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SPECIAL FEATURE: ORIGINAL ARTICLE

Citizens' Attitudes, Preferences, Willingness-to-pay for Climate Change Mitigation Options in Asia

Are all renewable energy sources the same? A comparative analysis of public perceptions and preferences for renewable energy types in Southeast Asian cities

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Abstract

The realization of a sustainable energy transition in Southeast Asia will require the overcoming of the current high reliance on fossil fuels in the energy mix and the steady and rapid growth in energy demand in the region. To achieve an economically, socially, and environmentally sustainable energy transition in the region, it is vital to utilize all available renewable energy sources to the greatest extent possible. It is therefore essential to gain an understanding of how citizens in each country perceive the available renewables. However, the majority of existing literature in this region has been constrained by a narrow focus on a comparison between fossil and renewable energy. Furthermore, while previous research has predominantly concentrated on single-country analyses, there are significant implications that could be disseminated across ASEAN countries. In light of the aforementioned limitations of existing literature, this paper aims to make a contribution by undertaking a comparative analysis of public preferences for renewable energy sources in eight major urban areas in seven Southeast Asian countries. The findings of this study indicate that, while climate change (or global warming) is perceived as a significant issue, it is often regarded as a secondary concern compared to other environmental issues. This is despite the fact that many of these issues are closely interlinked with and would be exacerbated by climate change. Furthermore, the findings suggest that solar energy is the most preferred renewable source across all urban areas surveyed. In contrast, bioenergy (or biomass) is generally the least preferred source of energy in all cities. There is considerable variation in perceptions of wind, hydro, and geothermal energy, with a high degree of variability between and within countries. These similarities and differences in preferences for renewable energy sources appear to be associated with varying levels of knowledge or familiarity with each source, which is consistent with differing willingness to pay for each source. These findings highlight the necessity for policies that address this apparent lack of understanding of how the transition to a sustainable energy system and each renewable energy technology can help mitigate the impact of environmental problems highlighted in each society.

Keywords ASEAN · Public preferences · Renewable energy · Willingness to pay · Solar · Hydropower · Wind · Geothermal · Biomass

Introduction

The transition to net-zero electricity systems is a common goal for the countries in Southeast Asia. In 2014, their governments endorsed a new ASEAN Plan of Action for Energy Cooperation (APAEC) 2016–2025 under the framework of the Association of Southeast Asian Nations (ASEAN). The APAEC outlines seven key actions to promote the energy

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transition in the region, including reducing energy intensity by 32% and promoting renewable energy to reach 23% of the total primary energy supply and 35% of the installed electricity capacity by 2025 (ASEAN Centre for Energy 2021). In the period subsequent to the 26th Conference of Parties (COP 26), several member countries have revised their Nationally Determined Contributions (NDCs) and incorporated new commitments to attain carbon neutrality and net-zero energy systems by 2050 (ASEAN Centre for Energy 2023). If achieved, this will put the region on a trajectory to achieve net zero by the end of the century, exceeding the expectations of previous individual and collective targets. Laos, Myanmar, Indonesia, Malaysia, Thailand, Vietnam, and Singapore have announced zero targets, while Cambodia has committed to carbon neutrality. Brunei Darussalam and the Philippines have set more ambitious emission reduction targets (Net Zero Tracker 2023).

Renewable energy sources in ASEAN should account for between 90 and 100% of the total electricity supply by 2050 to achieve a regional electricity system that is compatible with the global net-zero goal (IRENA and ACE 2022). However, despite an increase in renewable energy generation over the past decade, the electricity mixes of Southeast Asian countries remain heavily dependent on coal and natural gas. Myanmar and the Lao People's Democratic Republic (PDR) are the exceptions, with large-scale hydropower being the primary source of electricity from non-fossil resources. Even in Vietnam, where solar energy has rapidly increased since 2018, renewables constitute a minor portion of the electricity mix (IRENA and ACE 2022). It is therefore evident that to achieve the desired reduction in carbon emissions, a significant transformation of the power generation mix will be required. In many instances, this will exceed the existing targets delineated in their power development plans (Arino and Prabhakar 2022).

Public support will be essential to ensure the long-term continuity and legitimacy of policies promoting the growth of renewable energies in the region. The investment requirements for renewable energy are commensurate with the current levels of investment and have not been met in the past (Vakulchuk et al. 2022). As a result, these may require increased efforts by governments and citizens alike, which may manifest itself in anticipated increases in electricity tariffs, even if only in the short to medium term. At the same time, Southeast Asian countries will need to deploy a range of renewable energy technologies to achieve decarbonized security of supply.

The objective of this paper is to elucidate the discrepancies in public perceptions and to undertake a comparative analysis across Southeast Asia. To this end, we have conducted choice experiment surveys in major urban areas in Southeast Asia with the objective of estimating households' willingness to pay (WTP) for different scenarios of renewable energy integration and comparing between renewable energy technologies. WTP has been employed in numerous previous studies as a means of evaluating public preferences towards renewable energy (Soon and Ahmed 2015). However, the literature in Southeast Asia is still scant on the comparison on preferences between renewable energy technologies. Several studies have contrasted public preferences towards renewables versus fossil fuels, such as hydropower versus coal-fired in Indonesia (Siyaranamual et al. 2020) and renewables versus coal-fired in Vietnam (Bakkensen and Schuler 2020). Others have looked at citizens' support towards renewables through renewable energy funds (Azlina et al. 2018) and Azlina et al. (2022).

