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Valuing energy poverty costs: Household welfare loss from electricity blackouts in developing countries

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ABSTRACT

Supply of electricity is not keeping up with the rapidly increasing demand due to industrialization as well as electrification of rural areas in many developing countries. This study adds to the scarce literature on valuing the welfare loss to households in developing countries from energy poverty in terms of access only to intermittent or unreliable electricity networks. We conducted a Contingent Valuation (CV) survey of households in both urban (city of Mekelle) and rural areas (village of Ashegoda) in Northern Ethiopia to estimate households' willingness-to-pay (WTP) to avoid electricity blackouts. On average, the households experienced 160 blackouts per year with an average duration of four hours; and were on average willing to pay 499 Ethiopian birr (18 USD) per household per year. This corresponds to a 34% increase in their annual electricity bill and represents 1% of their mean annual income. Thus, this type of energy poverty represents significant welfare losses in developing countries. The households' WTP to avoid blackouts increases significantly both with annual income and expenditure as a proxy for income; and with the annual number of experienced blackouts, the average length of these blackouts, and the number of damage categories experienced. These results are all as expected and support the validity and reliability of CV surveys to assess household welfare loss from this type of energy poverty in a developing country context.

1. Introduction

Energy poverty is defined as the inability of households to have access to adequate, affordable, reliable, high-quality, safe and environmentally benign energy services (Reddy et al., 2000). There is a general agreement that electrification is fundamental to economic growth and social welfare. There are numerous studies showing the positive effects of electricity on income, education, employment, and indoor air quality (Chakravorty et al., 2014; Khandker et al., 2013; Dinkelman, 2011; Barron and Torero, 2017). In developing countries like Ethiopia only 45% of the population had electricity in 2018, meaning that 60 million people have no electricity connection (IEA, 2019). The Ethiopian government continues to set goals to increase access to electricity and have launched a national electrification program aiming for universal access by 2025 (IEA, 2019). Increased use of decision support tools like cost-benefit (CBA) analysis to assess the profitability of energy investments, increase the need to document the full economic benefits of these investments, which includes reductions in energy poverty among households. This paper provides an example of how welfare effects of reducing energy poverty to households in Northern Ethiopia can be valued in monetary terms using state-of-the art Stated Preference (SP)[1] methods to map their willingness-to-pay (WTP) to avoid black-outs.

Higher quality of electricity i.e., less blackouts and brownouts, is just as important as access to electricity. Fewer power outages have a positive effect on income (Chakravorty et al., 2014; Dang and La, 2019), land and investment decisions (Dang and La, 2019), women empowerment (Sedai et al., 2020), consumption expenditures (Sedai et al., 2021) and ownership of basic appliances (Bajo-Buenestado, 2021). Poor quality of electricity has a significant negative impact on the production and income of companies (Fisher-Vanden et al., 2015; Allcott et al., 2016). Blackouts and brownouts are linked to slower economic growth. In 2010, power shortage caused a 3.1% loss in Gross Domestic Product (GDP) in Ethiopia (Engida et al., 2011). Since GDP does not include household welfare losses, it is essential to document the welfare losses due to poor electricity quality.

Many SP studies in the developed world have estimated households'

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[1] Stated Preference (SP) methods include Contingent Valuation (CV) and Choice Experiments (CE).

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willingness-to-pay (WTP) for power reliability (Hensher et al., 2014; Woo et al., 2014; Kim et al., 2015; Blass et al., 2010; Cohen et al., 2016; Cohen et al., 2018; Layton and Moeltner, 2005; Carlsson and Martinsson, 2007; Carlsson and Martinsson, 2008; Reichl et al., 2013; Morrissey et al., 2018; Bliem, 2009; Amador et al., 2013; Pepermans, 2011; Ozbafli and Jenkins, 2016; London Economics, 2013; Accent., 2008; Merk et al., 2019; Motz, 2021). However, in developing countries, and Africa in particular, there are still relatively few SP studies of households' welfare loss from unreliable electricity supply (Abdullah and Mariel, 2010; Oseni, 2017; Meles, 2020; Zemo et al., 2019; Alastaire, 2015; Nkosi and Dikgang, 2018; Twerefou, 2014; Amoah et al., 2017;) although power insecurity is very widespread.

Our study adds to this scarce literature in developing countries and complements Meles (2020) and Zemo et al. (2019) by providing a new case study in Northern Ethiopia. Meles (2020) used both defensive (averting) costs and Contingent Valuation (CV) to estimate households' welfare loss from power outages in the Ethiopian capital of Addis Ababa. Zemo et al. (2019) studied the determinants of households' WTP to reduce power outages using a sample of urban households from Mekelle, Ethiopia. A main contribution of our paper in this respect is that we perform an urban-rural analysis in order to identify any spatial variation in households' welfare loss from electricity blackouts and try to determine what socio-economic characteristics and other factors that can explain such variation.

The main aim of this paper is to apply the best practice guidance in SP methods (Johnston et al., 2017) to design a CV survey to get a valid and reliable estimate of households' WTP for eliminating electricity blackouts in Northern Ethiopia and determine the factors affecting their WTP. This study adds to the scarce developing country context literature on this topic in terms of: i) a clearly specified change in energy reliability, ii) covering both urban and rural households, and iii) extending the set of explanatory variables from socio-economic variables to also include households' possession of alternative energy sources and their recall of the government's unfulfilled promises with regards to energy supply.

The remainder of this paper is structured as follows. Section 2 provides a literature review of energy poverty and SP studies valuing household welfare losses from power outages Section 3 describes the methods and data, while section 4 presents and discusses the results, and section 5 concludes.

2. Literature review

Definitions of energy poverty (and fuel poverty) in the literature are centered around access to modern energy service, energy consumption levels, and affordability of energy for basic utilities (Boardman, 2010; Buzar, 2007; Li et al., 2014; Thomson et al., 2016). On the other hand, Reddy et al. (2000) cover multiple aspects by defining energy poverty as "the absence of sufficient choice in accessing adequate, affordable, reliable, high-quality, safe and environmentally benign energy services to support economic and human development". This is a more inclusive definition which corresponds better with the actual experience of households, especially in developing countries.

There are different approaches to measuring energy poverty. Below we summarize the most prominent ones. The most applied measure of energy poverty is the *Income-expenditure approach*; also known as the *Economic threshold* (Awaworyi Churchill and Smyth, 2020; Awaworyi Churchill and Smyth, 2021; Kahouli, 2020). It is based on income and energy-related household expenditures where the share of energy spending is higher for energy-poor households (Herrero, 2017; González-Eguino, 2015; Boardman, 2010). An example of the Economic threshold can be found in the UK fuel poverty official statistics, where the Energy expenditure (ENEX) threshold is set at 10% of household income (Hills, 2012). Households spending more than the 10% mark are considered energy poor. One problem with this approach is that it is challenging to compare countries because of its relative nature (González-Eguino, 2015). There is also no emphasis given to the type or quality of energy service households have. Therefore, this approach may underestimate the extent of energy poverty in developing countries in which some households spend a share of their income on traditional energy sources (Ismail and Khembo, 2015).

The *Low income-high cost (LIHC) approach* uses the income threshold and energy expenditure threshold. Households with a residual income (after deducting energy expenditures) lower than 60% of the median income, and with a higher energy expenditure than the median expenditure are considered energy poor (Hills, 2012). In both the Economic threshold and LIHC approaches the actual threshold chosen will influence the number of households categorized as energy poor (Rafi et al., 2021). Another potential problem is that these measures are based on actual energy expenditures, which can be lower than the desired expenditure because of costs (Awaworyi Churchill and Smyth, 2020), or because of frequent power outages.

The *Technology threshold approach* originates from the energy poverty definition stating that there is a lack of access to modern energy services. Energy poverty is measured by counting the number of people with no access to modern energy services such as electricity (González-Eguino, 2015). This measure is widely used in the context of developing countries and is easy to compute and compare, but it does not capture the affordability dimension of energy poverty. Some households have access to energy but are not able to afford it (Ye and Koch, 2021; Winkler et al., 2011). It also does not consider the degree of energy insecurity, which is a very common scenario in developing countries.

The *Physical threshold approach* measures energy poverty through the minimum energy consumption associated with basic necessities. Any household below the minimum threshold is categorized as energy poor, but the number of people categorized as energy poor is sensitive to the choice of threshold, and the definition of basic necessities. (González-Eguino, 2015; Herrero, 2017).

Subjective measures use households' feelings and perceptions of their energy use (González-Eguino, 2015). The most used subjective measure is households' self-assessment of the inability to afford adequate warmth (IAAW) in their homes (Thomson et al., 2017; Awaworyi Churchill and Smyth, 2020). The subjective measures are criticized for their lack of consistency across respondents and that the responses are influenced by respondents' cultural, geographical, and demographic characteristics (Thomson et al., 2017). For instance, Deller et al. (2021) found that household heads aged 65 or more are less likely to report IAAW while they are at a higher risk of being declared as energy poor according to the expenditure based indicators (i.e., ENEX and LIHC). The IAAW is a widely applied subjective measure but fails to include other energy demands such as cooling (Thomson et al., 2017). In addition, households may be unwilling or unable to identify themselves as energy poor (Deller et al., 2021).

Despite the shortcomings, subjective measures are proposed and widely used in the energy poverty literature, either independently or coupled with other measures (e.g., Awaworyi Churchill and Smyth, 2020; Thomson and Snell, 2013; Thomson et al., 2017; Price et al., 2012). One of the reasons behind this popularity is that these measures captures the lived experience and the feeling of being energy deprived (Thomson et al., 2017).

