the share of renewable energy. We would like to know, if the share of renewable energy increases to 50%, how much increase in the current monthly electricity bill is acceptable for you.

Please remember that the survey you are participating in today is only to find out your opinion about this matter. It is not an actual referendum. But we would like to request you to vote in this survey exactly how you would vote in an actual referendum.

We also would like to remind you that should the program push through, you and all the other households will have to pay the increase in electricity bill, and hence your budget for your other consumption items will be reduced by the amount of the increase in electricity bill.

WTP QUESTIONS

CV-Question 4: Suppose the Program that will increase renewable energy share to 50% would mean that the monthly bill of your households and all other households in Philippines increase by **20%** – (*compute current bill amount PhP______ X 1.20 = PhP_________*) from 2030 (when the target 50% share ng Renewable Energy is achieved). Would you vote in favour or against the Renewable Energy Program?

□ Vote for (Yes) → *Go to Question 4a.* □ Vote against (No) → *Go to Question 4b.*

CV-Question 4a: If the Renewable Energy Program would mean a **25%** increase in your monthly electricity bill (*current bill amount PhP_____ X 1.25 = PhP________*), would you still vote in favour of the Renewable Energy Program?

□ Vote for (Yes) → *Go to Question 7.* □ Vote against (No) → *Go to Question 7.*

CV-Question 4b: If the Renewable Energy Program would mean a **15%** increase in your monthly electricity bill (*current bill amount PhP_____ X 1.15 = PhP________*), would you vote in favour of the Renewable Energy Program?

□ Vote for (Yes) → *Go to CV-Question 7.* □ Vote against (No) → *Go to CV-Question 5.*

CV-Question 5: Is there any increase (%) in the current month electricity bill that you would be willing to pay for the Program? _________ %. *(Put zero if not willing to pay any amount at all.)*

CV-Question 6: Why would you not vote for the Renewal Energy Program and be not willing to pay for increased share of renewable energy? *(Check all that apply.)*

□ 1. I don't believe the Program will succeed in achieving the target of renewable energy.

□ 2. I don't think the renewable energy would help mitigate global warming and sea level rise.

□ 3. My current electricity bill is already high.

□ 4. Many households in Philippines would not afford the bill increase.

□ 5. Poor households in Philippines would not afford the bill increase.

□ 6. Other reasons, please specify _________________________.

Go to CV-Question 8.

CV-Question 7: Why would you vote for the Renewable Energy Program and be willing to pay a higher electricity bill for this? *(Check all that apply.)*

□ 1. I should pay for the higher costs of electricity production.

□ 2. I would pay for the mitigation of global warming and sea level rise.

□ 3. I don't think my vote matters. I and other households will ultimately have to pay for it.

□ 4. Other reasons, please specify ___________________________.

CV-Question 8: How certain are you of your 'YES'/'NO' vote?

1. Siguradong-sigurado	2. Sigurado	3. Medyo sigurado	4. Medyo hindi sigurado	5. Sobrang hindi sigurado

CV-Question 2: Do you believe that the Program would achieve the goal of increasing renewable energy and contribute to the mitigation of global warming and sea level rise?

□ OO　　□ HINDI

CV-Question 3: Do you think that the government will successfully implement the Program to achieve the goal of 50% renewable energy??

□ OO　　□ HINDI

PART 2B: CHOICE EXPERIMENT

70% of the gross electricity production in the Philippines is sourced from coal-, oil- and gas-fired thermal power plants. Electricity generation by these fossil fuels produce a great amount of greenhouse gases, which considerably contribute to the process of global warming.

Switching fossil fuels to renewable energy sources (e.g., solar, wind, geothermal, biomass and small-scale hydropower) is considered to be an important measure of global warming mitigation because greenhouse gases emission from the production of renewable energy is much lower than fossil fuels.

Renewable energy includes many types. Popular types of renewable energy in Philippines are geothermal power, solar energy, wind power, biomass power, and small-scale hydropower.