This paper also contributes to the comparison of willingness to pay across several countries. In recent years, there is a growing interest in this type of analysis, even though most of the research are single case studies. To overcome these limitations, several meta-analyses have been conducted to investigate previous surveys. Ma et al. (2015) conducted a regression analysis of previous willingness to pay studies to investigate the influence of the study designs. Their analysis found that solar, wind energy, and other general renewable energies were generally preferred over biomass. Also, it was found that the design and choice experiments generally led to higher willingness to pay results than contingent valuation methods. The majority of WTP studies were conducted as independent singles cases. This has led to several studies looking at reviewing the results of previous studies through econometrics approaches. Soon and Ahmad (2015) used a random-effect met-analytic approach, finding a higher WTP for renewables among urban North American households and lower for rural and Asian respondents. Sundt and Rehdanz (2015) conducted a meta-regression on willingness to pay for increasing the share of renewable energy in electricity mixes. They found the importance of considering knowledge about renewables, household characteristics, income, and education in determining the WTP for renewables. Cerdá et al. (2024) also conducted a meta-analysis of previous studies through three econometric approaches, namely generalized least squares, weighted least squares, and a panel data model. In their study, they found that marine renewables were less preferred by citizens, on comparing between onshore and offshore wind energy. Besides the results from the estimation of comparative WTP values and investigation of the factors influencing different values, these studies indicate the research interest in comparative analysis of WTP across countries.

This paper is a part of a three-year collaborative research project between researchers at the University of Tokyo and research institutions in Southeast Asia. In total, we conducted surveys in urban areas in Indonesia (Jakarta), Lao PDR (Vientiane), Malaysia (Terengganu), Myanmar (Mandalay and Yangon), the Philippines (Manila), Thailand

(Bangkok), and Vietnam (Ho Chi Minh City). While this paper focuses on the comparative analysis; detailed results for each country study can be found in other papers of this special feature and two previously published papers elsewhere (Jotaworn et al. 2023; Numata et al. 2021a; Palanca-Tan et al. 2024).

The remainder of this paper is structured as follows. Firstly, the methodology employed in the survey, including the sampling strategies used, is outlined. Subsequently, the findings are presented, including public attitudes towards climate change and knowledge and perception of renewable energy types. Subsequently, the willingness to pay for renewable energy types in each city is estimated and compared. Finally, the paper concludes with a discussion of the implications of the results of this comparative analysis.

Survey design and sampling strategies

This study is a multi-city survey in Southeast Asia over the three-year period from 2020 to 2022. Target areas were Mandalay and Yangon in Myanmar, Vientiane in Lao PDR, Bangkok in Thailand, Ho Chi Minh City in Vietnam, Terengganu in Malaysia, Manila in the Philippines, and Jakarta in Indonesia (see Table 1 for the exact dates for each). Each survey was conducted by a local team, following a consistent protocol, as outlined by Numata et al. (2021a). This study design allows for inter-city comparison.

The survey had several sections, including questions regarding energy usage, the most important environmental issues, a choice experiment, knowledge and perceptions towards renewable energy types, and socio-demographics.

The focus of the survey was the choice experiment, which was presented as a series of alternative future scenarios regarding the penetration of renewable energy and the primary renewable energy sources. The respondents were requested to select their preferred scenario from three alternatives: two hypothetical and one reflecting the status quo in their country (see Fig. 1). Each alternative included different levels of future renewable energy share in the generation mix, the type of predominant renewable energy source, and the cost of it, which was presented as an increase in the respondents' monthly electricity tariff.

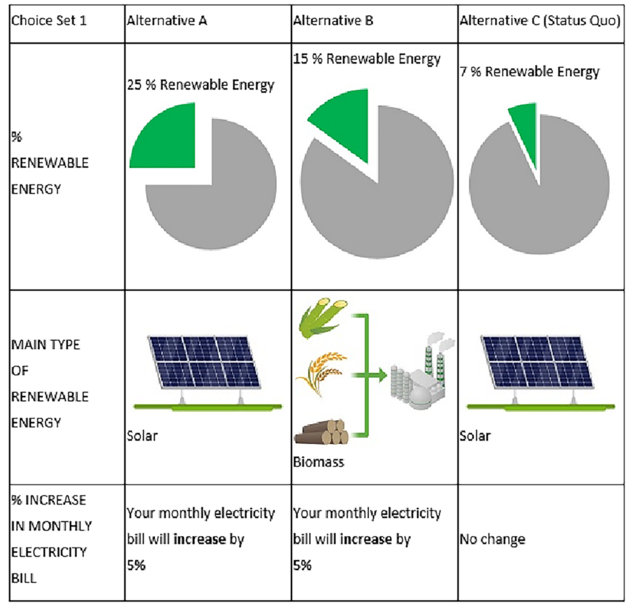


Fig. 1 Choice-set card sample

In the choice experiment, the levels for each attribute were expressed as a percentage of the share of renewable energy and an increase in electricity bills to facilitate the comparability between the cities. However, some differences were necessary for the type of renewable energy due to local specifications. For example, during the pre-test it was found that respondents in Ho Chi Minh City did not differentiate between small and large hydropower, and geothermal energy was only sufficiently known in Jakarta. The hypothetical alternatives were prepared using a D-optimal design (Numata et al. 2021b) and combined into choice sets. The choice sets were combined in groups to create blocks, ensuring equal occurrence of all alternatives. The surveys were distributed face to face in all cities, adapting to local conditions in terms of availability of sampling frames and