Deller et al. (2021) describes significant variation between the subjective and objective measures. The limited overlap between the subjective and objective measures is persistent through time, and not temporary. One of the suggested reasons is that households may not consider the threshold of the expenditure-based approaches as unaffordable. The households may also not feel comfortable declaring that they are energy poor. There could also be a degree of household heterogeneity affecting their responses due to differences in demographics, geographical and cultural conditions. Finally, households may report IAAW but spend much less of their income on energy to restrict their energy consumption for affordability reasons (Deller et al., 2021).

Multidimensional measures use a set of different indicators to capture multiple dimensions of energy poverty. These measures have become widely used in the literature. For example, Awaworyi Churchill and Smyth (2020) and Munyanyi et al. (2021) used a composite index of energy poverty (households' energy deprivation score), combining the subjective and expenditure measures. In their study, equal weights (0.5 each) were assigned to the subjective and expenditure indicators. A household with a household energy deprivation score of 0.5 or more is considered energy poor.

The results of the multidimensional indices are sensitive to how they are designed. The assigned weights and the type of indices chosen to be included may significantly influence the results (Ye and Koch, 2021). Nussbaumer et al. (2012) introduce the multidimensional energy poverty index (MEPI), which comprehensively frames energy poverty in terms of household energy deprivation in different areas, as opposed to access only. The inclusion of services contingent upon electricity access broadens the measurement to include the affordability of energy, and not just the access. The reliability of the power grid is not included, but the cooking method is included, and can in some way be said to capture a bit of the variation in grid reliability.

Energy insecurity is directly related to the measures mentioned above. Together with the above measures, energy insecurity should be accounted for, in relation to energy poverty, and included where possible. In the income-expenditure approach, power outages will reduce the energy costs, and potentially put households artificially below the threshold of energy poverty. In the technology threshold approach, households will be counted as energy poor only if they are not connected to the grid, and effects of unreliable connections will not be accounted for. In the physical threshold approach, a blackout-related reduction in energy consumption increases the number of energy poor households counted as energy poor. In the subjective measures, households may feel deprived of basic energy services due to unplanned frequent blackouts and brownouts. This makes them more likely to self-report as energy poor, depending on how the energy poverty questions are framed. Lastly, in the multidimensional approaches, the frequency and duration of blackouts can easily be included in the framework and should be included if data is available. Failure to include any measure of energy insecurity will bias the results, and potentially misclassify households with regards to energy poverty.

Consistent electricity supply should be given equal attention to ensuring just access to electricity. Lack of regular access to electricity in developing countries has various negative impacts on households, small businesses, manufacturers, and public services. It interferes with day-to-day activities and hinders productivity, which limits growth and development. It also increases the households' use of kerosene, charcoal, and firewood causing increased indoor air pollution and associated health risks in terms of respiratory diseases, especially for those spending much time at home. Women, small children, and the elderly are the most vulnerable (WHO, 2018).

In addition to direct monetary costs, households face non-monetary costs due to interrupted electricity supply. Such welfare losses were estimated in a cross-country study by Cohen et al. (2016). They examined households' WTP to avoid blackouts in 15 EU countries.

They reported that the average household in Romania, Bulgaria, Greece, Hungary, Poland, Finland, Slovenia, Spain, Estonia, Sweden, Denmark, Ireland, Netherlands and Germany was willing to pay between €1.035 and €3.994 to avoid a 1-h power outage in winter, and between €0.088 and €1.100 to avoid a 4 h power outage in the summer. For France, the WTP was €0.364 to avoid a 1-h blackout in the winter season and a negative estimate for the summer outages, which indicated the general aversion of additional cost related to power service in the French household sample. WTP was generally high for the wealthiest nations (Finland, Denmark and Germany) and for the lowest power reliability tier (Romania, Bulgaria, Hungary and Poland) in their sample. Another cross-country CV study by Cohen et al. (2018) reported that households had an average WTP of €1.40 (Belgium), €1.47 (UK), €1.72 (Sweden), €1.96 (Netherlands), €2.31 (Austria), €2.83 (Luxembourg),

Table 1
Review of Stated Preference surveys (Contingent Valuation, CV and Choice Experiment, CE) in Africa of households' willingness-to-pay (WTP) for improved energy security.

Authors	Valuation Method[2]	Country	Data collection Year	Households' willingness-to-pay (WTP)[1] for improved energy security
Abdullah and Mariel, 2010	CE	Kenya	NA	WTP KES 51.79 (0.68 USD) per month for improved electricity service
Oseni, 2017	CV	Nigeria	2011	WTP between NGN 956.60 (6.16 USD) and NGN 1160.72 (7.48 USD) per month to reduce blackout to half of the level they were experiencing.
Meles, 2020	CV	Ethiopia	2016	WTP 31 ETB (USD 1.3) per month for improved electricity service
Zemo et al., 2019	CE	Ethiopia	NA	The marginal WTP to reduce the frequency of outage by one is 1.857 ETB (0.07 USD) and 6.191 ETB (0.22 USD) per month when the outage happens ten times in a month and three times in a month, respectively
Alastaire, 2015	CV	Benin	2010	Weekend 800 FCFA (1.76 USD); Weekdays 400 FCFA (0.88 USD); Night 831 FCFA (1.83 USD); Day 381 FCFA (0.84 USD); Weekday 1 h 109 FCFA (0.24 USD); Weekend 1 h 642 FCFA (1.41 USD)
Nkosi and Dikgang, 2018	CV	South Africa	2015	WTP ranges from ZAR 69.53 (5.79 USD) to ZAR 106.68 (8.89 USD) to avoid a 5-h long blackout
Amoah et al., 2017	CV	Ghana	2015	Those who trust the government were willing to pay GHS 66.78 (20.77USD) per month and those who do not trust the government were willing to pay GHS 69.76 (21.7USD) per month for improved electricity
Twerefou, 2014	CV	Ghana	2013	WTP ₵0.2734 for a kilowatt-hour

Remarks: 1. Converted from national currencies to US dollar (USD) using exchange rates in the year of the study (and publication year if study year not available (NA)). 2. Stated Preference methods: CV = Contingent Valuation and CE = Choice Experiment.

€4.02 (Ireland) and €4.10 (Denmark) to avoid a 1-h loss of front door electricity in winter.

According to Blass et al. (2010), households in Israel had a mean WTP of 0.98 USD for a one-minute reduction in the duration of a blackout when there was only one such event per season, and 0.36 USD when there were five outages per season. They also found that households' valuation of power outages vary with how the reduction in power outage time is obtained. Households were willing to pay only 0.42 USD for a one-minute reduction achieved by reducing the frequency of blackouts when the blackouts have a 1-h duration.

In Canberra, Australia, Hensher et al. (2014) found that households' average WTP was 60 AUD (45.52 USD) to avoid an 8-h long power

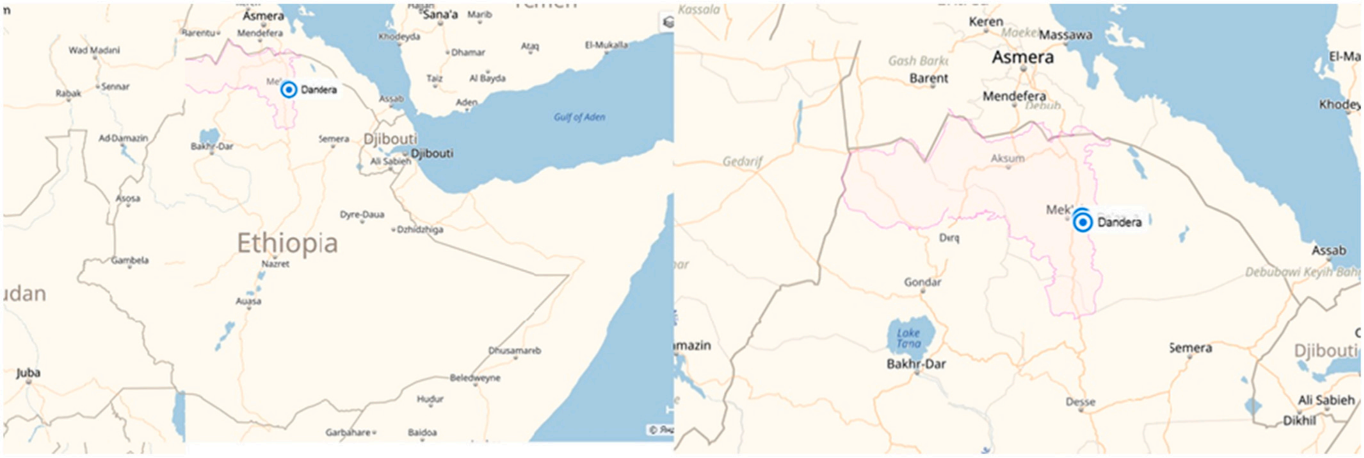

Fig. 1. Map of Mekelle and Ashegoda (Dandera village) in Northern Ethiopia (Map of Ashegoda – GeoLocated Ethiopia, 2021)

outage when it occurred once a year and 9 AUD (6.83 USD) to avoid a flicker in the electric current. Woo et al. (2014) estimated that, the average household cost in Hong Kong for a 1-h power outage was 350 HKD (45 USD). A recent Choice Experiment (CE) study in Switzerland by Motz (2021) mapped households' preferences with regards to frequencies and duration of blackouts and the primary energy sources used for generation. The willingness-to-accept (WTA) compensation estimates for having blackouts had a wider range from slightly negative values to more than 10 times the average price of electricity.[2]

Other studies in developed countries estimating the welfare loss of power outages using SP methods include: Kim et al., 2015; Carlsson and Martinsson, 2007; Carlsson and Martinsson, 2008; Reichl et al., 2013; Morrissey et al., 2018; Bliem, 2009; Amador et al., 2013; Pepermans, 2011; Ozbafli and Jenkins, 2016; London Economics, 2013; Merk et al., 2019. For a review of these papers and their results, see (Motz 2021)). Motz (2021) concluded from her literature review that the large variably of the WTP/WTA estimates observed in the literature is due to the differences in scenario descriptions in SP studies, and the different structure of the electricity sector and consumption habits in different countries. However, it could also arise from consumer reactions in different contexts and structural taste variability.

