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Will the public in emerging economies support renewable energy? Evidence from Ho Chi Minh City, Vietnam

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A R T I C L E I N F O

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A B S T R A C T

Public acceptance and support are crucial to increasing the adoption of renewable energy technologies and establishing new renewable energy policies. In Vietnam, where plans to rapidly scale-up electricity generation are among the fastest globally, one question of interest is what would motivate people to pay more for electricity generated by renewable energy sources? As part of its national Power Development Plan, Vietnam targets a future electricity mix consisting of at least 21% renewable energy by 2030. This study assesses the public's willingness to pay (WTP) for increasing renewable energy share and corresponding motivating factors in Ho Chi Minh City, Vietnam. Drawing from a valid sample of 294 households, this study uses a double-bounded dichotomous choice contingent valuation method (CVM) to evaluate the public perception of renewable energy. On average, respondents are willing to pay about $4.39 USD more on their monthly electric bill to support renewable energy, which represents a 9.48% increase. Notably, respondents most concerned with air quality and the utility's profitability indicated their support to pay more for renewable energy. This study suggests the importance of communicating health-related air pollution mitigation benefits for emerging economies and building support among customers so that electric utilities can increase renewable energy targets. From a policy perspective, improved and transparent disclosure of air pollution data and utility financial statements could expedite the transition to renewable energy in emerging economies, such as Vietnam.

1. Introduction

Energy infrastructure decisions and systems are changing rapidly in fast-growing economies, such as Vietnam. Replacing conventional energy with low-carbon renewable electricity is one of the easiest ways to ensure emission reductions in the energy sector. As an integral part of energy policy, the government enacted renewable energy policies to achieve a more rapid transition to sustainable energy. For instance, Vietnam's Power Development Plan (hereinafter referred to as the Plan) is expected to increase the share of renewable energy (RE) from its current level of 7%–21%. However, implementation of the Plan will require millions of dollars of new infrastructure investment across the grid to accommodate variable renewable energy. Congestion problems in the existing grid are also increasing the costs of achieving the renewable energy target that is promised by the new Power Development Plan. The power generation costs from renewable energy potentially make renewable electricity more expensive than electricity generated from conventional fuels, and the increased generation cost will eventually be borne by consumers in certain forms [1]. Understanding public concerns and perceptions of the Plan and the underlying motivations behind renewable energy adoption is critical for renewable energy marketing and energy policy design, thus stimulating voluntary demand for renewable electricity.

Various willingness-to-pay studies for renewable energy have been conducted in countries and regions such as Italy [2], South Korea [3], and China [4]. However, as one of the fastest growing emerging economies with unique geographical features and energy requirements, few studies have been conducted to understand public perceptions of renewable energy deployment in Vietnam. It is documented that the population living in the Mekong Delta could be one of the biggest

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victims of climate-induced threats such as land subsidence, saline intrusion, and rising sea levels [5]. Furthermore, Vietnam, located in the tropics, faces increasing residential electricity demand due to more direct use of air conditioning to cool buildings. On the industrial side, Vietnam has one of the highest electricity intensities of any Asia-Pacific country, further complicating the relationship between increased demand for electricity and the lack of existing generation capacity to support system-wide needs [6]. As a result of dependence on coal in the current energy mix, greenhouse gases and pollution emissions are expected to rise if energy consumption exponentially increases. Vietnam could become a major contributor to global climate change and simultaneously bear the health burdens of local air pollution without adoption of alternative energy sources. Copious reasons may prompt customers in Vietnam to share different views about how much to pay for enhanced energy infrastructure, especially the non-market value from climate change mitigation and air quality improvement, making a comprehensive survey in Vietnam of high research significance and applicable for policymakers across Southeast Asia and beyond.

To estimate the value the public is willing to pay for renewable energy in Ho Chi Minh City, Vietnam, a survey was conducted in 2020 administered by the University of Economics, Ho Chi Minh City. The purpose is to answer two questions: (1) to what extent is the public willing to pay for renewable energy; and (2) what would motivate people to pay more for electricity generated by renewable energy sources? Specifically, this survey estimates factors affecting public WTP, such as perceptions of air quality and other environmental issues to understand the motivation that supports upcoming changes in the capacity mix based on the Power Development Plan, and projected electricity bills. For example, the survey investigated whether households were willing to pay for more renewable energy when they were concerned about local air pollution. Households may be willing to pay for electricity and the added infrastructure required to integrate renewables on the grid. However, the public perception related to air pollution may further affect the WTP by capturing the non-market value of renewable energy systems. This study contributes to a growing literature on willingness to pay for renewable energy in the following ways: (1) enhancing the understanding of public WTP and potential renewable energy adoption in Ho Chi Minh City, a rapidly growing urban environment; (2) for utilities, identifying motivating factors for renewable electricity adoption on the grid will be critical to communicate costs of renewable energy integration and to ensure a more sustainable power sector transition; (3) providing significant policy implications for renewable energy adoption in emerging economies to reduce greenhouse gases and improve air quality.

