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Should Indians Pay more for Renewable Energy Based Electricity? - The Need for Evidence Based Consumer Tariffs for Electricity in India

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ABSTRACT

India seeks to achieve 175 Giga-watts (GW) of renewable power by 2022. By December 2017, almost 62 GW of the total installed capacity of electricity (333 GW) came from renewable sources. In order to achieve the targets for renewable power, capacity of renewable energy would need to be increased as expeditiously as possible. However, the local utilities (or distribution companies) have been suffering from financial losses in the recent past. These utilities, act as the primary purchasing authorities of such power, and hence the financial losses are posing as a threat to the success of the renewable industry. This paper highlighted that even though the cost of renewable power has gone down significantly in the recent years, the worsening of financial health of utilities remained a key concern. Data was presented to prove that the distribution companies/utilities were suffering from high gaps between the Average Cost of Supply (ACS) and the Average Revenue Requirement (ARR). Revenues of the electricity supplying utilities were going down due to the long-term subsidization in the Indian electricity sector. The tariff applicable for electricity consumption for agricultural and residential consumers was lower than the commercial and industrial consumers. Therefore, a case is presented for implementation of tariff setting, based on the evidences of willingness to pay for "green electricity" by end consumers. Under the suggested framework, electricity tariffs for different consumer categories could be charged with a premium for green power, based on their willingness to pay for such electricity. Collected funds could be used for purchasing of green energy by the mentioned utilities, consequently helping to develop the green energy footprint in the country. Also, this study presented limited empirical evidence and documented the willingness to pay for such premiums, and across different categories of paying consumers.

1. INTRODUCTION

Owing to aggressive growth of India, it ranks as the fourth largest emitter of CO_2 emissions in the world in 2016, attributed to increasing fossil fuel based electricity generation [1]. Almost 47% of the total carbon emissions in India are due to coal fired power plants, which provide to an increasing demand for electricity. Carbon emissions in India increased by 5.4% in 2015 as compared to 2014, while all other major emitting countries had shown a considerable reduction [2]. Electricity generation in India is continuously dependent on coal and is explained by the fact that 192 Giga-Watt (GW) of total installed capacity (326 GW) is added from coal-fired power plants, as of March 2017 [3] and the current utilization rates of operational coal power plants are only 64.5% [2]. This increasing demand for electricity has led to increased emissions of greenhouse gases, and has also caused major health problems as well. The combustion of coal releases harmful gases catastrophic for human health [4]. Guttikunda and Jawahar found that almost 80,000 – 115,000 pre-mature deaths were attributed to the released emissions of coal based power generation in 2010-2011, owing to the release of dangerous atmospheric emissions [5].

In accordance with the above, and breaking the dependency on coal, the Indian government has emphasized the movement to alternative fuels with special focus on green electricity generation. More focus on the cleaner form of energy was announced through the Bali Action Plan in 2008 (under the United Nations Framework Convention on Climate Change (UNFCCC)) [6]. The plan focused on limiting and reducing emissions from developed countries, whereas all developing countries were required to cut emissions growth rate by adopting environment-friendly technologies. The National Action Plan for Climate Change (NAPCC) in 2008 [7] further re-affirmed the government's intent to move to a cleaner economy, by announcing 8 national missions. These mission

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statements are concerned with promoting understanding about and combating climate change, promote energy efficiency and ensure natural resources conservation. The National Solar Mission, one of the most admired of mission statements, has created a specific emphasis on the adoption of more solar based electricity generation. Increasing the use of renewable energy technologies has been widely known for several benefits such as increasing access to the energy, increasing energy supplies, reducing negative health impacts and job creation (depending on the nature and amount of used technology) [8]. According to the same view and to facilitate a transition to a "green economy", several policy and regulatory level interventions have been introduced by the Indian government in the past [9]. The Electricity Act 2003 (EA 2003), National Tariff Policy 2006, District Advisory Committees and Akshay Urja Shops(that emphasizes more on renewable energy sources in rural areas), are a few of such notable involved policies. The Jawaharlal Nehru National Solar Mission (JNNSM) 2010, is one of the most ambitious plans of the government, according to which India plans to install 20 GW of the grid connected solar energy by 2022, spread across three phases of implementation [10]. As a result of such policies, India installed 62 GW of Renewable Energy Sources (RES) at the end of December 2017 [11].