Table 1 provides an overview of eight SP studies in Africa estimating households' WTP for improved energy security.

These studies also provide interesting results with regards to what factors determine households' WTP, and the relative size of their WTP compared to their current electricity bill. Some examples are provided below, and are also discussed in relation to the results from our study in section 4.

Abdullah and Mariel (2010) used a CE to estimate households' WTP to avoid power outages in Kisumu, Kenya. They show that those who are unemployed, own a bank account, and are engaged in a farming activity were willing to pay on average KES 28.30 (0.26 USD), 90.96 (0.84 USD) and 74.95 (0.70 USD), respectively. Mean WTP for the rest of the sample was KES 51.79 (0.48 USD).

Oseni (2017) investigated the relationship between engagement in self-generation to mitigate impacts of poor electricity service and WTP for electricity service reliability in Nigerian households; and found that self-generation is positively correlated with their WTP.

Meles (2020) used both defensive (averting) costs and CV to estimate households' welfare loss from power outages in the Ethiopian capital of Addis Ababa. On average households were willing to pay 31 ETB (1.30 USD) per month for improved electricity supply, which is 23% of their average monthly electricity bill. His analysis shows that monthly household income, distance from the utility head office, education, and belief in future service improvement increased households' WTP for improved electricity supply; while WTP decreased with age.

3. Methods and data

3.1. Survey design and data collection procedure

The survey design and the implementation of this CV study was based on the contemporary guidance for stated preference studies (Johnston et al. (2017) in order to increase the validity and reliability of the survey results. Validity refers to maximizing accuracy in estimation while reliability refers to minimizing variability, and a credible CV study incorporates both attributes (Bishop and Boyle, 2017).

An eight-page long questionnaire was developed (see Appendix A). It was originally in English and then translated to Tigrigna.[3] The questionnaire starts by asking respondents to assess public services and goods, including electricity security (i.e. avoidance of blackouts); and then goes on to ask about their energy saving and environmental behavior[4]; see appendix C (Tables 29 and 30, respectively). These questions aim at helping respondents to put electricity blackouts in a broader perspective.

The second part of the questionnaire contains the CV scenario and willingness-to-pay (WTP) questions. The respondents were presented with a hypothetical scenario where the government plans to eliminate blackouts by upgrading hydropower dams, building new wind farms and new transmission lines. They were told that the project cost will be covered by the government, international donors, companies, and households collectively; and that the project will be implemented if these parties are able to cover the cost of the project. Then respondents were asked the most they would certainly be willing to pay annually, on the top of their electricity bill, to eliminate blackouts. The payment card showed different amounts ranging from zero to 3600 Ethiopian birr[5] per year.

Questions on respondents' socio-demographics and a question about respondents' perception of the survey constituted the last part of the questionnaire. To avoid any disruptions of the survey, income related questions which were judged to be the most sensitive, were placed at the very end of the questionnaire.

[2] The average electricity price was about 0.21CHF/kWh (0.22 USD/kWh).

[3] Tigrigna is a language spoken by inhabitants of Mekelle and Ashegoda.

[4] Recommendation 12 for Stated Preference (SP) surveys: SP studies should contain supporting questions to enhance validity (Johnston et al., 2017).

[5] 1 US dollar (USD) = 27.28 Ethiopian Birr (EB) at the time of the survey (2018).

3.2. Sampling procedure

A sample of 150 respondents were drawn using cluster sampling and simple random sampling in Mekelle, and a similar procedure was used to sample 51 respondents in Ashegoda. Mekele is a big city and Dandera is a small village in rural Ashegoda (see Fig. 1). Although larger sample sizes are preferred, we were not able to exceed 201 because of financial constraints. The generalizability of our results should therefore be tested in further surveys with a larger sample size in developing countries.

The clustered sampling involved selecting one out of a total of seven 7 sub-cities in Mekelle, for simple random sampling of households. In the selected sub-city Hadenet there are five weredas. Out of the five weredas three were selected randomly. Finally, respondents were selected randomly from the selected weredas. For the Ashegoda sample, respondents were randomly drawn from the village Dandera.

3.3. Scenario description

In the CV scenario the status quo, the proposed change, the mechanism of change and payment vehicle should be described in a clear and understandable manner to help respondents figure out their expected gain or loss from the proposed change (here: elimination of electricity blackouts). A survey design procedure that ensures respondents' understanding of the questions is also required (Johnston et al., 2017).

The following valuation question format was used to elicit respondents' WTP to avoid blackouts:

"The Government is now considering implementing a program to reduce the number of blackouts from the current level to eliminate the blackouts. The program includes upgrading old and building new electricity production plants and new transmission lines. The costs of this program will be covered by international donors, government, companies and the households. If the government sees that these interest groups are willing to pay more to avoid the blackouts than what it costs, they will implement the program, which will eliminate blackouts. Think about what it is worth to you to fully avoid the negative impacts you have experienced from blackouts the last 12 months. What is the most, if anything, your household certainly is willing to pay per year for 10 years on the top of your annual electricity bill (or on the top of your house rent, if you are not paying the electricity bill by yourself) to fully avoid blackouts? Remember that this payment will reduce your spending on other goods and services". Here, the baseline scenario is clearly stated as the current level of blackouts the household is experiencing, and which they had reported prior to the WTP-question in terms of the annual number of blackouts. Further, the proposed change is to *eliminate* blackouts.[6] Thus, it is clearly specified what change in the provision of the good (electricity security) the households are asked to state their WTP for, as opposed to Meles (2020) that used a dichotomous choice CV question to elicit respondents' WTP for "improving the electricity supply".[7] Meles (2020) specified a project and listed measures to improve the electricity supply, but did not specify the change in energy security the respondents were asked to value. We avoided listing the measures in order not to divert respondents' attention from the benefits they had from avoiding blackouts, and instead asked them specifically to tell us what it was worth to them to avoid the negative impacts they had experienced from the blackouts.

The last pilot survey we conducted verified that respondents understood the information provided.

To increase the credibility, realism, and acceptability of the CV scenario, we told our respondents that international donors, the government, companies, and households would cover the cost of the proposed program. It was important to mention that international donors and companies would contribute for two main reasons. First, to increase its acceptability, as respondents might not trust the government to implement the measures needed on their own; given the political unrest in the country. Second, it is consistent with the current practice in the country; i.e. international donors and companies participate in similar development projects.

A binding and realistic decision rule is important in SP surveys (Johnston et al., 2017).[8] Hence targeting the truth-telling behavior of respondents, we made it clear that the program will be implemented given that the interest groups are willing to pay more to avoid blackouts than what it costs to eliminate them. This will increase the likelihood of obtaining true WTP values from subjects. If a respondent state a higher WTP amount than what it is really worth to him/her to fully avoid the negative impacts, there is a higher probability that the program will be implemented and therefore the respondent will end up paying more than their true WTP. On the other hand, if a respondent states a lower WTP amount than what it is really worth to them to fully avoid the negative impacts for them, then there is a lower probability that the program will be implemented and therefore they might not get the desired change. A rational respondent will then provide his/her true WTP value.[9]

We clearly informed about the payment type and process of the proposed change. We used a payment card approach in which respondents were asked to choose an amount (from a list of amounts; including a "Don't know" option), which reflects what their household certainly is willing to pay per year for 10 years on the top of their annual electricity bill to fully avoid blackouts. A different payment vehicle, housing rent, was used for those who do not directly pay the electricity bill themselves.[10] Using an electricity bill as a payment vehicle for such respondents would be absurd and may even stand as an excuse for respondents' payment-rejection.[11]

3.4. Survey pretesting

While designing the questionnaire for this study, consecutive pilot tests were conducted with the intent of developing an understandable and credible questionnaire for the respondents. There are two types of pretesting, qualitative and quantitative pretesting. Though time and budget limitation allow us to conduct only qualitative and quantitative pretesting, conducting post surveys was also favorable. As for Johnston et al. (2017) an ideal survey process includes both types of pretests and post-survey tests.[12]

We conducted the first pilot test in July 2017, where 10 people were interviewed. The interview constituted open-ended questions including the valuation questions. In addition to helping us frame the auxiliary questions, the responses also helped us determine what range of amounts to put on the payment card for the WTP-question.

The second pilot was conducted in September 2017. Questionnaires were sent to 20 respondents by e-mail. Nine of them replied. The responses were helpful in re-designing and simplifying questions in order to make them easier to understand and avoid misunderstandings.

Just before the main survey, the third pilot was conducted in January 2018. There were no major changes in the questions after this last pilot

[6] Based on our findings the average number of blackouts is 160 times per year. Note that we do not have a uniform baseline for all the respondents as different households experience and recall different number of blackouts.

[7] *"Do you support the project, if every household in Addis Ababa including your household has to pay ____birr monthly for improving the electricity supply?" (*Meles, 2020*; p.3)*

[8] Recommendation 10

[9] Recommendation 13: Design of an incentive compatible and consequential valuation questions are important for credibility of the study (Johnston et al., 2017).

[10] This is the case where households rent a house and do not pay electricity bill directly.

[11] Recommendation 11: a realistic, credible and binding payment vehicle must be used (Johnston et al., 2017).

[12] Recommendation 2

survey, but it helped us to see the potential biases enumerators could introduce if they are not sufficiently trained. Therefore, the enumerators were trained[13] for the second time to ensure the quality of the survey.