The rest of this paper is structured as follows. In Section 2, we review existing literature on WTP studies for renewable energy. Section 3 introduces the specific survey design and contingent valuation methods. The descriptive statistics and estimation results are reported in Section 4. Section 5 is for discussion and policy recommendations.

2. Willingness to pay for renewable energy

Unlike traditional market products, the determinators of willingness to pay for environment-related non-market goods, such as clean energy and air quality, are diverse and complex, often requiring consideration of psychological, socioeconomic, and demographic factors [7,8]. The contingent valuation method (hereafter referred to as CVM) has been widely used to capture the influence of multiple potential factors and provide an accurate estimate of willingness to pay for environmental non-market goods, including deep decarbonization [9], emission control [10,11], pollution control [12–15], and green spaces [16,17]. Since the CVM can be combined with survey questionnaires, researchers can intuitively ascertain respondents' willingness to pay by asking them hypothetical questions about the value of environmental goods [18].

The results of existing studies that apply contingent valuation method (CVM) to estimate willingness to pay for renewable energy vary considerably by country and scenario [19]. In general, high-income countries have a higher willingness to pay for renewable energy. For example, before the introduction of the Green Power Fund, a mail survey conducted by Nomura and Akai [20] interviewed Japanese households about their willingness to pay extra, in the form of a fixed monthly surcharge, for renewable power systems (represented by wind and solar); the results indicated that the median willingness to pay for green power among Japanese residents was about $17/month per household. Similarly, Aldy et al. [21] conducted a nationwide online survey assigning fixed bid amounts under three technology scenarios: renewables, renewables and natural gas, and renewables and nuclear; the results showed that the average U.S. consumers were willing to pay an additional $13.50 per month for their electricity bills to support the national clean energy standard (NCES) that requires 80% clean energy by 2035. In another web-based regional study asking respondents how much they would specifically pay on top of their current electricity bills, Mozumder et al. [22] found that the median willingness to pay estimates among New Mexico residents were ~$10/month and ~$25/month for 10% and 20% share of renewable energy supply (e.g., wind, solar, hydro, geothermal and biomass) in the total energy mix, respectively. However, even within high-income countries, public perception and acceptance of renewable energy varies considerably. Through a face-to-face survey in Crete, Greece, Zografakis et al. [23] claimed that, on average, households were willing to pay €5.44 (about $7) per month as an extra payment on the electricity bill in support of an 18% share of renewable energy (e.g., wind, solar, hydro, biomass and biofuels) in final energy consumption by 2020. To facilitate the transition from feed-in tariff (FIT) to renewable portfolio standards (RPS), Kim et al. [24] and Kim et al. [25] conducted two national face-to-face surveys in South Korea and found that the average willingness to pay of Korean households for electricity generated from three types of renewable energy sources, wind, PV, and hydro, was $1.35/month and $1.26/month, respectively. In the context of increasing the share of renewables in the total energy mix to 11% by 2035, Lee and Heo [26] conducted another national face-to-face survey in South Korea, which demonstrated that the median willingness to pay, as an additional charge on electricity bills, doubled to $3.21/month after the Fukushima nuclear disaster, while still much lower than in other high-income countries. In medium- and low-income countries, renewable energy is significantly undervalued. For instance, a face-to-face survey by Guo et al. [27] in Beijing, China, obtained an average willingness to pay of $2.70 (non-parametric estimation) to $3.30 (parametric estimation) per month for green electricity from renewable energy sources such as solar, wind, small-scale hydropower and biomass. Besides, they stated that the mean willingness to pay for the mandatory payment vehicle was slightly higher than the voluntary payment vehicle. It is worth noting that Beijing is the capital city of China and one of the highest-income cities. The willingness to pay may be lower in other lower-income countries or regions. This can be documented through another regional survey based on email and mail in Jiangsu Province, China, which found that the willingness to pay for electricity generated from renewable energy such as wind and solar was about $1.15–1.51/month [28]. In Türkiye, a face-to-face study conducted by Dogan and Muhammad [29] indicated that consumers from 12 major cities were willing to pay ~$1/month in addition to monthly electricity bills to increase the share of renewable energy (e.g., hydro, wind, solar, tidal, and biomass) in the total electricity mix to 20%.

The willingness-to-pay for renewable electricity differs significantly between higher-income countries and lower-income countries, reflecting the potential impact of economic development levels and income levels [30,31]. In addition, factors contributing to the large difference in WTP may originate from respondents' individual characteristics, such as age, gender, job, and educational background [22,28,32,33]. Some studies particularly pointed out that concerns over air pollution would significantly increase the public's willingness to pay for renewable energy [27,34]. In addition, respondents' awareness of environmental protection [29,35], knowledge of renewable energy [36], and trust in environmental policies or government [13] will likewise influence their environmental perceptions and attitudes, and ultimately change their willingness to pay for renewable energy [37].