Table 1 Summary of sample sizes and type of renewables considered in the choice experiments

Year	Urban area	Pop. (million)	Size (km^2)	Country	Sample size	Sampling method
2020	Ho Chi Minh City	8.99	2095	Vietnam	319	Simple random sampling
2020	Mandalay	1.73	163.8	Myanmar	250	Spatial random sampling
2020	Yangon	5.61		Myanmar	250	Spatial random sampling
2020	Vientiane	0.95	3920	Lao PDR	400	Stratified sampling
2021	Bangkok	11.07	1568	Thailand	250	Multi-stage stratified sampling
2021	Manila	14.7	619.57	The Philippines	250	Stratified sampling
2022	Terengganu	0.237	605	Malaysia	1050	Stratified sampling
2022	Jakarta	10.56	661.5	Indonesia	1000	Stratified sampling

mobility restrictions imposed due to health concerns and government recommendations related to COVID-19. Table 2 summarizes the attributes and levels included for each city.

The total number of respondents for each city was chosen at a minimum of 250 respondents. This threshold was estimated according to the equation provided by Bekker-Grob, Donkers, Jonker, and Stolk (de Bekker-Grob et al. 2015): nta/c > 500. The number of respondents '*n*' is calculated based on the number of alternatives '*a*', the maximum number of attributes '*c*', and the number of tasks '*t*'. For the surveys used, $a=2$; $c=5$ and $t=7$. As a result, the minimum number of respondents to be collected (n) should be greater than 178.6. As a result, 250 valid complete responses were the minimum required.

The surveys were conducted by the teams in local universities in each urban area. The research team initially convened to discuss the "prototype" survey, with the objective of reflecting the specific local conditions of the area under investigation while maintaining sufficient consistency with the other surveys to facilitate comparability. At this stage, the most pertinent renewable energy sources and their respective levels were determined. The surveys were translated into the local language and underwent a preliminary testing phase to ensure their validity and adaptability.

We employed multiple sampling strategies that were tailored to the situation of each city. Simple random sampling is the ideal approach, as it is deemed to be the most effective in minimizing potential selection bias. Nevertheless, this was feasible solely in Ho Chi Minh City, where a sampling frame was accessible. The complexity and usual difficulty of relying on such existing sampling frames has also been encountered by researchers in developing countries (Mostafa 2016; Whittington 1998), and only a limited number of researchers have been able to apply it (see for example Arega and Tadesse 2017; Osiolo 2017; Sievert and Steinbuks 2020). Existing literature offers many innovative approaches to overcome limitations in the availability of sampling frames. In Beijing, Guo et al. (2014) divided the number of respondents proportionally among eight districts or the urban area. Households were then selected in three steps. First, blocks were randomly selected for each district. Then, buildings were randomly selected from these blocks. Finally, dwellings were randomly selected from these buildings. The survey strategies in Bangkok, Manila, Jakarta, and Terengganu followed this process. For Mandalay and Yangon, a spatial random sampling approach (Kondo et al. 2014) was found to be most useful, as the structure of the streets did not allow for the identification of smaller blocks. The sampling methods used for each city is shown in Table 1.

Public attitudes towards climate change

During the first year of the research project, a number of key environmental concerns were identified in each city. Southeast Asian cities face a wide range of environmental challenges, including climate change. The region is vulnerable to extreme weather events, which are expected to increase in intensity and frequency due to climate change (ASEAN Secretariat 2021). Climate change will also exacerbate other problems such as flooding and water scarcity. Changes in river cycles will also lead to disruptions in electricity supply in countries that rely heavily on hydropower generation and whose economies are highly dependent on it, such as the case of Lao PDR. Air pollution has also become a constant concern throughout the region. This is due to man-made activities such as local transport and the formation of haze on land and in forests, which can travel long distances.

These were incorporated into the survey template to indicate the relative importance of climate change to respondents in each city. Adjustments were made based on the results of the pre-tests. For example, it was found that some respondents were more familiar with the term global warming, while others were more familiar with climate change, so for ease of interpretation, both or only one of the terms was translated into local languages. Respondents

Table 2 Attribute and levels for each urban area in the choice experiments

	Share of RE in 2030	Type of RE	Increase monthly electricity tariff (%)	Status quo
Ho Chi Minh City	10%/5%/25%/35%	Solar, wind, biomass	2%/5%/10%/15%/25%	7% RE/solar/no change
Mandalay	10%/15%/25%/35%	Solar, mini hydro, biomass	2%/5%/10%/15%/25%	0%/none/no change
Yangon	10%/15%/25%/35%	Solar, mini hydro, biomass	2%/5%/10%/15%/25%	0%/None/no change
Vientiane	10%/15%/25%/35%	Solar, wind, mini hydro, biomass	2%/5%/10%/15%/25%	0%/None/no change
Bangkok	10%/15%/25%/35%	Solar, wind, mini hydro, biomass	2%/5%/10%/15%/25%	9%/solar/No change
Manila	35%/40%/45%/50%	Solar, wind, mini hydro, biomass	5%/10%/15%/20%/30%	30%/large-hydro and geothermal/No change
Terengganu	25%/30%/35%/40%	Solar, mini hydro, biomass	2%/5%/10%/15%/25%	17%/hydropower/No change
Jakarta	15%/35%/45%/50%	Solar, wind, biomass, geothermal	2%/10%/15%/25%	11%/hydropower/No change

were asked to select the first and second most important environmental problems they thought their respective cities would face in the next decade. This allows us to map the types of environmental problems across the region. The results for the first and second most important environmental problems identified by respondents in each city are shown in Fig. 2.