3.5. Experimental design

Many researchers, as cited by Johnston et al. (2017), advise that effective designs for CV questions should ensure monetary amounts which are credible to respondents and can give unbiased and consistent estimates.[14] Our CV design attempts to adhere to this guidance, as the proposed change to be valued, previous studies and insights learned through pretesting influence the decision in experimental designs (Johnston et al., 2017).

3.6. Valuation question response formats

There are multiple response formats in CV, each with their own advantages and disadvantage. Binary or dichotomous choice, iterative bidding, open-ended elicitation and payment card are among the common response formats. Dichotomous choice format is known to be the most incentive compatible format under certain conditions. Nonetheless, the responses from such elicitation format provide limited information about the respondent's preferences (Carson and Groves, 2007). Like iterative bidding, it is subject to yea-saying and starting bid bias. The payment card approach and open-ended elicitation, on the other hand, suffer from range bias and unrealistically high or zero responses, respectively. The advantage of the payment card approach is that the range bias can be minimized using pilot tests. As mentioned earlier the payment card approach was used for this study, and it seems to provide a relatively unbiased and effective way of eliciting respondents' preferences.[15] Amounts on the payment card were ranging from zero to 3600 birr per year. "Other" and "don't know" reply options were included in order not to constrain respondents to the amounts listed. Even though Johnston et al. (2017) points out that SP studies need not necessarily include "don't know" or "no-answer" options, it is important to include them for CV studies to increase the validity of the WTP amounts elicited (Groothuis and Whitehead, 2002).[16] CV studies and valuation questions as such are not familiar to respondents, and therefore some respondents may struggle in realizing their WTP for the good to be valued. In cases where there is no "Don't know" option, they are forced to give a pseudo-WTP amount.

3.7. Best practice in Stated Preference surveys

This CV survey tried to adhere to the recent best practices recommendations for SP studies as described by Johnston et al. (2017). Table 2 summarizes these recommendations and how they were adapted in the design and implementation of our CV survey.

3.8. Statistical models

Using the payment approach in our CV design, we do not get the real maximum WTP amount, as opposed to an open-ended WTP question. Respondents' reported amount on a payment card is a minimum

Table 2
Summary of best practice guidance for Stated Preference (SP) survey design and implementation from Johnston et al. (2017), and how they were implemented in our Contingent Valuation (CV) survey.

No.	Recommendations for SP survey design and implementation from Johnston et al. (2017)	Our CV survey
1.	Scenario presentation: Clear presentation of baseline scenario, the proposed change to be valued, the mechanism of change and the payment vehicle	The status quo, the proposed change, the mechanism of change and the payment vehicles were clearly described for respondents for both valuation questions
	Scenario presentation: Evidence that respondents' perception of the information provided	According to the last pretesting conducted, all respondents seem to understand the information provided by the interviewers.
2	Survey pretesting: Qualitative pretesting	Consecutive qualitative pretests were conducted
	Survey pretesting: Quantitative pretesting	A quantitative pretesting was conducted prior to the main survey
3	Attribute versus non-attribute approaches: Decision, whether to use CV or CE, should base on the objective of the study, the complexity of valuation scenario and respondents' perception towards the good	The choice of CV for this study was based on a number of considerations i.e. objectives of the study, respondents' perception towards the goods and the simplicity of the CV method (as opposed to CE) for respondents.
4	Experimental design: CV questions should ensure credible monetary amounts that can give unbiased and consistent estimates.	Valuation questions and auxiliary questions were carefully designed based on pretesting and the SP literature.
5	Ethical considerations: Survey procedure should avoid significant negative effects for respondents. Neither should it influence the validity of the study adversely.	Standard procedures for data collection were applied.
6	Survey mode: survey mode should be context specific	Face-to-face (f2f) interviews in the field was the most appropriate survey mode for our respondents, as internet and mail services are unreliable/have limited coverage.
	Sampling: random sampling from the population	Respondents were randomly selected from the population.
7	WTA (willingness-to-accept) compensation versus WTP: The decision between WTA and WTP should be based on empirical and theoretical considerations.	WTP was considered, both theoretically and empirically, to be most suitable for truthfully revealing respondents' welfare loss. However, note that as WTP is limited by income it also depends on the current income distribution, which may be deemed unjust. Distributional weights can be assigned to the stated amounts to adjust for this.
8	Valuation question response format: reasonable response format should be applied	A payment card approach was used for its relative efficiency
9	"No answer" options	"Don't know" options in the payment cards were provided to increase the validity of the responses.
10	Decision rule: a binding and credible decision rule should be selected	If the parties collectively paying for the program, including households, stated benefits exceeding the program, the program to eliminate blackouts will be implemented (and households have to pay increased electricity bills). This is both a credible, binding decision rule.
11	Payment vehicle: a realistic, credible and binding payment vehicle must be used.	The payment vehicle was an annual addition to households' electricity bills for those who pay electricity bills. For those not paying their electricity bill directly, the payment vehicle was increased house rent. Paying for electricity stability, directly or indirectly, over the

(continued on next page)

[13] Enumerators were trained to familiarize themselves with reading the questions and do it in unbiased manners. For example if respondents did not understand the questions, the enumerators should just reread the questions and should not attempt to further explain the question or interpret it in their own way, as that might introduce another bias. Enumerators were also tested by the supervisors who have extensive experience in data collection.

[14] Recommendation 4

[15] Recommendation 8: reasonable response format should be applied (Johnston et al., 2017)

[16] Recommendation 9: "No answer" option

Table 2 (*continued*)

No.	Recommendations for SP survey design and implementation from Johnston et al. (2017)	Our CV survey
		electricity bill is both a realistic and credible payment vehicle, as well as involuntary /binding.
12	Auxiliary questions: SP studies should contain supporting questions to enhance validity.	The questionnaire includes supporting questions to check the understanding and acceptability of the WTP-question as well as to collect data on socio-economics and other determinants of WTP.
13	Design of an incentive compatible and consequential valuation questions are important for credibility of the study.	Valuation questions were designed in a way that enhances both payment consequentiality (by using an addition to the electricity bills they are used to pay) and decision consequentiality (by stating that foreign donors, government companies and households will collectively pay the costs). Payment card amounts and their range was based on careful pretesting and framed to enhance incentive compatibility and truthful responses.

indicator of the true maximum WTP as stated by Voltaire (2015). It is assumed that the true WTP lies between the observed amount and the next, higher amount in the payment card (Cameron and Huppert, 1989). Thus, we can take the average between the observed value and the next, higher amount. This average value or mid-point is an approximation of the true unobserved WTP. It can be used in estimating an OLS regression. Alternatively, we can use an interval regression without calculating the mid points. In this case, the respondents' real maximum WTP lies in-between a lower boundary, equal to the amount the respondent picked, and an upper boundary which is less than the next, higher amount. Moreover, a logit model is used to explain what factors affect the decision to pay or not, in order to see whether the same factors that affect the decision to pay or not also affects *how much* they like to pay. In the logit model the dependent variable is a binary variable taking the value 0 and 1, denoting willing to pay nothing and willing to pay some positive amount, respectively.[17]

In this study, models are specified for WTP to eliminate blackouts.

$$WTP_{bo} = \beta_0 + \beta_1 income + \beta_2 bo\_damages + \beta_3 number\_bo + \beta_4 length\_longest\_bo + \beta_5 avg\_length\_bo + \beta_6 recall\_gov\_promise + \beta_7 age + \beta_8 age^2 + \beta_9 sex + \beta_{10} number\_ppl\_in\_hh + \beta_{11} alternative\_energy\_sources + e$$

where, WTP_{bo} is WTP to avoid blackouts.

3.9. Survey mode

The survey mode for this study was face-to-face (f2f) interview. F2f Interviews are the most appropriate survey mode for a developing country like Ethiopia.[18] Other survey modes like telephone surveys and internet survey adversely affect the representativeness of the sample respondents in countries with low internet coverage. Nevertheless, f2f interviews have their own disadvantages e.g. interviewer bias. Therefore, to minimize unintended interviewer bias, we trained our enumerators and tested their performance prior to the data collection.

Table 3
Age distribution of the sample and population in Mekelle.

Age range	Mekelle sample (in percent)	Mekelle population aged between 20 and 74 (in percent)[a]
20–29	33.8	34.8
30–39	23.4	25.8
40–49	19.3	15.2
50–59	12.4	12
60–74	11	11.9

[a] The calculation is based on the census conducted in 1994 by central statistical agency. Note that the percentage we provided are for the population aged between 20 and 74 in order to be able to compare it with the sample data (which ranges between 20 and 73)AGENCY, C. S. *Census 1994 Report* [Online]. Available: http://www.csa.gov.et/census-report/complete-report/census-1994?start=20 [Accessed 2018].

Table 4
Duration and frequency of blackouts in rural (Ashegoda) and urban (Mekele) areas. Number of observations in parenthesis.

	Rural	Urban
Mean number of blackouts	167.4 (36)	157.68 (140)
Mean average length of blackout (hours)	5.8 (33)	3.4 (137)
Mean length of the longest blackout (hours)	342.5 (38)	22.6 (143)

4. Results and discussion

4.1. Sample representativeness[19]

In Mekelle city, the female and male population accounted for 52% and 48% of the total population in 2009, respectively (Mekelle Population Data - Millennium Cities Initiative, 2021). For the Mekelle sample 55% of the respondents were females which is quite representative of the population. However, in the Ashegoda sample the female population was slightly overrepresented. In Dandera village 64% of the inhabitants are female, but in the sample we have 84% female respondents. A possible explanation for this overrepresentation is the relativly higher availablity of females for an interview during the day. possible limitation that stem from having more women is that the WTP may be biased upward since women benefit more from less blackouts.