WTP studies in Vietnam have mainly focused on insurance [38], public health [39], and ecological restoration [40,41]. A recent study compared the willingness to pay for renewable energy with coal-based electricity generation [42]. Other studies for Vietnam have evaluated the grid's preparedness for renewable energy integration or energy security concerns, but these have occurred based on national statistics reporting without considering public support [43]. To date, existing empirical evidence in rapidly growing energy demand centers such as Ho Chi Minh City is insufficient. Therefore, this paper aims to provide support to the study of willingness to pay for renewable energy through a questionnaire. More importantly, this paper discusses whether consumers' willingness to pay for renewable energy has changed given the context of the increasingly urgent public issues of rising energy demand, air pollution, and sustainable development.

3. Method

3.1. Questionnaire and data

In the full-scale survey, team members from University of Economics, Ho Chi Minh City conducted door-to-door interviews with 320 households in Ho Chi Minh City from May to July 2020. The overall response rate is 40%. Households were randomly selected from the customer records of the Ho Chi Minh City Power Corporation. Of 320 questionnaires collected, 301 responses were valid. We further excluded incomplete questionnaires and selected 294 responses for CVM analysis.

The Willingness to Pay for Renewable Energy Plan questionnaire consists of 4 sections. The first section focuses on micro-level information on household electricity usage, which includes electricity consumption, monthly electricity bill, and the uses of appliances. In the second section, the survey measured respondents' willingness to pay for the Plan to increase renewable energy to 21% using a double-bounded dichotomous elicitation format. This method is adopted because it potentially allows us to know the maximum price respondents are willing to pay for the Plan. The survey not only asked the respondents if they are willing to pay for the Plan but also presented respondents with two different bid ranges expressed as percentage increases in monthly electricity bills. The bid range for the first WTP question was to increase the current monthly electricity bill by 2, 5, 10, 15, 25 (%) and the bid range for the second WTP question was 1, 2, 5, 10, 15, 25, 35 (%). Both bid levels were randomly assigned to the respondents, and the bid level of the second WTP question was randomly selected based on the response to the first WTP question. For instance, if the respondent answers "Yes" to the first WTP question, which means they accept the first bid range, then a higher bid level from the set of (1, 2, 5, 10, 15, 25, 35%) will be randomly selected for the second WTP question, otherwise, a lower bid level will be assigned. In addition, respondents were asked whether they are certain about their answers. Follow-up questions with a selection of the reason for supporting/disapproving the Plan were also proposed for reliability and validity check. For example, "I would pay for the Plan due to global warming and sea level rise" or "I don't vote for the Plan because my current electricity bill is already high". The third section was mainly related to awareness, attitudes, and perceptions. The survey asked respondents separately closed-ended questions about their awareness of renewable energy, their concerns on environmental issues, and their expectations for utility profitability, i.e., whether Vietnam Electricity (hereafter referred to as EVN) will make a profit or a loss. The final section deals with the demographic and socioeconomic characteristics of the respondents such as gender, age, education level, and occupational category.

3.2. Estimation strategy

WTP responses are analyzed using the approach proposed by Hanemann et al. [44] and Lopez-Feldman [45]. In this approach, the *WTP* of respondent *i* is modelled as:

$$WTP_i = X_i\beta + u_i \tag{1}$$

where β is the corresponding vector of parameters. X_i is a linear function of covariates that can potentially affect WTP, including electricity bill, knowledge, concerns, demographic characteristics, etc. u_i is the error term. Given a bid level t_i, a respondent will say "Yes" if the WTP is greater than t_i. The probability of saying "Yes" to a bid level t_i is therefore given by the following function:

$$\Pr(y_i = 1|X_i) = \Pr(WTP_i > t_i) = \Pr(u_i > t_i - X_i\beta) \tag{2}$$

where y_i is a binary dummy variable denoting the response of respondent i to the WTP questions. $y_i = 1$ represents a "Yes" response, otherwise $y_i = 0$. Assume that the error term follows a standard normal distribution, i.e., $u_i \sim N(0, \sigma^2)$, the probability function becomes:

$$\Pr(y_i = 1|X_i) = \Phi\left(X_i\frac{\beta}{\sigma} - t_i\frac{1}{\sigma}\right) \tag{3}$$

where that estimates of $\frac{\beta}{\sigma}$ and $\frac{1}{\sigma}$ are the coefficients estimated by Probit model. y_i is the dependent variable. X_i and t_i as covariates.