In addition to the government already committed to establishing a green economy by submitting the Intended Nationally Determined Contribution (INDC) in the renewable energy sector as a part of the Paris agreement on climate change under the United National Framework Convention on Climate Change (UNFCCC), India is now committing to install 100 GW of solar power and 60 GW of wind power by 2022 [12], with an aim to achieve 40% of non-fossil fuel based electricity generation by 2030 [2].

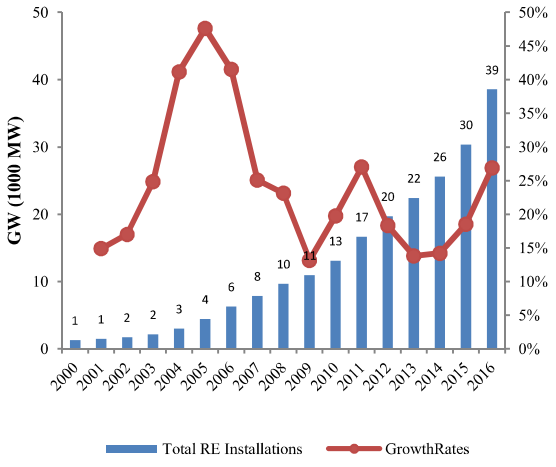

Figure 1. Growth of renewable energy in India from 2000-2016 [14]

The major push to the clean energy sector in India was introduced through the EA 2003. The EA 2003 introduced dedicated procurement tariff setting for power generated through renewable energy sources. Such tariffs (which is the cost to supply electricity for the local utilities) is currently determined by the State Electricity Regulatory Commission (SERC). Further, mandatory purchase obligations for renewable energies were also applied on the utilities/power suppliers [13]. As a result, there was a notable increase in renewable energy installations after the 2003 period, as seen in Fig. 1.

Particularly, the solar sector received a boost from the launch of the National Solar Mission in 2010 [15], as shown in Fig. 2.

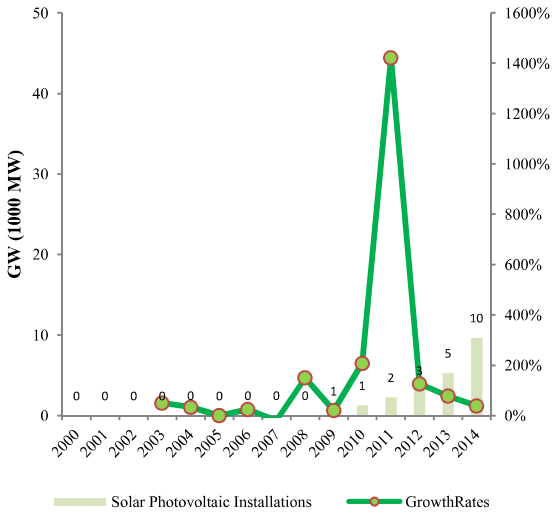

Figure 2. Solar photovoltaic (PV) installations in period of 2000-2016 [14]

Beneficial options were provided for generators by introducing the high procurement tariff rates (the rate of purchasing the generated electricity by the power suppliers). Such a policy push for renewable energy came at a higher cost for the utilities. The price of the power purchase agreement (PPA) for power generated through wind and solar energy were in the ranges of Rs.[2] 5- Rs. 6, which were substantially higher than the cost of generated power from conventional sources. An evidence of approved power purchase rates from 2010 is provided in Table 1.

This meant increases in the cost of purchasing electricity for the utilities and worsened the financial health of power suppliers. To provide relief, the Ministry of Power (MoP) announced the financial restructuring of the state distribution company in 2012 [16]. As on October 2012, the accumulated losses of all state distribution companies (DISCOMs) were 38.4

[2]Indian rupee

billion of US dollars (USD 38.4 Bn)[3].The most important factors contributing to these losses, were the high cost of power supply, non-revision of consumer tariffs, non-payment of subsidies and the high distribution losses [16]. These losses continued over the next few years. Then, the accumulated losses increased to USD 42.7Bn[4]in 2012-2013, and to USD 64.1 Bn[5] in 2014-2015 [17]. The cost of purchasing electricity, as a part of total costs for the DISCOMs, increased from 75.16% in 2012-2013 to 78.56% in 2014-2015 [17]. Looking at the financial worries of the utilities, the MoP announced the Ujwal Discom Assurance Yojana (UDAY) in 2015, focusing on ensuring improved operational efficiency and bringing financial relief to the stressed financial health of the said DISCOMs. Under this current plan, there was a tripartite agreement among the DISCOMs/utilities, the state government and the MoP. Targets had been undertaken in the contexts of tariff revisions, reduction of losses and restructuring of debt by the DISCOMs [18]. Operational improvements should be measured by two specific criteria as below:

- Reducing Aggregate Technical and Commercial (AT&C) Losses to 15% in 2018-2019, as per the loss reduction trajectory that was decided between the States and MoP.
- Reducing the gap between Average Cost of Supply (ACS) and Average Revenue Realized (ARR), per unit of electricity supplied. This gap should be equal to zero in 2018-2019, as finalized between States and MoP.

However, the latest available data for the gap between the ACS and ARR indicates that the cost of supplying power for power suppliers is more than the sale price to end consumers. Despite of all efforts, this gap has not been substantially reduced. As shown in Fig. 3, 13of the 19 states where data is available (at the time of writing this paper) are still suffering from a positive gap of ACS- ARR.

As a solution to reduce the cost of procurement for the power suppliers/DISCOMs, the government introduced the competitive bidding process in the solar and wind sectors. Competitive bidding is a mechanism in which the power generator proposes to accept the lowest tariff/price to sell the generated electricity. Therefore, the lowest bidder will win. The competition among the bidders ensures that the cost of supplying power (in the case of DISCOMs/utilities) is significantly reduced. Beck and Martinot [19] found that the rates of power purchase for renewable power was reduced to 4.5p/kWh in the UK in the 1990s, due to implementing the competitive bidding process. Similarly, the cost of wind and solar based power has already fallen below Rs. 3/Unit in India [20].

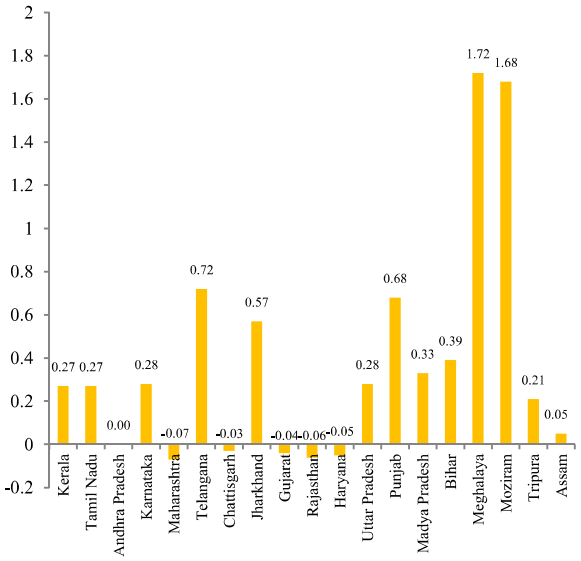

Figure 3. The gap between ACS and ARR for utilities/DISCOMs (In Rs/unit of electricity supplied), in July 2018[6], [7]

Although, the competitive bidding process has reduced the cost for the utilities, revenue growth is also important for the DISCOMs. The change of the mentioned utilities will be successful if a mutual strategy of reducing the cost of power procurement, (which has already proceeded) and increasing the revenue through regular revisions of tariffs is adopted. In this regard, many western countries, which have implemented "green energy premiums" in end consumer tariffs, can be adopted. Consumers of electricity have contributed financially to the utilities/power suppliers, by paying a premium for green power that has helped develop their energy plans. At the time of writing this paper, such studies have not been done in India, where the willingness to pay for green power is investigated. This gap guided the purpose of this study.

The rest of the paper is as follows:

Section 2 presents the evidences of "green energy premiums" in other countries. Section 3 explains the details of important studies in India, which investigated whether Indian consumers are ready for evidence based tariff setting or not. Such tariffs are recommended to be based on the willingness of consumers to pay for electricity produced from cleaner sources, and for its environmental benefits.

[3]Conversion rate of 1 USD = Rs. 49.45 considered, as per the prevalent exchange rate in 2012.

[4]Conversion rate of 1 USD = Rs. 61.79 considered, as per the prevalent exchange rate in 2013.

[5]Conversion rate of 1 USD = Rs. 63.18 considered, as per the prevalent exchange rate in 2014.