In terms of age, the Mekelle sample represents the population well as shown in Table 3. We are not able to compare the Ashegoda age distribution with its sample due to lack of population statistics.

[17] Recommendation 14: Econometric estimator selection should base on the data type, the hypothesis to be tested and how the results will be used(Johnston et al., 2017).

[18] Recommendation 6: survey mode should be context specific (Johnston et al., 2017).

[19] Recommendation 20: the generalizability and the sample representativeness of an SP study should be documented (Johnston et al., 2017).

Table 5
Descriptive statistics.

Variables	Mean	Std. Dev.	Min.	Max.	N
Age; in years	38.63	13.77	18	73	196
Number of household members	3.97	2.13	1	11	200
Electricity bill per month; birr	128.3	111.55	1	550	140
Household expenditures per month; birr	3406.47	2323.24	100	10,000	132
Net income per month; birr	3699.33	3438.48	0	25,000	82
Number of blackouts per year	159.67	107.16	14	1080	176
Length of the longest blackout per year; in hours	89	232.44	1	2160	181
Average length of blackouts per year; in hours	3.87	3.95	0.05	24	170
Gender; male = 0, female = 1	0.62	0.49	0	1	201
Recall unfulfilled government promise; 1 = yes, 0 = otherwise	0.36	0.48	0	1	198
Damage of blackouts[a] 0 = less than 4 damage categories; 1 = 4 or more	0.43	0.50	0	1	200
Alternative energy sources; 0 = less than 3 alternative energy sources, 1 = 3 or more	0.22	0.41	0	1	192

Note: 1 US dollar = 27.28 = Ethiopian birr at the time of the survey, 2018.
[a] Damages from blackouts for the households includes the following unable to cook with electric appliances, unable to refrigerate food, unable to use bank services and ATM, negative entertainment effects, vulnerable to robbers in a dark night, not able to read or study and so on.

4.2. Descriptive statistics

The raw data is a set of continuous, categorical and binary variables. Some variables were transformed to dummy variables. The variables transformed to dummies are: if respondents recall previous unfulfilled government promises about eliminating blackouts, damage of blackouts, and what other energy sources than electricity they have.

A total of 201 households were interviewed. Among the respondents, 62% were female. For the combined sample, the average age was 38. Half of the respondents were between the age of 22 and 38, 5% were under the age of 22, 26% were between 38 and 50, the rest of the respondents were distributed above 50 and the maximum is 73 (see Table 5).

Respondents were asked the highest attained education. 26% of the respondents had no schooling. 2% can only read and write. Those who attained vocational training, primary or secondary school constituted about 39.5% of the sample respondents. The remaining 32.5% had attained a diploma, bachelor or a master degree.

54.5% of the respondents had either a full time or part-time jobs. However, in the Ashegoda sample more than half were females and most of them were housewives. Around 54% of the respondents were married, 27% were single. The remaining were divorced and widowed. The average household size was approximately 4, and the average number of children in the household is 2. The largest family in the sample had 11 household members.

Almost half of the respondents live in a rented house. Out of these respondents, 36% does not pay electricity in a rented house. Therefore, those people were asked how much they would be willing to pay for the proposed program on the top of their monthly rent in the WTP part of the questionnaire. However, for other respondents, they were asked how much they would be willing to pay on the top of their electricity bill. Average electricity bill was 128 birr per month for those who are paying electricity bills. The average rent was 848 birr per month for those who do not pay electricity.

The average household income was 3700 birr per month but more than half of the respondents were not willing to reveal their income, therefore in the estimated models expenditure was used as a proxy variable for income. The average household expenditure was 3406 birr per month.

The average number of blackouts per year was 160 times with an average length of 3.9 h (see Table 4). Respondents were asked to report the longest blackout they experienced in the last year. The mean length of the longest blackout is the average of the longest blackout each household reported. The mean length of the longest blackout per year was 89 h. Dropping those who reported power outage of more than 7 consecutive days, the mean length of the longest blackouts becomes 26.5 h.

Damages of blackouts for the household includes the inability to cook, light, bake, iron, refrigerate, do laundry and other household chores. The overall frequency of different damage categories experienced by households is provided in the descriptive statistics in Table 18 in appendix C. For the regression modelling these data were converted into a dummy, where 0 denotes less than four types of damages and 1 denotes four or more types of damages experienced by the household. 56.5% of the respondents experienced less than four types of damages whereas the remaining respondents suffer from four or more damages.

The majority, 78% of households, use less than three alternative energy sources other than electricity for home making whereas 22% had three or more alternative energy sources. The alternative energy sources include coal, gas, woodfire, dung and others. The frequency distribution of this variable is provided in the descriptive statistics in appendix C. For the analysis, this variable was converted to a dummy variable.

Two respondents did not answer the question regarding government promises. Out of the 198 who responded, only 35.9% of them recall the government's previous promises of eliminating blackouts, the remaining either don't remember or don't know.

4.3. Mean willingness-to-pay (WTP) and determinants of WTP

The mean WTP to avoid the blackouts is positive. On average respondents were willing to pay 366.5 birr every year for ten consecutive years; based on the stated amounts on the payment card (PC). Using the mid point between the stated amoiunt and the next amount on the PC, the mean WTP grows to 499 birr per year, with the median being 210. The maximum WTP amount was 3600 birr whereas zero is the minimum. 19% of the respondents had zero willingness to pay and 8% answered "don't know". Out of all the zero responses, 17.4% were considered as protest zeros. Mean WTP was calculated with and without protest zeros. The mean WTPs calculated without and with the protest zeros are provided in Tables 6 and 7, respectively. The main reason for excluding protest zeros from any calculations is that those zeros are not true zeros. These respondents could have positive WTP for the elimination of blackouts, but we cannot observe it as they are answering zero to protest one or more aspects of the CV scenario. Thus, all respondents stating zero WTP were asked why they were not willing to pay anything in order to identify the protest zeros. Reasons classified as protest responses include: i) they do not think the program would be effective, ii) they do not think they should pay for the proposed program, iii) they do

Table 6
Willingness to pay (WTP) to avoid blackouts without protest zeros; WTP/household/year (in Ethiopian birr); selected amount on the payment card, and midpoint between selected amount and the next, higher amount on the payment card (but zero and highest amount coded as stated).

WTP to avoid blackouts	Mean	Median	Standard deviation	Minimum	Maximum	Number of observations
Selected amount	366.55	120	496.64	0	3600	174
Midpoint interval	499.14	210	578.68	0	3600	174

Table 7
Willingness to pay (WTP) to avoid blackouts with protest zeros; WTP/household/year (in Ethiopian birr); selected amount on the payment card, and midpoint between selected amount and the next, higher amount on the payment card (but zero and the highest amount stated explicitly are coded as the amount stated).

WTP to avoid blackouts	Mean	Median	Standard deviation	Minimum	Maximum	Number of observations
Selected amount	350.44	120	491.35	0	3600	182
Midpoint interval	477.20	210	574.98	0	3600	182

Table 8
WTP/household/year (for 10 years) to eliminate blackouts for the Ashegoda rural and Mekelle urban samples (without protest zeros), based on the stated payment card (PC) amount and the mid-point to the next, higher amount on the PC; in Ethiopian birr.

Location		Mean	Median	Std. dev.	Mini-mum	Maxi-mum	Number of obs. (N)
Ashegoda (Rural sample)	Stated PC amount	230.27	120	299.50	0	1200	37
	Mid-point	321.89	210	392.79	0	1500	37
Mekelle (Urban sample)	Stated PC amount	403.36	120	532.53	0	3600	137
	Mid- point	547.01	210	611.78	0	3600	137

Table 9
Regression models for WTP to eliminate blackouts; OLS and Interval regressions.

	(OLS 1)	(OLS 2)	(Interval regression 1)	(interval regression 2
Household expenditures	0.148***		0.151***	
	(0.0000)		(0.0000)	
Damage of blackouts	221.3	290.3*	203.1	273.9**
	(0.1086)	(0.0118)	(0.1026)	(0.0100)
Number of blackouts	1.405**	1.554***	1.333**	1.486***
	(0.0032)	(0.0006)	(0.0020)	(0.0004)
The longest blackout	−0.0123	−0.233	−0.0411	−0.236
	(0.9790)	(0.6064)	(0.9226)	(0.5748)
Average length of blackouts	43.58**	23.20+	42.75**	21.89+
	(0.0099)	(0.0852)	(0.0051)	(0.0806)
Alternative enrgy sources	396.6	232.2	394.3	198.7
	(0.2343)	(0.4413)	(0.2001)	(0.4839)
Recall unfullfilled government promises	−148.8+	−131.9+	−135.6+	−122.0+
	(0.0639)	(0.0679)	(0.0604)	(0.0688)
Age	−3.757	−1.553	−2.826	−0.713
	(0.8958)	(0.9508)	(0.9145)	(0.9760)
Age-squared	−0.0173	0.0190	−0.0310	0.0103
	(0.9567)	(0.9482)	(0.9158)	(0.9703)
Rural	−301.2	−405.1	−265.1	−355.3
	(0.4321)	(0.2113)	(0.4524)	(0.2420)
Female	−417.6**	−241.2*	−414.8***	−236.8*
	(0.0020)	(0.0250)	(0.0005)	(0.0177)
Household members	41.15	53.86*	44.06	52.40*
	(0.2617)	(0.0482)	(0.1875)	(0.0381)
_cons	27.60	238.1	−4.642	228.5
	(0.9661)	(0.6433)	(0.9938)	(0.6357)
lnsigma				
_cons			6.136***	6.234***
			(0.0000)	(0.0000)
N	90	131	90	131
adj. R^2	0.4246	0.1958		

p-values in parentheses.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

not support new government programs, and iv) they don't trust the government.