The WTP can be rewritten as follows:

$$\overline{WTP_i} = \overline{X_i}\widehat{\beta} \tag{4}$$

Specifically, in the setting of the double-bounded dichotomous choice, we denote the first bid level as t^1 and the second bid level as t^2. The second bid level depends on the response to the first question, because the second question will be randomly assigned a higher bid level if the first bid range is accepted. For instance, $t^2 > t^1$ ($t^1 > t^2$) means the response to the first question is "Yes" ("No"). y_i^1 and y_i^2 denote the binary response to the first and second question, respectively. Therefore, the responses could be classified into two cases (four scenarios) with the following probabilities:

When the first response is "Yes", which implies $t_2 > t_1$: (1) If the response to the first question is "Yes" while the response to the second question is "No", then $t_1 < WTP_i < t_2$, $p_{yn} = Pr(y_i^1 = 1, y_i^2 = 0) = F\left(\frac{t^2 - X_i\beta}{\sigma}\right) - F\left(\frac{t^1 - X_i\beta}{\sigma}\right)$; (2) If the responses to these two questions are "Yes", then $t_2 < WTP_i < \infty$, $p_{yy} = Pr(y_i^1 = 1, y_i^2 = 1) = 1 - F\left(\frac{t^2 - X_i\beta}{\sigma}\right)$.

When the first response is "No", which implies $t_2 < t_1$: (1) If the response to the first question is "No" while the response to the second question is "Yes", then $t_2 < WTP_i < t_1$, $p_{ny} = Pr(y_i^1 = 0, y_i^2 = 1) = F\left(\frac{t^1 - X_i\beta}{\sigma}\right) - F\left(\frac{t^2 - X_i\beta}{\sigma}\right)$; (2) If the responses to these two questions are "No", then $0 < WTP_i < t_2$, $p_{nn} = Pr(y_i^1 = 0, y_i^2 = 0) = F\left(\frac{t^2 - X_i\beta}{\sigma}\right)$.

$F(\bullet)$ is the cumulative distribution function, which is assumed to be logistically distributed in this study considering that the WTP may be right-skewed. The parameters β and σ can be estimated by maximizing the log-likelihood function.

$$\ln L = \sum_{i=1}^{N}\left(d_i^{yn}\ln p_{yn} + d_i^{yy}\ln p_{yy} + d_i^{ny}\ln p_{ny} + d_i^{nn}\ln p_{nn}\right) \tag{5}$$

where d_i^{yn}, d_i^{yy}, d_i^{ny}, and d_i^{nn} are binary variables that divide respondent i into the above four scenarios.

3.3. Hypothetical bias control

One common issue worth discussing in the CVM studies is that the hypothetical willingness to pay may overstate willingness to pay in actual situations, also known as hypothetical bias. To minimize the overestimation of willingness to pay, we adopted multiple ex-ante approaches to control for hypothetical bias. For instance, before starting the WTP questions, we provided detailed descriptions of the given scenarios to help respondents understand the survey and the Plan. Specifically, we introduced detailed background information for types of renewable energy, positive impacts of renewable energy on the mitigation of greenhouse gases and global warming, and action plans for the 21% renewable energy target implemented by Vietnam Electricity and relevant government agencies. We also informed respondents of the provisions of the survey and their choices, e.g., they will pay more for electricity if the 21% share of renewables is achieved. Moreover, we provided a cheap talk script to remind respondents of the existence of hypothetical bias and thus they should answer the WTP questions as if it was an actual referendum. All of these ex-ante approaches have been documented to reduce hypothetical bias effectively [27,46].

4. Results

4.1. Statistical description

4.1.1. Descriptive statistics of the respondents

Table 1 summarizes the descriptive statistics of households. There were more females (66%) than males (34%), and the average age was 43.5 with a range from 17 to 77. Most of the respondents only completed high school or less (73.13%), and the majority completed high school (32.31%). Regarding occupation, 29.59% of the respondents were self-employed, followed by housekeepers with a relatively high proportion of 19.73%. 12.24% of the respondents were students, retired, or unemployed. Additionally, the average household had 4.84 members, earned $952.11 per month and paid $46.28 for electricity, which accounted for 4.86% of monthly income.

4.1.2. Awareness, attitude, and perception

The study also investigated public awareness of renewable energy, concerns about environmental protection, and expectations of the financial profitability of the electricity utility. From Fig. 1, we can find that among the whole sample, 85% of the respondents were aware of solar energy, followed by wind energy (58.84%), small-scale hydropower (32.99%), and biomass energy (18.37%). Regarding the concerns on cost preference and environmental issues (Fig. 2), most of the respondents expressed a preference for lower energy costs (70.07%) over investments in renewable energy. Meanwhile, 37.76% of respondents agreed that air pollution is the most important environmental issue that they pay close attention to and share concerns.

For utility profitability, the survey asked respondents whether Vietnam Electricity (EVN) is making a profit or a loss, and how much the supply cost of EVN is lower or higher than the monthly electricity bill. Table 2 shows that 201 respondents (68.37%) think that the supply cost is lower than the utility's revenue, and thus EVN is making a profit. Only 93 respondents (31.63%) think that the cost is higher than revenue, which means EVN is losing money. For those respondents stating EVN gains profits, they think that the cost is lower than revenue by 23.41% on average. For the others, they claim that the cost is higher than revenue by 17.84% on average.