Hydroelectric energy is a form of energy that harnesses the power of water in motion (such as water flowing over a waterfall or stream/river) to generate electricity. There are large-scale as well as small-scale hydropower systems. Unlike large-scale hydropower systems, small-scale hydropower systems cause little or no environmental impacts.

Show visual aid 2a and 2b

Geothermal energy is the thermal energy generated and stored in the earth (mainly from volcanic activity). The steam generated by geothermal energy is used to generate electricity by turning a steam turbine connected to a generator.

Show visual aid 3

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Show visual aid 4a & 4b

People can use wind to create electricity. When wind blows, the blades of wind turbines rotate and generate electricity.

Show visual aid 5

Biomass power is generated by burning organic wastes. It generates less greenhouse gases than fossil fuels.

Show visual aid 6

The installation of renewable energy sources might increase cost of electricity production. As a result, retail price of electricity may have to increase. We would like to know if you would be willing to pay for the increased renewable energy production.

You will now be asked to answer seven to eight questions, each requests you to make a choice between three alternatives of energy services. Each alternative is characterised by three attributes:

the share of renewable energy in total capacity: the current level is 30% and this figure is not enough. In the following questions, we assume that it increases to 35%/40%/45%/50% in 2030.

type of renewable energy: Please consider that the increase in renewable energy (from the current 30% to 50% in 2030) will be powered only by one of these sources - solar/wind/biomass/small-scale hydropower, although current share of 30% is a combination of those renewable power sources.

increase in monthly electricity bill: as producing renewable energy is likely more costly at this moment, the monthly electricity bill of your households as well as all other households in Philippines may also increase when the share of renewable energy increases. Please note that increase in monthly bill is in percentage, so households with higher monthly electricity bills would have to pay larger additional amounts.

Please assume that your monthly bill won't increase until the share of renewable energy indicated in each choice question is achieved. Please also assume that any attributes other than the three attributes presented in the alternatives remained identical. We would like to know which alternative you most prefer.

CHOICE SETS: Enumerator checks the alternative chosen Block ____________

Choice Set	Alternative A	Alternative B	Alternative C
1			
2			
3			
4			
5			
6			

7			
8			

FOLLOW-UP QUESTIONS

FU-Q 1. How certain are you of the choices you made?

☐ 1. Very certain ☐ 2. Certain ☐ 3. Not sure ☐ 4. Uncertain ☐ 5. Very uncertain

FU-Q 2: Have you ever heard of or know about renewable energy sources below before this survey?

Solar power	☐ 1. Yes	☐ 2. No
Wind power	☐ 1. Yes	☐ 2. No
Biomass power	☐ 1. Yes	☐ 2. No
Small-scale hydropower	☐ 1. Yes	☐ 2. No
Geothermal power	☐ 1. Yes	☐ 2. No

FU-Q 3: How do you feel about renewable energy sources below?

	1. Very Environmentally Friendly	2. Environmentally Friendly	3. Not sure	4. Environmentally Unfriendly	5. Very Environmentally Unfriendly
Solar power	☐	☐	☐	☐	☐
Wind power	☐	☐	☐	☐	☐
Biomass power	☐	☐	☐	☐	☐
Small-scale hydropower	☐	☐	☐	☐	☐
Geothermal power	☐	☐	☐	☐	☐

FU-Q 4. Are the types of renewable energy important to you when making your choice?

☐ 1. Yes ☐ 2. No

FU-Q 5. Do you consider the proportion of renewable energy when making your choices?

☐ 1. Yes ☐ 2. No

FU-Q 6. When making your choices between alternatives, do you think that the shares of renewable energy presented in the alternatives are feasible to implement?

☐ 1. Yes ☐ 2. No

FU-Q 7. Do you believe that your household's monthly electricity bill would increase if the share of renewable energy increases?

☐ 1. Yes ☐ 2. No

FU-Q 8. Were you aware about the difference between large-scale hydropower and small-scale hydropower before this survey?