The responses indicate that in the majority of the cities under investigation, climate change is not identified as the most significant or second most significant environmental concern. In contrast to the majority of cities surveyed, Mandalay and Terengganu exhibit a notable level of concern regarding climate change. In Mandalay, climate change is considered the most critical environmental problem (34% of respondents), followed by air pollution (19%). In terms of priority (first or second), climate change remains the primary concern (22%), followed by air pollution (19%), water shortage (14%), and electricity shortage (15%). The notable level of awareness regarding climate change in Mandalay may be attributed to the active involvement of the civil society and environmental groups in the region, which have been particularly vocal in opposing the construction of dams in the northern part of the country. It is also noteworthy that climate change is ranked higher than electricity shortage, despite the endemic nature of the latter in the country. A comparable pattern is observed in Yangon, another urban area in Myanmar. In this case, 25% of respondents identified electricity shortages as their primary concern. In Terengganu, climate change is identified as the primary concern, ranking as the most important issue when considered in isolation (24%) and as the second most important when considered alongside other factors (24%).

Several of the most relevant environment concerns are indeed linked to climate change and policies to mitigate its impacts, such as air pollution, flooding, and water scarcity. Air pollution was identified as a significant concern for all cities except Yangon and Terengganu. In Bangkok, the majority (68%) of respondents identified air pollution as the most critical environmental issue in their city. Similarly, although to a lesser extent, air pollution is identified as the most serious problem by respondents in Ho Chi Minh City (36%), Manila (38%), and Jakarta (30%). The reduction of air pollution in these cities is contingent upon the decarbonization of their electricity generation mix and the transition to sustainable urban mobility modes, as well as the implementation of more sustainable agricultural practices to prevent the effects of haze (Jones 2006). In addition, flooding is a significant environmental concern in the region, particularly among respondents in Jakarta (31%) and Ho Chi Minh City (18%). At the same time, water scarcity is a major concern in other urban centers, including Terengganu (28%), where flooding is also a major concern (18%), Vientiane (12%), and Mandalay (10%).

Knowledge and perception of renewable energy

Respondents were asked about previous knowledge of the different renewable energy sources (see Fig. 3) and the perceived environmental friendliness of each of them (Fig. 4) to provide an overview of the different levels across the region. The knowledge question included only two options (yes or no) to avoid some unclear answers such as "know a lot" or

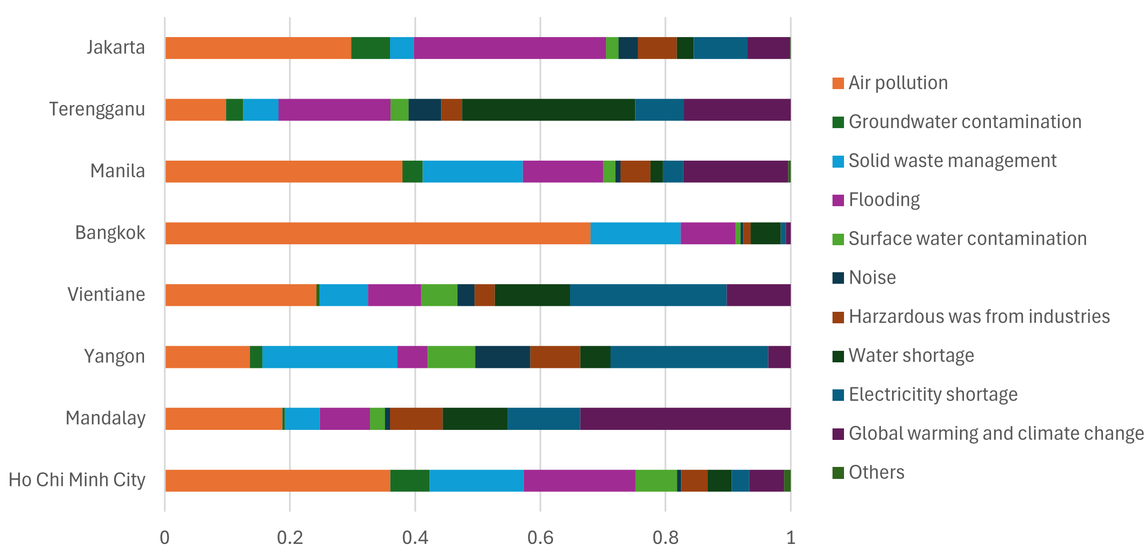


Fig. 2 Responses to the question "Which of these environmental problems is the most important for the government to solve in this city in the next 10 years?"