4.1.3. Main reasons for supporting/opposing the plan

Table 3 reports the results for the certainty of WTP responses. The majority of respondents were sure about their willingness to pay for the Plan, with ~83% of the total sample being very certain or certain of their WTP responses, indicating the relative validity of the estimates from this WTP study. Table 4 depicts the main reasons for voting or not voting for the Plan of increasing the share of renewable energy from 7% to 21%. Of those 220 respondents (74.83%) who were willing to pay for renewable energy, 55% of the respondents stated that they would pay for the mitigation of global warming and sea level rise. 19.55% of the respondents thought that they should pay for the higher cost of renewable electricity production because the electricity utility could lose money. Among 74 respondents (25.17%) who were not willing to pay for the

Table 1
Household characteristics among the respondents (N=294).

Variable	Mean	Std. Dev.	Min	Max
Electricity bill (USD/month)	46.28	32.99	4.31	172.41
Income (USD/month)	952.11	777.99	107.76	3771.55
Household size (members)	4.84	2.47	1	25

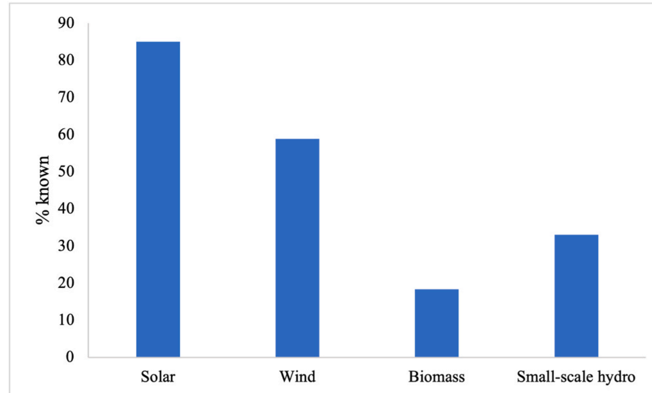

Fig. 1. Awareness of renewable energy among respondents.

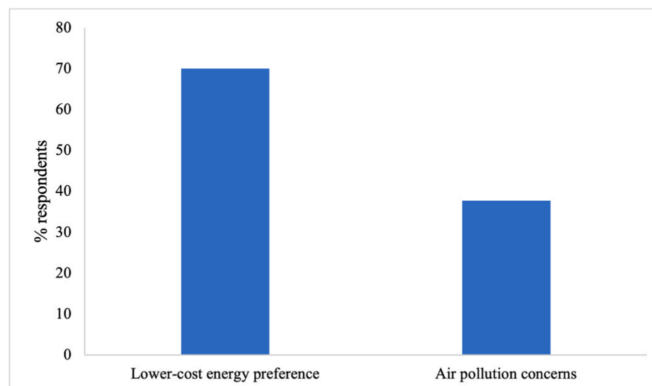

Fig. 2. Concerns on energy cost and air pollution among respondents.

Table 2
Profitability of the utilities.

	N	Mean	SD	Min	Max
Perceived supply cost is lower than revenue (in %)	201	23.41	15.95	0	70
Perceived supply cost is higher than revenue (in %)	93	17.84	19.26	0	100

Table 3
Certainty of WTP responses.

	Freq.	%
Very certain	101	34.35
Certain	143	48.64
Not sure	28	9.52
Uncertain	18	6.12
Very uncertain	4	1.36
Total	294	100

Table 4
Reasons for supporting or not supporting the Plan.

	Total	Freq.	Ratio
Reason for supporting the Plan			
I should pay for the higher costs of electricity production	220	43	19.55%
I would pay for the mitigation of global warming and sea level rise	220	121	55.00%
I don't think my vote matters	220	89	40.45%
Other reasons	220	13	5.91%
Reason for not supporting the Plan			
I don't believe the Plan will succeed in achieving the target of RE	74	11	14.86%
I don't think RE will help mitigate global warming and sea-level rise	74	3	4.05%
My current electricity bill is already high	74	45	60.81%
Many households in Vietnam would not afford the bill increase.	74	44	59.46%
Poor households in Vietnam would not afford the bill increase.	74	26	35.14%
Other reasons	74	4	5.41%

Plan, the top three reasons are related to household electricity bills. About 61% of respondents who were unwilling to pay attributed to current high monthly bills, and 59.46% of respondents were due to unwillingness to afford the bill increase induced by renewable energy. Notably, 11 respondents (14.86%) were not willing to pay for the Plan due to the lack of confidence in achieving the targeted level of 21% renewable energy.