☐ 1. Yes ☐ 2. No

PART 3: ATTITUDES TOWARDS ENVIRONMENTAL ISSUES

1. In your opinion, Which of the following environmental problems are the two most important for the government to solve in this city in the next 10 years?

Problem	Rank 1 (most serious/urgent & 2 (2nd most serious/urgent)
Air pollution	
Groundwater contamination (pollution sa tubig sa ilalim ng lupa)	
Solid waste management	
Flooding (pagbabaha)	
Surface water contamination (pollution sa mga ilog, lawa, dagat)	
Noise	
Hazardous waste from industries (nakakalason at nakapipinsalang waste materials mula sa mga pabrika)	
Water shortage (kakulangan ng tubig)	
Electricity shortage (kakulangan ng elektrisidad)	
Global warming and climate change	
Others, specify: _____________	

2. Do you agree or disagree with each of the following statements?

	Lubos na sumasang-ayon (1)	Medyo sumasang-ayon (2)	Neutral (3)	Medyo di sumasang-ayon (4)	Lubos na di sumasang-ayon (5)	Hindi alam (0)
1. Government should subsidise electricity for the poor households.	☐	☐	☐	☐	☐	☐

2. I don't care about the source of electricity. I prefer cheapest electricity source.	□	□	□	□	□	□
3. I am willing to pay more for electricity if there are fewer blackouts.	□	□	□	□	□	□
4. The government should provide electricity at a higher price to encourage electricity saving practices.	□	□	□	□	□	□

3. Do you agree or disagree with each of the following statements?

	Lubos na sumasang-ayon (1)	Medyo sumasang-ayon (2)	Neutral (3)	Medyo di sumasang-ayon (4)	Lubos na di sumasang-ayon (5)	Hindi alam (0)
1. I am concerned about climate change.	□	□	□	□	□	□
2. Climate change can harm me and my household.	□	□	□	□	□	□
3. Science and technology will eventually solve our problem with climate change.	□	□	□	□	□	□
4. Renewable energy is good for the environment.	□	□	□	□	□	□

5. I hear a lot about renewable energy in the news.	☐	☐	☐	☐	☐	☐
6. I hear a lot about climate change in the news.	☐	☐	☐	☐	☐	☐

The enumerator reads the following information carefully. The enumerator also gives a copy of the paragraph so the respondent can also read with the enumerator.

'Scientists and policymakers have become more interested in carbon dioxide removal or 'CDR' as a strategy that may slow or reverse climate change. These strategies remove excess carbon dioxide (CO2) from the atmosphere through various biological, chemical or physical processes. The carbon dioxide would be stored by plants, in soils, or deep underground and in the deep ocean so that it cannot contribute to an increase in the Earth's temperature.'

4. Before today, how much, if anything, would you say that you know about carbon dioxide removal technology?

	1. I know a great deal about carbon dioxide removal technologies
	2. I know a fair amount about carbon dioxide removal technologies
	3. I know just a little about carbon dioxide removal technologies
	4. I have heard of carbon dioxide removal technologies but know almost nothing about it
	5. I have not heard of carbon dioxide removal technologies before today

5. Some people believe that carbon dioxide removal technologies may have associated risks and benefits. To what extent do you agree or disagree with the following statements?

	Lubos na sumasang-ayon (1)	Medyo sumasang-ayon (2)	Neutral (3)	Medyo di sumasang-ayon (4)	Lubos na di sumasang-ayon (5)	Hindi alam (0)
1. There may be negative impacts of carbon dioxide removal technologies on the environment	☐	☐	☐	☐	☐	☐
2. Carbon dioxide removal technologies will lower the drive to cut carbon emissions	☐	☐	☐	☐	☐	☐
3. Carbon dioxide removal technologies are being driven more by profit than by the public interest	☐	☐	☐	☐	☐	☐
4. Carbon dioxide removal technologies will mainly benefit rich countries and impact on poor countries	☐	☐	☐	☐	☐	☐
5. Carbon dioxide removal technologies could help to provide	☐	☐	☐	☐	☐	☐

more time to reduce emissions						
6. It will be cheaper to use carbon dioxide removal technologies than to reduce the consumption of fossil fuels	□	□	□	□	□	□
7. Carbon dioxide removal technologies will help slow climate change down faster than by simply cutting greenhouse gas emissions	□	□	□	□	□	□
8. Carbon dioxide removal only deals with the symptoms and not the causes of emissions	□	□	□	□	□	□

6. In your opinion, which countries should lead in developing carbon removal technologies?

(1) Countries with the highest carbon dioxide emissions

(2) Countries with the highest technical capacity and knowledge

(3) Countries most severely affected by global warming.