Table 8 shows the mean WTP (without protest zeros) to eliminate blackouts in the two different locations. From the mid-point WTP estimates we see that the rural (Ashegoda) respondents are willing to pay on average 322 birr per year for the next 10 years, whereas the urban (Mekelle) respondents are willing to pay 70% more (547 birr). Although mean WTP varies between the samples, the median is the same. Thus, the WTP distribution is more skewed towards higher amount in the urban sample, with the highest stated WTP amount in Mekelle being three times higher than the one in Ashegoda.

The overall mean WTP (without protest zeros, and based on the midpoint; see Table 6) of 499 Ethiopian birr was 1.1% of mean annual net income, 1.2% of mean annual household expenditure and 32.4% of mean annual electricity bill. Households being willing to pay an additional one third of their electricity bill shows the extent of the blackout problem. The respondents could be paying lower electricity bill because of frequent blackouts and not using electricity as much, or respondents could be willing to pay this much because they desperately want to avoid blackouts.

The results in Table 9 shows that household expenditures (as a proxy for income) is positively associated with WTP. This is in line with the economic theory that a higher household income will result in a higher WTP. Previous studies (e.g Meles, 2020; Twerefou, 2014; Carlsson and Martinsson, 2007) also reported that income is important in determining the amount households would be willing to pay to avoid blackouts. In our regressions, the expenditure variable reduces the number of observations. Therefore, we run regressions without the expenditure variable. In addition to the previously significant variables, damages of blackouts and household size were significant and positively associated with WTP. These results are as expected and confirm the results from previous studies: e.g. Abdullah and Mariel (2010) demonstrated that household with 10 members had a higher mean WTP than those with 6 household members. The adjusted R-square, and thus the explanatory power, of the model with the expenditure variable is much higher than the regression model without it.

In the estimated models, the number of blackouts has a significant positive effect on households' WTP to eliminate blackouts. Average length of the blackout also appears to significantly increase WTP. This is consistent with previous studies (e.g., Nkosi and Dikgang, 2018; Alastaire, 2015; Carlsson and Martinsson, 2007) that also find that the duration of blackouts significantly affects WTP amounts. Zemo et al., (2019) on the other hand found a contrasting result that marginal WTP decreases with the frequency and length of power outages.

In line with the findings of Twerefou (2014) and Nkosi and Dikgang (2018), male respondents are willing to pay significantly more than females. Carlsson and Martinsson (2007) also show that male respondents have higher WTP than females. This could be because men are more in control of the household finances.

Recalling unfulfilled government promises significantly reduces the willingness to pay to avoid blackouts. Fulfilled political promises and historical practices are very important in shaping citizens' trust in government (Amoah et al., 2017). Previous studies (e.g. Oh and Hong, 2012) have shown that trust in government influences WTP for other projects. Amoah et al. (2017) looked at if trust in government had an influence on Ghanaian households' WTP for improved electricity

Table 10
Logit model for WTP to eliminate blackouts.

	(Logit 1)	(Logit 2)
Household expenditures	0.00663	
	(0.1033)	
Damage of blackouts	−2.965	1.973**
	(0.2420)	(0.0066)
Number of blackouts	0.0998+	0.00618
	(0.0811)	(0.1066)
The longest blackout	−0.00934	−0.000304
	(0.1908)	(0.8953)
Average length of blackouts	−0.641	0.0434
	(0.1290)	(0.5211)
Alternative energy sources	30.82	3.924
	(0.9915)	(0.2804)
Recall unfullfilled government promises	−14.97+	−1.068*
	(0.0903)	(0.0129)
Age	−2.049+	−0.187
	(0.0554)	(0.2205)
Age-squared	0.0189+	0.00188
	(0.0620)	(0.2806)
Rural	−33.52	−4.720
	(0.9907)	(0.1969)
Female	−21.21+	−0.894
	(0.0990)	(0.1638)
Household members	4.797+	0.515**
	(0.0892)	(0.0062)
_cons	47.74+	4.319
	(0.0565)	(0.1495)
N	96	140
pseudo R^2	0.7394	0.2919

p-values in parentheses.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 11
Tobit models for respondents with positive WTP to eliminate blackouts.

	Tobit 1	Tobit 2
Household expenditures	0.210***	
	(0.0000)	
Damage of blackouts	560.5*	394.0+
	(0.0207)	(0.0605)
Number of blackouts	1.835**	2.107**
	(0.0100)	(0.0048)
The longest blackout	−0.325	−0.528
	(0.7512)	(0.5756)
Average length of blackouts	95.72**	38.53
	(0.0011)	(0.1062)
Alternative energy sources	312.9	151.4
	(0.5580)	(0.7829)
Recall unfullfilled government promises	−273.4+	−130.2
	(0.0687)	(0.3306)
Age	−6.308	1.878
	(0.8945)	(0.9649)
Age-squared	0.0473	0.0532
	(0.9265)	(0.9128)
Female	−541.5*	−391.7*
	(0.0111)	(0.0386)
Household members	7.275	31.57
	(0.9014)	(0.5246)
Rural	−393.6	−396.6
	(0.5423)	(0.5211)
_cons	−560.3	−148.1
	(0.6175)	(0.8734)
N	76	108
pseudo R^2	0.0566	0.0214

p-values in parentheses.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

services, and unexpectedly found a negative relationship between trust and WTP. Oseni (2017) pointed out that consumers who have confidence in future service improvements were willing to pay more for power reliability.

Length of the longest blackout, age, household size and number of alternative energy sources were insignificant in these models and thus they do not contribute to explaining the variation in households' WTP to avoid blackouts. A reduced model was formulated to test the stability of the results, as the reduced model has a higher number of observation than the full model. The same variables (expenditure, number of blackouts, average length of blackout, recalling government unfulfilled promise and gender) were also significant with the same signs in the reduced model as well as in regression models including protest zero observations (see appendix B). In addition to this, the F-test shows that these variables were jointly significant. A variance inflation factor (VIF) test was conducted to detect multicollinearity. The test result shows no evidence of multicollinearity. For robustness purposes, Table 14 in appendix B presents set of regression results where we delete one control variable at a time. The results seem quite consistent across the regressions.

Table 12
Principal component analysis (PCA).

	(OLS1)		(OLS_PCA)	
Household expenditures	0.148***	(0.0000)	0.139***	(0.0001)
Damage of blackouts	221.3	(0.1086)		
Number of blackouts	1.405**	(0.0032)	1.117*	(0.0184)
The longest blackout	−0.0123	(0.9790)	0.163	(0.7303)
Average length of blackouts	43.58**	(0.0099)	38.12*	(0.0249)
Alternative energy sources	396.6	(0.2343)		
Recall unfullfilled government promises	−148.8+	(0.0639)	−159.3+	(0.0631)
Age	−3.757	(0.8958)	17.99	(0.5476)
Age-squared	−0.0173	(0.9567)	−0.255	(0.4394)
Rural	−301.2	(0.4321)	621.6	(0.1312)
Female	−417.6**	(0.0020)	−406.5**	(0.0027)
Household members	41.15	(0.2617)	52.78	(0.1668)
Unable to use appliances and services			71.81	(0.2884)
Unable to do basic activities			−95.69	(0.2097)
Vulnarablity to robbers in a dark night			−22.45	(0.7467)
Use of woodfire and dung			−141.5	(0.1561)
Use of coal			209.6+	(0.0644)
Use of gas			134.6+	(0.0693)
_cons	27.60	(0.9661)	−398.2	(0.5661)
N	90		90	
adj. R^2	0.4246		0.4204	

p-values in parentheses.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

To explore what factors affect respondents' decision to pay something or not, we estimated logit models (see Table 10). The significant variables with regards to WTP were, number of blackouts, recalling unfulfilled government promises, age, gender and number of household members. Male respondents are more likely to be willing to pay than females. Increased number of blackouts increases the probability of being willing to pay something to avoid blackouts. Thus, The average length of blackouts does not affect the decision of whether to pay or not. However, if the respondent has decided to pay something, the average length of the blackout significantly increase their WTP.

Age and respondent's recollection of government's unfulfilled promises to improve electricity supply has a significant negative effect in one of the logit models, whereas the possession of alternative energy sources does not have a significant effect on WTP. The number of people in the household significantly increases the likelihood of paying something.

Tobit models were run only for the respondents stating positive WTP to see whether the same factors determine the decision to pay compared to the decision on how much to pay when you have a positive WTP (see Table 11). The tobit models show that household expenditures (as a proxy for income), damages from blackouts, the number of blackouts, and the average length of blackouts all significantly increase WTP to eliminate blackouts. Males pay significantly more than females. Recalling government unfulfilled promises significantly decreases WTP

(See Table 11.)

To better identify which category of damages from blackouts (i.e. being unable to cook with electric appliances, refrigerate food, to use bank services, to read, have negative entertainment effects, vulnerable to robbers in a dark night, etc.) are important determinants of WTP, we conducted a principal component analysis and identified three components which we named: i) unable to use appliances and services (unable to use refrigerator, unable to use tv/radio for entertainment and unable to use bank services), ii) unable to do basic activities (reading and cooking) and iii) vulnerability to robbers in a dark night. Similarly, we found three components for alternative energy sources: i) use of woodfire and dung, ii) use of coal and iii) use of gas. Out of these predictor variables only use of coal and use of gas were significant and positively influencing WTP (see Table 12). This means that households which use coal and gas as alternative energy sources were willing to pay more to avoid electricity blackouts. This could be due to those using coal and gas having higher income than those who use woodfire and dung. It could also be due to the fact that coal and gas cost more than woodfire and dung.