4.2. *Results of mean willingness to pay and its influencing factors*

Table 5 reports the estimated willingness to pay for renewable energy in Vietnam. Specifically, we estimate the mean WTP and explore its influencing factors with three model specifications in the WTP space. In Model I, only a constant (β) and its standard deviation (σ) are estimated. In Model II, covariates such as monthly electricity bill, awareness, and attitudinal variables are included to investigate potential influencing factors of WTP. Model III further includes household and respondents' individual characteristics. We estimate the results under the assumptions of logistic and normal distribution, respectively. The two assumptions obtain similar results, and we focus more on the logistic distribution considering the possible right-skewed distribution.

Model I does not add any covariates. Thus, the value of the constant (β) is actually the mean WTP. The coefficient of constant is estimated as 9.48, indicating that on average, respondents are willing to pay for an increase of 9.48% in their current electricity bills. Given that the average electricity bill is $46.28 per month, we can find that the mean WTP

Table 5
Regression results of mean WTP and its influencing factors.

	LOGISTIC DISTRIBUTION			NORMAL DISTRIBUTION		
	Model I	**Model II**	**Model III**	**Model I**	**Model II**	**Model III**
Electricity bill, perceived utility profitability, and attitude/awareness						
Electricity bill (USD/month)		−0.065** (0.025)	−0.059** (0.029)		−0.074*** (0.027)	−0.069** (0.03)
% Perceived supply cost lower than revenue		0.036 (0.054)	0.03 (0.054)		0.042 (0.056)	0.04 (0.056)
% Perceived supply cost higher than revenue		0.129* (0.068)	0.148** (0.067)		0.12* (0.07)	0.142** (0.07)
Knowledge of solar (1 = Yes)		2.755 (2.605)	1.202 (2.669)		3.419 (2.755)	1.544 (2.79)
Knowledge of wind energy (1 = Yes)		−0.54 (2.205)	−1.19 (2.375)		−1.062 (2.254)	−1.613 (2.372)
Knowledge of biomass energy (1 = Yes)		1.779 (2.403)	3.317 (2.426)		1.834 (2.47)	3.27 (2.476)
Knowledge of hydropower (1 = Yes)		2.635 (2.158)	2.558 (2.147)		2.528 (2.237)	2.248 2.209)
Thinking lower cost of energy is better (1 = Yes)		−2.239 (1.866)	−2.359 (1.868)		−2.632 (1.901)	−2.667 (1.904)
Thinking air pollution is the most important issue in the city (1 = Yes)		2.928* (1.742)	3.284* (1.732)		2.725 (1.793)	2.944* (1.778)
Household characteristics						
Home business (1 = Yes)			−1.805 (2.311)			−2.521 (2.395)
Household size			−0.507 (0.504)			−0.211 (0.425)
Number of children under 6			−1.693 (1.265)			−2.303* (1.267)
Number of elder			0.474 (1.239)			0.12 (1.244)
Individual characteristics						
Male (1 = Male)			−1.029 (2.011)			−1.227 (2.069)
Age (years)			0.116 0.081)			0.115 (0.081)
Occupation (Base = Others)						
unskilled labor			−2.227 (3.602)			−2.874 (3.77)
office worker			−4.316 (4.06)			−4.6 (4.222)
skilled labor			2.672 (4.116)			2.439 (4.195)
housekeeper			−3.357 (3.513)			−3.244 (3.667)
unemployed			3.343 (3.813)			2.692 (3.812)
Self-employed			−1.017 (3.502)			−0.419 (3.585)
Education (Base = Not yet finished primary school)						
Primary school			−6.043 (4.287)			−5.725 (4.602)
Secondary school			0.528 (4.034)			0.94 (4.27)
high school			1.446 (4.121)			2.758 (4.32)
College			0.173 (4.966)			1.377 (5.201)
University			1.786 (4.702)			2.509 4.916)
Constant	9.48*** (0.856)	8.432*** (3.011)	9.072 (6.693)	10.282*** (0.886)	9.631*** (3.144)	9.031 (6.763)
Sigma	7.926*** (0.527)	7.635*** (0.509)	7.279*** (0.488)	13.865*** (0.817)	13.364*** (0.79)	12.804*** (0.76)
N	294	294	294	294	294	294
Log-likelihood	−411.66	−403.17	−392.35	−414.79	−405.81	−395.15

*Note: ***, **, and * indicates significance at 1%, 5% and 10%, respectively.*

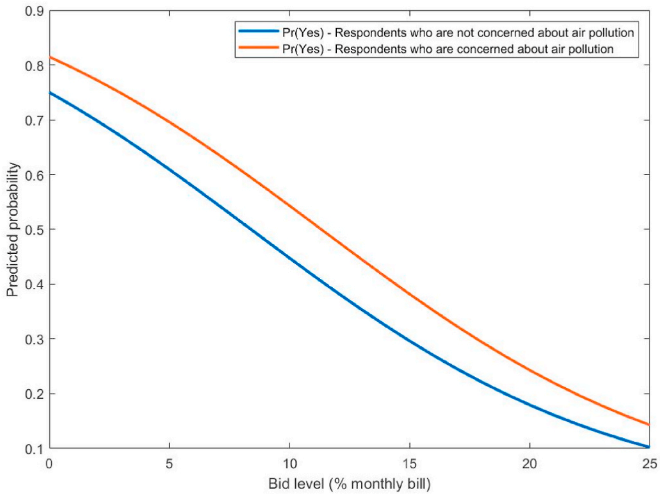

Fig. 3. Survivor functions and the concern on air pollution.