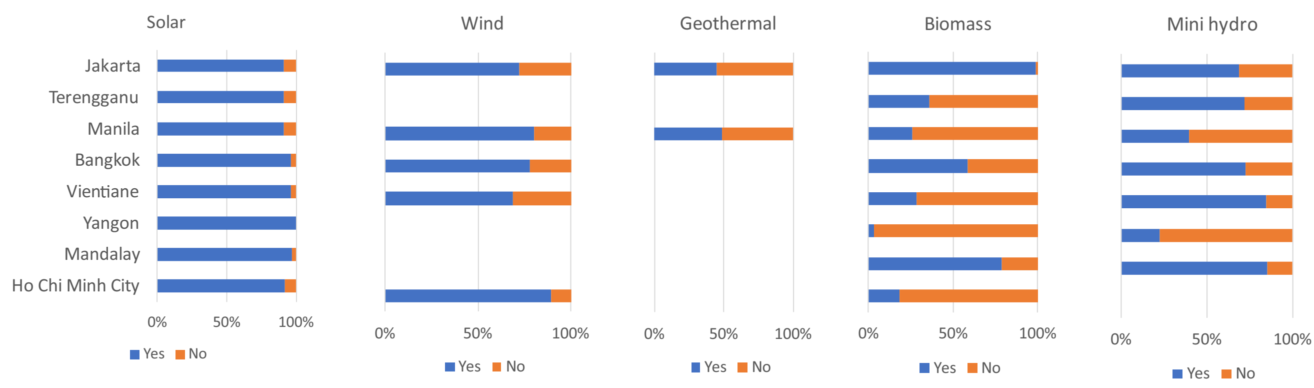


Fig. 3 Knowledge about different renewable energy types

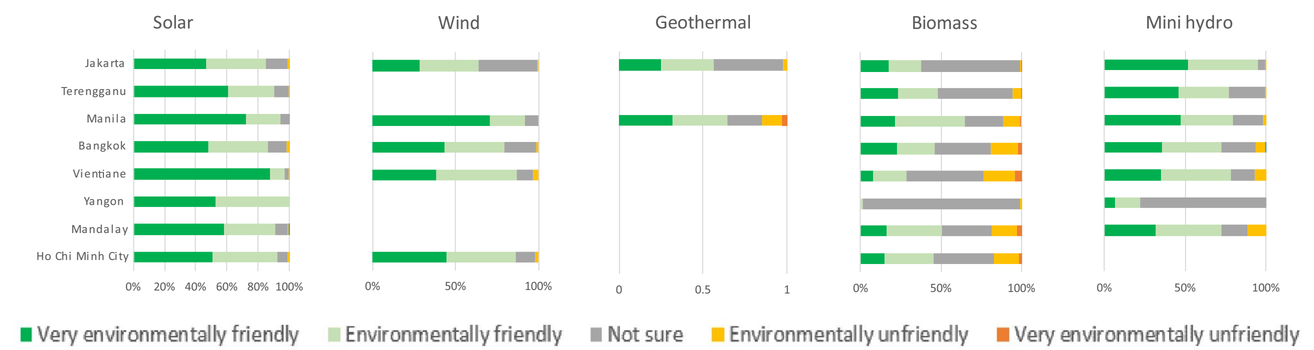


Fig. 4 Perception of environmental friendliness of renewable energy types

"know a little". The main purpose was not to test their actual knowledge, but rather to determine their perception or familiarity with the different types of renewable energy. The question on perceived environmental friendliness was included as an indicator of the possible support or preference for each renewable energy source. Respondents answered on a five-point Likert scale from very environmentally unfriendly to very environmentally friendly.

The survey findings revealed significant discrepancies in the level of knowledge between cities, as well as between different renewable energy sources, particularly for solar and biomass. Solar energy is the most widely recognized renewable energy source in the region. The only exception is Jakarta, where as many as 91% of respondents have heard of solar energy, while biomass is the most widely known (over 98%). Awareness of biomass is more varied. It is well known in some cities such as Jakarta and Mandalay (approximately 80%), but almost unknown in Yangon (only 3% have heard of it), Manila (26%), and Vientiane (28%). Regional differences in the utilization of biomass energy sources may serve as a potential explanation for these findings. However, it is also possible that the results do not fully align with the actual circumstances in these countries, as the surveys were conducted in urban areas, where the utilization of agricultural waste for energy purposes may be less prevalent. For the case of hydropower, the survey asked explicitly about mini hydro, as different from large-scale hydropower. The results show different levels of knowledge, even in countries with high levels of installed hydropower, such as Laos, Myanmar, and countries with large numbers of mini hydro plants, Indonesia (Rospriandana et al. 2023). Myanmar and Laos have constructed numerous hydropower dams for the purpose of supplying energy to the national grid and export. However, while respondents in Vientiane (84%) and Mandalay (85%) are familiar with mini hydro, only few (22%) respondents in Yangon responded positively. In Indonesia, the level of awareness of mini hydro in Jakarta (69%) is larger than in Yangon, but still below the levels in the other two cities. This may indicate that the distance to the projects affects the knowledge on energy technologies.

Additionally, the survey inquired about the perceived environmental friendliness of the various types of renewable energy (see Fig. 4). The results demonstrate a pervasive positive perception of solar energy, which is consistently rated highly across the region. Furthermore, the survey revealed a favourable perception of all renewable energy sources with the exception of biomass and, to a lesser extent, mini hydro.