5. Conclusion and policy implications

Electricity blackouts are among the major problems in Ethiopia, and thus it is important to study households' willingness to pay to avoid blackouts to assess the welfare loss from one aspect of energy poverty. Reducing this aspect of energy poverty should also be viewed as a contribution to the fulfillment of the UN Sustainable Development Goal no. 1 of eliminating poverty.

On average, households face 160 blackouts annually, each with an average length of four hours. In this study, the contingent valuation (CV) method was employed to an urban and a rural sample to estimate householdś willingness-to-pay (WTP) to eliminate blackouts in Northern Ethiopia. Results show that households are willing to pay an additional 32% of their annual electricity bill to eliminate blackouts. This could justify larger investments by the government (particularly the Ethiopian electric power corporation (EEPCo)) to reduce blackouts. Households' WTP to eliminate blackouts increase significantly with increasing income, number of blackouts experienced the last twelve months, average length of blackouts and the number of damage categories experienced. Male respondents have significantly higher WTP. Respondents' recollection of government's promises to improve electricity supply significantly reduces the probability of being willing to pay something to eliminate blackouts and the amount households are willing to pay.

This study looks at households' WTP to eliminate blackouts, providing that they have access to electricity. Hence, future research should take a closer look at other external costs of blackouts, and other aspects of energy poverty including brownouts and the lack of access to electricity. Further, the transferability and generalizability of our results should be tested by conducting similar surveys in other developing countries.

The significant WTP among households to avoid blackouts does, however, indicate that this type of energy poverty could represent a significant welfare loss in developing countries. The results can be used to justify larger investments in electricity production and networks in developing countries to reduce the high number and long duration of unplanned power outages that many of these countries experience.

Appendix A. Questionnaire

A1. External cost of wind farms in Ethiopia: Assessment and valuation

Dear respondent, this is a survey on people's experience and attitudes towards energy use. It is conducted in partial fulfillment of master's degree program. I would be most grateful if you could take about 30 min of your time to complete this interview. There are no right or wrong answers. We would just like you to answer this as best as you can. Responses are confidential, so feel free to give your honest opinion.

Thank you in advance for your cooperation

Name of interviewer_________

Date ____

Time interview started _________________

Time interview ended ________________

Subcity____________

Tabia ____________

A2. Part I: perception and attitude towards different energy sources

1. How many years has your household lived where you live now? ________years
2. Resources and budgets are limited and hence a country cannot provide the highest level of all services to its citizens. Some goods and services are more important than other goods and services. In your opinion, how important is it to improve the amount or quality of the following goods and services

For interviewer: Rotate the order of the public goods and services for each respondent

	0.Very Important	1.Somewhat Important	2.Moderately Important	3.Slightly Important	4.Not Important	5.don't know
Primary and secondary schools						
Clinics and hospitals						
Hydro-power development						
Wind-power development						
Roads						
Energy security (avoid blackouts)						
Clean water supply						

3. Please indicate whether you agree or disagree with each of the following statements

	0.Strongly agree	1. agree	2. neutral	3. disagree	4.Strongly disagree	5.Don't know	6.Not applicable
I use energy saving light bulbs							
I turn off the lights when I am not using them							
I keep my home and my car smoke-free							
I plant trees and native plants							
I reduce my use of chemicals							
I dispose waste properly							
I buy bonds in order to support the development of renewable resources							
I recycle							
I volunteer, give time or some cash to environmental activities							
I use water sparsely							
I teach the young the importance of treating our environment with care							
I do like to see more diesel power generation plants built in my country							

A3. Part II: Willingness to pay questions.

4. For which of the following purposes do you use electricity

☐0. Cooking.
☐ 1. Light.
☐ 2. Baking.
☐ 3. Ironing.
☐4. Refrigerating.
☐5. Laundry.
☐ 6. Other (please specify)_______________.
☐ 7. I do not use electricity.

5. What other energy sources do you use for heating, light, and cooking?

☐ 0. Coal
☐ 1. Gas
☐ 2. Wood fire
☐ 3. Dung
☐ 4. Other, please specify:__________________
☐ 5. I do not use any other sources

6. Approximately how many blackouts approximately did your household experience the last 12 months?________blackouts
7. Approximately how long did the longest blackout last that your household experienced the last 12 months?_

Reply in number of _______hours OR_______days

8. What is the average length of most blackouts you have experienced during the last year?________hours
9. What kind of negative impacts does blackouts have on you and your household?

☐0.Unable to cook with electric appliances.
☐1.Unable to refrigerate food.
☐2. Unable to use bank services and ATM.
☐3. Negative entertainment effects (i.e television and radio do not function).
☐4. Vulnerable to robbers in a dark night.
☐5. Not able to read or study.
☐6. others please specify ____
____

10. The government is now considering implementing a program to reduce the number of blackouts from the current level to eliminate the blackouts. The program includes upgrading old and building new electricity production plants and new transmission lines. The costs of this program will be covered by international donors, government, companies and the households. If the government sees that these interest groups are willing to pay more to avoid the blackouts than what it costs, they will implement the program, which will eliminate blackouts. Think about what it is worth to you to fully avoid the negative impacts you have experienced from blackouts the last 12 months. What is the most, if anything, your household certainly is willing to pay per year for 10 years on the top of your annual electricity bill (or on the top of your house

rent, if you are not paying the electricity bill by yourself) to fully avoid blackouts? Remember that this payment will reduce your spending on other goods and services

0birr per month (0 birr per year) For 10 years	10 birr per month (120 birr per year) For 10 years	25 birr per month (300 birr per year) For 10 years	50birr per month (600 birr per year) For 10 years	100birr per month (1200 birr per year) For 10 years	150birr per month (1800 birr per year) For 10 years	200birr per month (2400 birr per year) For 10 years	250birr per month (3000 birr per year) For 10 years	300birr per month (3600 birr per year) For 10 years	Other; please specify: ____	Don't know

If your answer to #10 was zero or don't know, please respond to question #11; otherwise, skip #11and answer #12

11. Why are you not willing to pay anything for the program which will eliminate blackouts, or don't know what you are willing to pay? Please choose the **one** most important reason

☐ 0. I do not experience any blackouts.
☐ 1. I cannot afford to pay.
☐ 2. I do not think that this program would be effective.
☐ 3. I do not think that I should pay for this program.
☐ 4. I do not support any new government programs.
☐ 5. I do not trust the government.
☐ 6. This program is not important to me.
☐ 7. Other, please specify: ________________________________.

12. What is the most important reason for you being willing to pay something to eliminate blackouts?

____

13. Which form of payment do you then prefer?

☐0. Voluntary payment.
☐ 1. Increased Income tax.
☐ 2.Increase in electricity bill.
☐ 3.Indifferent.

14. Do you remember the government making a promise to diminish blackouts?

☐ 0. no.
☐ 1.yes.
☐ 2. Don't know.

15. Do you get electricity? 0. No___1. Yes___

A5. Part IV: Socio-demographic Characteristics

32. Age ___
33. Sex ☐ male ☐ female
34. Which is the highest level of education that you have completed?

☐0.No schooling ☐1.reading and writing only(keshi or medrsa)
☐2.primary school ☐3.high school.
☐4.Vocational training ☐5.diploma ☐6.bachelor's degree.
☐7. Masters degree ☐8.doctorate degree ☐9.Other (please specify)____

35. Employment status ☐0.full-time job ☐1.part-time job ☐2.unemployed
 ☐3.pensioner ☐ 4.student ☐ 5.farmer ☐6.Housewife ☐7.Other (please specify)____.
36. marital statuses ☐ 0. married ☐ 1. unmarried ☐2. divorced

☐3.widowed

37. Number of children (if any):___
38. Number of people in your household (including yourself):______
39. Type of home ownership ☐ 0. own house ☐1. rent ☐2.other(please specify)________

40. If you rent the house you are currently living in, do you pay electricity yourself? 0. No 1.Yes If no, skip question #41
41. How much does your household pay approximately per month in electricity bill?____birr per month
42. How much do you pay for rent?____birr per month
43. Approximately how much money does your household spend per month on average for goods and services?_______birr per month
44. How much is your monthly net household income (after taxes) ____birr per month
45. Do you have any comments on this survey? Feel free to state anything which could help us improve the questionnaire. ____________________________

Thank you for your time and help!

Appendix B. Other models

Table 13
Results for the reduced model for households willingness-to-pay (WTP) to avoid blackouts. OLS and Interval regression models.

	(OLS)	(Interval regression)
Expenditure	0.152***	0.152***
	(0.0000)	(0.0000)
Number of blackouts	1.211**	1.169**
	(0.0081)	(0.0077)
Average length of blackouts	35.16*	34.92*
	(0.0276)	(0.0218)
Recall unfullfilled government promise	−139.4+	−129.1+
	(0.0517)	(0.0563)
Female	−360.9**	−345.9**
	(0.0014)	(0.0010)
_cons	148.0	132.6
	(0.4056)	(0.4370)
lnsigma		
_cons		6.185***
		(0.0000)
N	99	99
adj. R^2	0.3941	

p-values in parentheses.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 14
OLS regression results (one control variable deleted at a time).

	(1)	(2)	(3)	(4)	(5)
Expenditure	0.152***	0.159***	0.155***	0.140***	0.139***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number of blackouts	1.211**	1.425**	1.342**	1.341**	
	(0.0081)	(0.0029)	(0.0048)	(0.0051)	
Average length of blackouts	35.16*	36.50*	38.06*		
	(0.0276)	(0.0295)	(0.0239)		
Recall unfullfilled government promise	−139.4+	−108.5			
	(0.0517)	(0.1444)			
Female	−360.9**				
	(0.0014)				
_cons	148.0	−167.1	−262.9+	−76.73	107.1
	(0.4056)	(0.2889)	(0.0699)	(0.5380)	(0.2671)
N	99	99	99	103	117
adj. R^2	0.3941	0.3305	0.3223	0.2868	0.2268

p-values in parentheses.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 15
OLS and Interval regression results when including protest zeros.