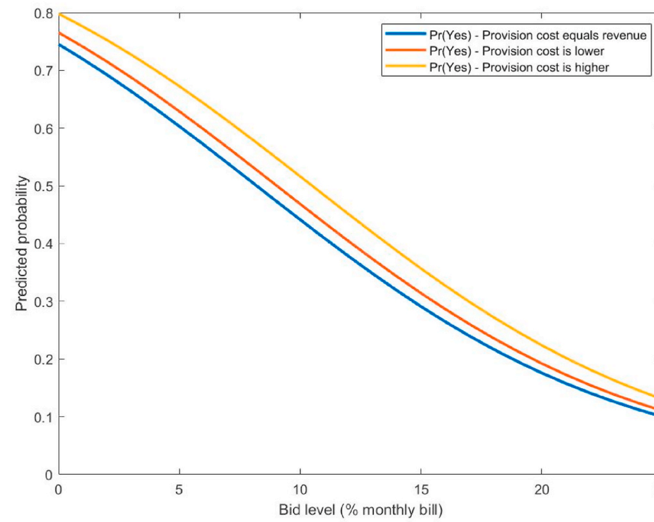

Fig. 4. Survival function (from Model II, logistic distribution).

value for the Plan is $4.39 per month.

Model II and Model III show similar results. Given that potential factors affecting the respondents' WTP were more carefully explored in Model III, we report the estimation results for Model III. We are interested in the significantly positive impact of concerns on air quality, which shows a 3.28% point increase in the WTP compared to those who are less concerned about air quality. The perceived cost of electricity supply appears to be another important factor that may affect the WTP. The coefficient of perceived cost is 0.148 and significant at the 5% level, which implies that respondents thinking the supply cost is higher than the utility's revenue (i.e., EVN is losing money) are willing to pay more for the Plan. Specifically, a 1% point increase in expected utility losses will lead to a 0.15% point increase in the WTP. Besides, respondents thinking EVN is making a profit will not actually affect the WTP. The coefficient of electricity bill is estimated to be −0.059 and significant at the 5% level, indicating a $1 increase in the current monthly electricity bill will result in a 0.06% point decrease in the WTP. However, the overall respondents with a lower energy cost preference are not statistically different in WTP from those with no preference, which may represent that cost considerations may not be the first priority. In terms of other factors, we can find that unexpectedly, awareness of renewable energy will not significantly affect WTP even at the 10% level. Besides, none of household and individual characteristics is statistically significant, which implies that the WTP is more likely to be driven by perception, awareness, and attitude factors instead of socioeconomic and demographic factors.

We are particularly interested in the specific impact of respondents' concerns on air pollution issues. Fig. 3 depicts the projected survival function based on Model II under the logistic distribution.[1] Each curve in the figure shows the predicted probability of willingness to pay for the Plan, denoted as the percentage of the monthly electricity bill, under different bid levels. The blue curve denotes respondents who are not concerned about air pollution. The yellow curve represents respondents who are concerned about air pollution. We can find that the predicted probability curve of respondents that are concerned about air pollution is higher than the other. For both groups, the predicted probability of willingness to pay decreases sharply with the bid level increases. Specifically, respondents concerned about air pollution have a predicted probability of 80% being willing to pay for the Plan when the bid level is 1% of their monthly electricity bill. However, the predicted probability decreases to around 15% when the bid level increases to 25% of their monthly electricity bill. For respondents who are not concerned about air pollution, the predicted probability drops from 72% to 10% when the bid level increases from 1% to 25%.

Besides, we estimate the specific impact of respondents' perceived utility profitability. Fig. 4 illustrates the projected survival function using Model II under the logistic distribution. The blue curve represents the group that thinks the supply cost of the utility is equal to its revenue. The red curve and yellow curve denote the group that thinks that the supply cost is lower and higher than the revenue, respectively. The results show that the probability of willingness to pay for the Plan of the group that thinks EVN is making a loss is higher than the other two groups. The survival curve for the group that thinks the supply cost is equal to the revenue is very close to that of the group that thinks EVN is making a profit, indicating that the impact on the WTP is similar. For all three groups, the probability of willingness to pay is observed a relatively sharp decrease as the bid level increases. Specifically, the group that thinks EVN is losing money has a predicted probability of about 78% to pay for the Plan when the bid level is 1% of their monthly electricity bill. By contrast, the group that thinks EVN is making a profit has a predicted probability of about 75% to pay for the Plan when the bid level is 1% of their monthly electricity bill. The predicted probability is about 72% for the group that thinks the supply cost is equal to the revenue. When the bid level is raised to 25% of the monthly electricity bill, the predicted probability of the group that thinks EVN is losing money falls to around 14%. For groups that think supply costs are less than or equal to revenues, the predicted probability is about 10%.