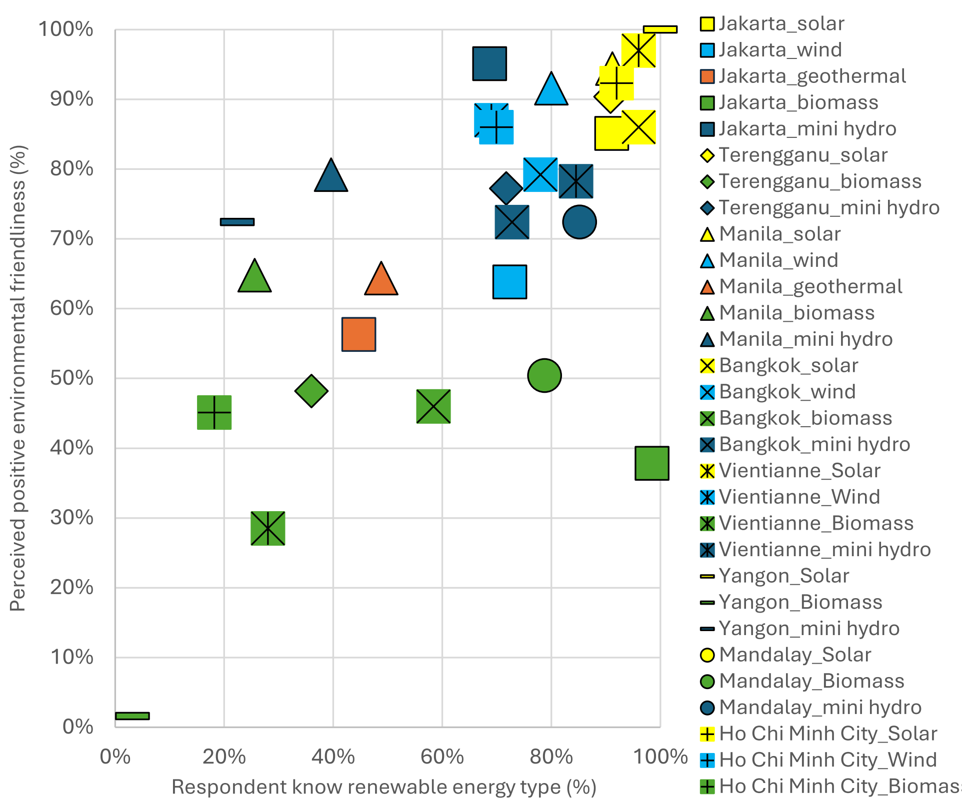
In the case of the city of Manila, the perception of biomass was found to be more positive than negative perceptions.

The discrepancies in respondents' perceptions of renewable energy sources can be partially attributed to the varying levels of knowledge among them. Figure 5 illustrates the responses by city and by source. It appears evident that solar energy is both the mostly widely recognized and the most favorably perceived. The experience of either owning or observing the installation of solar panels on roofs, or their availability in local shops could explain why solar energy is the most widely known in all cities. Such experiences may, to some extent, account for the favourable view of solar energy held across the region. Similarly, wind energy is also well known across the region and benefits from a relatively positive perception, which is not negatively affected by respondents having a high level of awareness about it. This is in contrast to other experiences where wind farms currently face more opposition (Avila 2018; Petrova 2013). However, it would be erroneous to assume that a certain level of protest may not occur. Indeed, the total installed potential remains relatively modest which may have limited the opposition to aesthetic considerations (Do et al. 2021). Mini hydro is an interesting case with perceptions largely positive, although in some cities, such as Yangon, it is lesser well known. The relatively low level of perceived environmental friendliness of geothermal energy may be explained by the fact that it is generally the least known type of renewable energy. Biomass is perceived to be the least environmentally friendly of all the renewable energy sources considered in this study. Even the three cities where respondents demonstrated greater familiarity with biomass (Bangkok, Mandalay and Jakarta) exhibited relatively low levels of positive perception towards this renewable energy source. This may be attributed to the fact that the respondents reside in urban areas and are consequently less familiarized with biomass technologies and a possible association of biomass with unsustainable practices and the effects of transboundary haze in the region (Vidinopoulos et al. 2020), which underscores the necessity to transition towards modern bioenergy technologies that circumvent such issues.

Willingness to pay for renewable energy types

This study estimated the willingness to pay for different types of renewable energy for all the cities surveyed. The detailed calculation has been reported elsewhere, including other papers in this special issue for Manila (Palanca-Tan et al. 2023), Jakarta, and Ho Chi Minh City, and elsewhere for Mandalay (Numata et al. 2021a) and Bangkok (Jotaworn et al. 2023). This paper builds upon the aforementioned analyses by incorporating all the cities surveyed and focusing on a comparative analysis between

Fig. 5 Perceived environmental friendliness and knowledge of renewable energy types



them. The calculation of estimates of WTP for different levels of renewable energy share and different types of renewable energy was based on the results of the conditional logit. The utility was assumed to be a linear function of attributes of RE share and price. The various renewable energy types, including solar, biomass, wind, mini hydro, and geothermal, were represented by dummy variables. Solar was considered the status quo type in the model for all the cities. Mathematically, for the respondents, the utility of choosing an alternative j is a function of the characteristics of the alternative j. The utility function (U_j) comprises two components: a deterministic component V_j for observed characteristics and a stochastic error component ε_j for unobserved variables.

$$U_j = V_j + \varepsilon_j, \tag{1}$$

where the deterministic component V_j represents the observable portion of the utility for the respondents. It is expressed as a linear-in-parameter function:

$$V_j = \mathrm{ASC}_j + \sum_k X_{jk}\beta_k, \tag{2}$$

where ASC_j is an alternative specific constant which represents the utility from the alternative j, X_{jk} is the k attribute value of the alternative j, and β_k is the coefficient associated with the kth attribute.