PART 4: HOUSEHOLD INFORMATION

Question 1. How have you and your household been affected by the Covid 19 pandemic? ***Check all that apply.***

□ 1. Loss of job/s

□ 2. Decrease in household income

□ 3. Downturn/closure of household business

□ 4. Others: Please specify: ______________________________

Question 2. Please indicate number of household members *(Note to enumerator: Include members who have lived at home for at least 6 months in the last 12 months.)*

	Number of members
All household members	
Number of child members 6 years old and below	
Number of members 60 years old and above	
Number of family members regularly staying home during daytime (present situation w/COVID-19, include WFH members)	

Question 3. Total household monthly income

□ 1. Below PHP10,000
□ 2. PHP10,000–19,999
□ 3. PHP20,000–29,999
□ 4. PHP30,000–39,999
□ 5. PHP40,000–49,999
□ 6. PHP50,000–59,999
□ 7. PHP60,000–79,999
□ 8. PHP80,000–99,999
□ 9. PHP100,000–149,999
□ 10. PHP150,000–199,999
□ 11. PHP200,000 & above

Question 4. Gender of respondent? □ Male □ Female

Question 5. Age? ________________ years old.

Question 6. Currently smoking?

____ Yes. No of sticks per day?: _______ Price of cigarette/stick: PHP_______

____ No.

Question 7. What is your occupation?

□ Unskilled labor
□ Skilled labor
□ Office employee
□ Employee with managerial position
□ Housekeeper
□ Self-employed (free-lance professionals or with own business)
□ Student/Retired/Unemployed
□ Others, specify: _______________

Question 8. Highest educational attainment?

□ 1. No formal schooling
□ 2. Elementary school
□ 3. High school
□ 5. Vocational school
□ 6. College/University
□ 7. Master degree or higher

Question 9. Home appliances and other properties. Please indicate how many of each item your household possesses.

	How many?		How many?
a. TV		b. Aircon	
c. Electric fan		d. Videoke	
e. Rice cooker		f. Cellphone	
g. Washing machine		h. Computer	
i. Radio/stereo		j. automobile	

Question 10. Please indicate how happy and contented are you with your current living conditions. Please use a scale of 1-10, where 1 is very unhappy/discontented and 10 is perfectly happy/contented: ________

Question 11. Before the COVID 19 pandemic, how happy and contented are you with your current living conditions. Please use a scale of 1-10, where 1 is very unhappy/discontented and 10 is perfectly happy/contented: ________

THANK YOU FOR YOUR TIME!

PART 5: QUALITY MANAGEMENT

The following questions are for enumerators.

1. How would you judge the overall quality of this interview?

☐ 1. Excellent
☐ 2. Good
☐ 3. Fair
☐ 4. Poor
☐ 5. Unsure; difficult to say

2. Do you think the respondent thought carefully about the valuation questions and made an effort to give truthful answers?

☐ 1. Definitely yes
☐ 2. Probably yes
☐ 3. Not sure/Difficult to say
☐ 4. Probably not
☐ 5. Definitely not

3. How many people were listening to the interview, other than the respondent?

a. Number of other household members ____
b. Number of non-household members ____

4. Do you have any other comments to add about what happened during the interview that was noteworthy or interesting?

____
____
____

5a. Enumerator stands in the house and collects the GPS location using smart phone/tablet.

5b. Enumerator takes 2 pictures of the front of the house and records distinguishing features.