5. Discussion & policy implications

Vietnam's ambitious renewable energy plan is expected to provide important climate mitigation and ecological value to the public on top of meeting increases in projected electricity demand. Based on door-to-door interviews, this study finds that Ho Chi Minh City residents are willing to pay up to 9.48% of their current monthly electricity bill for more renewable energy, which approximately equals $4.39 per month. By comparing the willingness to pay for renewable energy in other Asian countries, the results demonstrate that the mean WTP of Vietnamese

[1] Out of interest in socioeconomic factors, we included household and individual characteristics in Model III. However, the results of the LR test cannot rule out the null hypothesis that the coefficients of these characteristics are statistically equal to 0, which means that Model II may be the better fit. Thus, we project the survival function based on Model II.

respondents[2] is higher than that the $1–2/month in Myanmar [47,48], $1–3/month in China [27,28], yet much lower than the $17/month estimates in Japan [20,49]. Overall, although lower than in high-income countries, respondents in Ho Chi Minh City have a higher willingness to pay for renewable energy compared to other emerging economies, implying that renewable energy diffusion may have a higher public acceptance in Vietnam.

There may be several reasons underlying this potential for public renewable energy support – mostly related to perceptions on air quality improvement, utility revenues, and grid integration costs, which ultimately result in several policy implications. For instance, one concern for respondents was air quality. As income grows, individuals are increasingly aware of the adverse effects of environmental quality issues on health benefits. Rising awareness and concern for poor air quality will prompt consumers to positively view green purchases and decisions that may have an effect on air quality. As one of the determinants of consumers' willingness, concerns about air quality contributes to the increase of renewable energy WTP in Vietnam, inspiring the local government to take appropriate educational interventions that increase public environmental protection awareness and perception of environmental risks. The timely and accurate release of massive air quality data with high temporal and spatial resolution and air quality inspection reports may also increase public concerns about air quality issues. Urban households are more concerned about air quality, which corresponds with the greater feasibility of implementing a higher share of renewable energy in rapidly urbanizing Vietnam.

Another interesting result lies in the public's perception of utility profitability. If the public perceives that the supply cost of the utility is lower than its revenues, i.e., the utility is making a profit, the public's willingness to pay is not affected. However, when the public perceives that the power sector is losing money, they are willing to pay a higher price for renewable energy as compensation to the utility. To this date, renewable energy in Vietnam may still depend on some forms of government subsidies, indicating that utilities are likely to be in the red in renewable energy deployment without effective electricity market reforms [50,52. If EVN improved its information disclosure, the public could have a better understanding of its financial status and renewable energy deployment plans, which would further increase the WTP of renewable energy and thus facilitate the adoption of renewable energy in Vietnam. Previous studies establish the financial viability of distributed rooftop photovoltaics for residential customers as a lower-cost option than grid electricity, but most customers lack knowledge of the potential bill savings and lack knowledge of the utility's financial status [51].

There are a few limitations to the survey – the sample mostly consists of urban residents in Ho Chi Minh City. These respondents are using an increasing amount of electricity with a higher concern on air pollution issues, but the perspectives of rural communities from other regions of Vietnam would be important as well to promote more renewable energy adoption. These perspectives may differ related to air quality and perception of the utility company. The urban sample is small, yet still provides insights into an understudied group of energy customers who may be critical to include in designing policy for Vietnam's electricity transition.

In summary, this research advances the literature's understanding of willingness to pay for renewable energy in fundamental ways. For international dialogues where climate resilience is being discussed, air quality benefits may present a more compelling piece of information to increase the public's acceptance of renewable energy. Transparent and open information such as the inclusion of air quality information in regular media reporting and outreach could benefit renewable energy and accelerate public support. Additionally, disclosing utility financial reports may also open a more competitive electricity market and allow for higher shares of renewable integration, which could further advance renewable energy deployment in Vietnam. If the public understands social costs of fossil fuel production, their willingness to pay for renewable energy may increase, as the operating costs and overall life-cycle costs may be less expensive than building new coal-fired power plants. Studies quantifying willingness to pay are important to understand human behavior and the adoption of emerging renewable energy technologies that can simultaneously improve air quality and address global climate change.

[2] It should be noted that as one of the largest cities in Vietnam, Ho Chi Minh City may have a higher average willingness to pay than other regions.

Credit author statement

Ying Yu – Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing, **Kensuke Yamaguchi** – Project administration, Writing – review & editing, **Truong Dang Thuy** – Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing, **Noah Kittner** – Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.rser.2022.112942.

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