The estimates of the utility model are presented in Table 3. The utility function presents a significant negative correlation with price (i.e., an increase in the monthly bill) and positive correlation with the share of renewable energy (RE), which corroborates our preliminary hypothesis. It is of particular interest to note that solar energy is the preferred option in all the cities under study. This result is significant in all cities except Bangkok and is consistent with the findings of the first part of the survey, which indicated that solar energy is the most widely known and perceived as the most environmentally friendly. However, the alternative specific constant (ASC) is found to be significant and positive in all cities except Vientiane, where it is significant but negative. This suggests that, with the exception of Vientiane, respondents are generally satisfied with the status quo. In Vientiane, however, there appears to be a strong inclination towards change or dissatisfaction with the current situation. The results demonstrate that (1) while there is a willingness to pay for renewable energy, there is a markedly stronger preference for solar energy than for other forms of sustainable energy, and (2) the necessity to transition the energy generation mix towards sustainability is not sufficiently perceived as a pressing issue by respondents.

Both significant and insignificant parameters were converted 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:

Table 3 Utility functions

	Ho Chi Minh City (Vietnam)	Mandalay (Myanmar)	Yangon (Myanmar)	Vientiane (Lao PDR)	Bangkok (Thailand)	Manila (Philippines)	Terengganu (Malaysia)	Jakarta (Indonesia)
Utility function								
Price (% monthly bill)	− 0.135*** (0.007)	− 0.132*** (0.006)	− 0.224*** (0.012)	− 0.092*** (0.004)	− 0.036*** (0.005)	−0.062*** (0.005)	− 0.070*** (0.003)	− 0.096*** (0.003)
RE share (%)	0.047*** (0.004)	0.036*** (0.004)	0.053*** (0.005)	0.036*** (0.004)	0.008* (0.005)	0.018*** (0.006)	0.006*** (0.003)	0.033*** (0.003)
Types of renewable energy (base category = solar)								
Wind	− 0.239*** (0.091)			− 0.796*** (0.073)	− 0.112 (0.110)	− 0.495*** (0.095)		− 0.291*** (0.059)
Biomass	− 0.315*** (0.093)	− 0.438*** (0.089)	− 3.458*** (0.210)	− 1.015*** (0.077)	− 0.178 (0.114)	− 0.465*** (0.094)	− 0.657*** (0.041)	− 0.213*** (0.059)
Hydro		− 0.452*** (0.086)	− 0.977*** (0.108)	− 0.167 (0.072)	− 0.082 (0.109)	− 0.541*** (0.095)	− 0.308*** (0.04)	
Geothermal								− 0.732*** (0.063)
ASC (SQ)	0.442*** (0.103)	0.771*** (0.096)	0.384*** (0.145)	− 1.746*** (0.096)	1.042*** (0.124)	0.902*** (0.121)	0.403*** (0.065)	0.548*** (0.063)
Number of observations	319	250	250	400	250	250	1050	500
Log− likelihood	− 3162	− 2756	− 1082	− 2756	− 2880	− 2024	− 8113	− 6219

$$V_j = \beta_1 \text{Price}_j + \beta_2 \text{share}_j + \beta_3 \text{Solar}_j + \beta_4 \text{Wind}_j + \beta_5 \text{Hyd}_j + \beta_6 \text{Geo}_j + \beta_7 \text{Bio}_j, \quad (3)$$

where V_j is the utility of choice set j; share_j is the RE share amongst total electricity production of choice set j; Solar_j, Wind_j, Hyd_j, Geo_j, and Bio_j are dummy variables representing RE types of choice set j; and Price_j represents the percentage of increasing monthly electricity tariffs. It is worth noting that the types of renewables were different for each city. This was done to reflect the differences in citizens' understandings and keep the choice experiments as close to reality as possible.

To examine Price_j at different share levels, we specified share_j and determined the changes in WTP_j using the following function:

$$\text{WTP}_j = \frac{\beta_2\left(\text{share}_j - \text{share}_{sq}\right) + \beta_3 \text{Solar}_j + \beta_4 \text{Wind}_j + \beta_5 \text{Hyd}_j + \beta_6 \text{Geo}_j + \beta_7 \text{Bio}_j}{-\beta_1}.$$

Table 4 shows the estimation of the mean WTP in the percentage of monthly electricity bills when increasing the RE share.

In accordance with the findings of the utility functions, respondents demonstrate the greatest willingness to pay (WTP) for solar energy. Wind energy is the second most preferred across all cities. Furthermore, willingness to pay for mini hydro is also positive, albeit at a comparative lower level. It is notable that the only two types of renewable energy that elicit a negative WTP are biomass and geothermal. This is likely attributable to the relatively substantial increase in the share of renewables considered in the calculations (up to 20%), but it does underscore the challenges faces by households in 'paying' (in this case, through their monthly electricity bill) to support them. The highest WTP is observed in Vientiane, while the lowest is seen in Jakarta. It is noteworthy that the two primary environmental concerns identified by respondents in Jakarta were flooding and air pollution. This may indicate that respondents do not perceive a shift in the power generation mix to have a significant impact on addressing these environmental concerns, and are more focused on their ability to meet their electricity costs. It is important to note here that the survey was conducted in 2022, a period during which the global impact of the pandemic was still a significant concern in the region.