	(OLS)	(OLS)	(Interval regression)	(Interval regression)
Expenditure	0.148***		0.151***	
	(0.0000)		(0.0000)	
Damage of blackouts	222.4	289.5*	204.5+	272.0**
	(0.1036)	(0.0114)	(0.0972)	(0.0098)
Number of blackouts	1.406**	1.518***	1.335**	1.453***
	(0.0030)	(0.0008)	(0.0018)	(0.0006)
The longest blackout	−0.0207	−0.192	−0.0533	−0.203
	(0.9640)	(0.6660)	(0.8975)	(0.6240)
Average length of blackouts	43.69**	22.32+	42.89**	21.07+
	(0.0092)	(0.0982)	(0.0046)	(0.0927)
Alternative energy sources	397.3	73.05	395.2	54.88
	(0.2305)	(0.7882)	(0.1965)	(0.8293)
Recall unfullfilled government promise	−147.1+	−125.4+	−133.1+	−116.2+
	(0.0589)	(0.0766)	(0.0573)	(0.0764)
Age	−4.123	−1.960	−3.437	−1.205
	(0.8840)	(0.9367)	(0.8944)	(0.9584)
Age-squared	−0.0109	0.0185	−0.0208	0.0112
	(0.9718)	(0.9481)	(0.9418)	(0.9666)
Rural	−295.0	−270.0	−255.9	−232.3
	(0.4322)	(0.3601)	(0.4595)	(0.3987)
Female	−416.5**	−227.9*	−413.3***	−224.1*
	(0.0018)	(0.0341)	(0.0005)	(0.0246)
Household members	40.77	53.60*	43.49	52.44*
	(0.2603)	(0.0441)	(0.1879)	(0.0333)
_cons	29.79	238.1	−0.211	230.4
	(0.9632)	(0.6417)	(0.9997)	(0.6304)
lnsigma				
_cons			6.130***	6.236***
			(0.0000)	(0.0000)
N	91	134	91	134
adj. R^2	0.4312	0.1858		

p-values in parentheses.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix C. Descriptive statistics. Summary tables for categorical variables

Table 16
purposes of electricity for the household.

Purpose of electricity for the household	Freq.	Percent	Cum.
0 cooking	10	4.98	4.98
1 lighting	15	7.46	12.44
2 baking	33	16.42	28.86
3 ironing	63	31.34	60.20
4 refrigerating	50	24.88	85.07
5 laundry	13	6.47	91.54
6 other	12	5.97	97.51
7 do not use electricity	4	1.99	99.50
.	1	0.50	100.00
Total	201	100.00	

Table 17
alternative energy sources.

Number of other energy sources the household use	Freq.	Percent	Cum.
0 coal	10	4.98	4.98
1 gas	85	42.29	47.26
2 wood fire	55	27.36	74.63
3 dung	35	17.41	92.04
4 other	7	3.48	95.52
.	9	4.48	100.00
Total	201	100.00	

Table 18
damages of blackouts for the households.

Number of categories of damages the household face due to the power outage	Freq.	Percent	Cum.
0 unable to cook with electric appliances	20	9.95	9.95
1 unable to refrigerate food	19	9.45	19.40
2 unable to use bank services and ATM	28	13.93	33.33
3 negative entertainment effects	46	22.89	56.22
4 vulnerable to robbers in a dark night	41	20.40	76.62
5 not able to read or study	33	16.42	93.03
6 others	13	6.47	99.50
.	1	0.50	100.00
Total	201	100.00	

Table 19
reason for not willing to pay to avoid blackouts.

Main reason for not willing to pay for sustainable energy:	Freq.	Percent	Cum.
0 do not experience BOs	1	0.50	0.50
1 cannot afford to pay	32	15.92	16.42
3 I do not think I should pay for the program	7	3.48	19.90
4 do not support any new government programs	1	0.50	20.40
5 I do not trust the government	3	1.49	21.89
6 this program is not important to me	2	1.00	22.89
7 other	8	3.98	26.87
.	147	73.13	100.00
Total	201	100.00	

Table 20
reason for being willing to pay something to avoid blackouts.

Main reason for willing to pay something for sustainable energy	Freq.	Percent	Cum.
0 because it's my responsibility as a citizen	4	1.99	1.99
1 because I believe that this matter is important	12	5.97	7.96
2 because it is important for development	19	9.45	17.41
3 because I believe that I (and my household) will be the beneficiary	70	34.83	52.24
4 to be able to receive a sustainable(and full) service	12	5.97	58.21
5 because I would like to see the problem been solved	29	14.43	72.64
6 to save time, energy and money(the money spent for other sources)	2	1.00	73.63
.	53	26.37	100.00
Total	201	100.00	

Table 21
if respondents recall government promising to diminish blackouts.

If respondent can recall the government making promise to diminish blackouts	Freq.	Percent	Cum.
0 no	39	19.40	19.40
1 yes	71	35.32	54.73
2 don't know	88	43.78	98.51
.	3	1.49	100.00
Total	201	100.00	

Table 22
if respondents in Ashegoda get electricity.

Ashegoda: if they get electricity: no = 0 yes = 1 don't know = 2	Freq.	Percent	Cum.
0	10	4.98	4.98
1	41	20.40	25.37
.	150	74.63	100.00
Total	201	100.00	

Table 23
Gender.

Male = 0 female = 1	Freq.	Percent	Cum.
0	76	37.81	37.81
1	125	62.19	100.00
Total	201	100.00	

Table 24
Education.

No schooling = 0 read and write only(keshi or merdsa) = 1 primary = 2 high = 3 vocational training 4 = diploma 5 = bachelor's degree 6 = master's degree 7 = doctorate degree 9 = other	Freq.	Percent	Cum.
0	52	25.87	25.87
1	4	1.99	27.86
2	38	18.91	46.77
3	36	17.91	64.68
4	5	2.49	67.16
5	34	16.92	84.08
6	26	12.94	97.01
7	5	2.49	99.50
.	1	0.50	100.00
Total	201	100.00	

Table 25
Employment.

Full time = 0 part time = 1 unemployed = 2 pensioner = 3 student = 4 farmer = 5 housewife = 6	Freq.	Percent	Cum.
0	73	36.32	36.32
1	36	17.91	54.23
2	10	4.98	59.20
3	5	2.49	61.69
4	7	3.48	65.17
5	7	3.48	68.66
6	46	22.89	91.54
7	16	7.96	99.50
.	1	0.50	100.00
Total	201	100.00	

Table 26
Marital status.

Marital status	Freq.	Percent	Cum.
Married	107	53.23	53.23
Unmarried	55	27.36	80.60
Divorced	10	4.98	85.57
Widowed	26	12.94	98.51
No response	3	1.49	100.00
Total	201	100.00	

Table 27
Home ownership.

Type of home ownership: own house = 0 rent = 1 government housing =2	Freq.	Percent	Cum.
0	99	49.25	49.25
1	95	47.26	96.52
2	6	2.99	99.50
No response	1	0.50	100.00
Total	201	100.00	

Table 28
If respondents pay electricity in a rented house.

if they pay electricity bill (for those living in a rented house): no = 0 yes = 1	Freq.	Percent	Cum.
0	34	16.92	16.92
1	61	30.35	47.26
.	106	52.74	100.00
Total	201	100.00	

Table 29
Percentage distribution: Respondents' opinion of the importance of different public goods and services.

	0.Very Important	1.Important	2.Moderately Important	3.Slightly Important	4.Not Important	5.don't know
Primary and secondary schools	78.11	16.42	2.49	0.00	0.00	2.99
Clinics and hospitals	91.04	7.96	0.50	0.50	0.00	0.00
Hydro-power development	76.62	13.93	1.99	0.50	5.47	1.49
Wind-power development	67.16	15.92	5.97	1.00	1.00	1.49
Roads	91.54	7.46	0.50	0.50	0.00	0.00
Energy security (avoid blackouts)	86.5	6.50	1.00	1.50	4.00	0.50
Clean water supply	96.02	3.48	0.50	0.00	0.00	0.00

Table 30
Respondents' environmental behavior; in percent.

	0. Strongly agree	1. Agree	2. Neutral	3. Disagree	4. Strongly disagree	5. Don't know	6. Not applic-able
I use energy saving light bulbs	40.8	21.89	4.98	20.40	4.48	2.99	4.48
I turn off the lights when I am not using them	59.7	25.87	5.97	1.99	1.99	0.00	4.48
I keep my home and my car smoke-free	39.3	6.97	7.96	3.48	9.45	2.99	29.85
I plant trees and native plants	33.33	23.38	19.90	15.42	5.97	1.00	1.00
I reduce my use of chemicals	40.20	3.52	2.01	2.01	3.02	32.6	16.18
I dispose waste properly	77.39	12.56	5.03	3.52	1.01	0.00	0.50
I buy bonds in order to support the development of renewable resources	23.28	7.96	15.92	24.88	6.97	14.43	6.47
I recycle	23.88	8.46	9.45	29.85	17.41	6.97	3.98
I volunteer, give time or some cash to environmental activities	46.23	22.61	8.04	16.58	3.02	1.01	2.51
I use water sparsely	83.00	9.00	4.50	1.00	2.00	0.00	0.50
I teach the young the importance of treating our environment with care	47.49	23.46	8.94	5.59	0.00	1.12	86.59
I do like to see more diesel power generation plants built in my country	28.00	18.00	11.00	11.50	10.50	17.00	4.00

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