Conclusions

This paper presents the findings of a comparative analysis of a survey and choice experiment conducted in eight urban areas across seven Southeast Asian countries. The cities of Mandalay, Yangon, Bangkok, Vientiane, Ho Chi Minh City, Terengganu, Jakarta, and Manila were selected for inclusion in the study. The analysis was conducted on the basis of data collected from surveys including choice experiments with households in each of the aforementioned locations. The findings indicate that respondents did not identify climate change to be the most significant environmental concern. Even considering that some of the most pressing threats, such as flooding and water scarcity, are closely associated with climate change. These findings offer valuable insights for policy-oriented researchers and policymakers alike. They can be used to inform the design of public awareness campaigns that highlight the tangible impacts of climate change, particularly beyond the increase in average temperature. This can be accomplished by advocating for renewable energy sources, emphasizing the climate benefits of such measures, and enhancing public awareness of climate change. This could include education programs that provide citizens with an understanding of the scientific evidence linking climate change and related disasters. This can be extended by deliberately incorporating public participation in energy planning and policy-making, what can be done with multiple instruments such as participatory workshops and citizens'

Table 4 Willingness to pay (% increase in monthly bill) for a 20% increase from the current situation in the share of renewables

Urban area	Solar (%)	Wind (%)	Biomass (%)	Mini hydro (%)	Geothermal (%)
Ho Chi Minh City (Vietnam)	6.91	5.10	4.34	–	–
Mandalay (Myanmar)	11.31	–	8.00	7.89	–
Yangon (Myanmar)	6.41	–	− 9.02	2.05	–
Vientiane (Lao PDR)	25.98	17.40	15.05	24.18	
Bangkok (Thailand)	4.51	0.88	− 0.47	2.02	–
Manila (The Philippines)	17.31	9.34	9.82	8.60	
Terengganu (Malaysia)	7.51	–	− 1.91	3.09	
Jakarta (Indonesia)	3.65	0.60	1.42	–	− 3.99

assemblies, or even, promoting decentralized ownership models of energy projects, including community based and energy cooperatives.

To meet the growing energy demands of Southeast Asia while simultaneously reducing emissions, it will be necessary to implement a significant expansion in the deployment of a diverse range of renewable technologies. The results indicate a predominantly favourable attitude towards renewable energy sources, with a discernible inclination towards solar energy in particular. This raises the question of why this is the case and what can be done to increase support for other renewables, including whether these are perceived differently by households. Some initial hypotheses discussed by the research group relate to the recent high level of positive publicity that solar energy has received across the region, as well as news of ambitious government targets and programmes. Additionally, the proliferation of solar installations in urban areas, on rooftops and in public spaces, may have contributed to a more favourable perception and acceptance. In the case of wind energy, there are some interesting cases, such as the development of tourist or sightseeing sites. The relatively low level of perceived environmental friendliness of biomass represents a potential area of concern and interest for further research. Modern forms of bioenergy have the potential to exert a significant positive impact in the region, particularly blended with transport fuels and industrial heat. Nevertheless, it seems evident that the respondents to our survey did not perceive this potential positive impact. This may result in a reduction in the willingness to pay for certain types of renewable energy. In the context of Southeast Asia, it is crucial to consider the social implications of rising electricity tariffs. Consequently, policies that distribute the benefits and costs of the transition to sustainable energy systems across society are of greater relevance.

The experience of a comparative survey across the region can also yield valuable insights that can inform studies employing analogous methodologies. It is important to note that there are some challenges inherent to this approach, and that implications of these challenges must be considered with caution. It is imperative to consider the context of each country, as this can have a significant impact on the findings. For example, in this comparative analysis, all urban areas are in Southeast Asian countries and ASEAN members. Although each country has its distinctive characteristics, this type of analysis is highly relevant in light of the growing importance of ASEAN institutions in shaping energy policy in the region and the potential for policy transfer between countries with high levels of cooperation. Furthermore, the survey design and sampling methods offer insights that are worthy of note. Despite the fact that the surveys were designed with the intention of being as similar as possible to ensure comparability, some differentiation was nevertheless necessary. While there may be some concerns about the possible generalization of our results to the general population in each city, we are confident that the results remain relevant for comparison between them and for the extraction of valuable implications. A further avenue for investigation would be interesting to compare the results for each city with those of future studies utilizing simple random sampling, something we were not able to do due to practical limitations, with a view to evaluating the impact of different strategies on the results. Furthermore, the sampling strategies had to be adapted to align with the specific local conditions. This included considerations such as the level of data availability, which presented limitations in all cities with the exception of Ho Chi Minh City, and the structure of each city, which was a crucial factor in the later stages of analysis. Consequently, the sampling methods were adapted to the administrative divisions, size, and structure of the neighbourhoods in each city. Also, further research could look at differences in socio-economic, cultural, and informational factors that affect the willingness to pay.

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