[6]A positive value represents that the ACS is greater than the ARR

[7]For the states with more than one local utility (for example: Gujarat), the average gap of ACS-ARR in all existing utilities have been represented.

Section 4 illustrates limited empirical evidences that were collected on the willingness of consumers to pay for green electricity premiums that can help finance of renewable energy projects in India, and help to further the goal of 175 MW of green power by 2022. Finally, conclusion and recommendations are presented in Section 5.

TABLE 1. Procurement tariffs for wind and solar based electricity generation

RE Source	2010-011	2011-012	2012-013	2013-014	2014-015	2015-016	2016-017
Wind	4.08	4.29	5.1	5.38	5.42	5.63	5.64
Solar	17.91	15.39	10.39	8.75	7.72	7.04	5.68

[As approved by the nodal regulatory authority in India, Central Electricity Regulatory Authority (CERC)]
Units: Rs/kWh

2. INTERNATIONAL STUDIES OF CHARGING GREEN ENERGY PREMIUMS

Several countries have implemented surcharges/ cess on sales of electricity to end consumers to finance development of renewable energy projects. Some examples are presented below:

2.1. China

The Chinese renewable energy law approved in 2005 and then improved in 2009,viewed the imposing of a renewable energy surcharge on sale of electricity to end consumers, as a "cost-sharing" mechanism. The surcharge which was a "Cost-sharing Measure" was applied at varying rates on different categories of consumers since 2006. The amounts of surcharges were also consistently increased over the years 2006-2011. Initially charged at 0.001 RMB/unit in 2006, the surcharge was increased to 0.008 RMB/unit, applicable for all consumer categories in 2011 [21]. Collected budgets were used to provide attractive procurement prices for the renewable generators and helped more to increase the quantum of renewable installations.

2.1. Canada (Ontario)

Canada also entered the green energy journey in 2009. By implementing the "green energy and green economy act 2009", Ontario set targets to reach the environmental goals of reducing emissions, eliminating all existing coal based capacities and creating jobs through increasing the renewable energy capacities. The feed-in tariff mechanism, which was introduced under the Green energy act 2009, guaranteed a fixed price for renewable generators for a 20-year contract, along with preferential access to grid connectivity. As Bohringer et al. highlighted [22], the increasing feed-in tariffs to the generators were financed through the electricity sales tax, paid by end consumers. The tax, called as the "Global Adjustment Fee" acted as a surcharge in the monthly bill of electricity paid by consumers and helped to generate budgets for supporting the feed-in tariff mechanism. "Global Adjustment Fee" was almost 7.9 cents/kWh in 2015 [23].

2.2. Germany

The intent of Germany to a cleaner country went back to the 1990s and the interests in clean energy had been expanding since 2009. The "Erneuerbare- Energien-Gesetz (EEG Act)", found merit in the Feed-in tariff systems, and hence the generators of renewable energy were offered remunerative procurement tariffs.19 European countries had adopted Feed-in tariff system by 2008 and Germany was positioned as being a success story to the other member of European Union (EU). The EEG program set great examples of reducing carbon emissions and increasing the jobs created through enhancing renewable energy capacities in the country. According to the EEG program, the costs of procurement of renewable power were charged to the end consumers as the EEG surcharge. The EEG surcharge, an important tool for realizing the goals of green energy, accounted for almost 4% of residential electricity costs in 2006 and 2007,while generating a pool of funds that contributed to a higher renewable energy footprint for the country [24]. Data suggested that German consumers of electricity paid as much as 22.4 billion Euros towards the EEG surcharge in 2015 [25].

Although, these programs have been criticized for providing high costs to the end consumers, these countries are now the leaders of renewable-based power generation. Each of these countries has recorded growth rates of over 10% in renewable-based electricity generation between 2005 and 2015 [26]. Similar surcharge is necessary in the Indian context for developing the renewable story of India. Indian utilities have paid higher feed-in tariffs to renewable generators in the past. However, the increasing costs were not matched by any appropriate recovery mechanism, such as that provided by charging green energy premiums. A similar surcharge/premium is assumed to be more important because power suppliers are competing for heavy losses, due to high costs of power purchasing, coupled with under-recoveries. The implementation of the suggested mechanism depends on the ability of the end consumer and his/her willingness to pay. The next

section carries details of studies that have been undertaken in India, to understand consumer's willingness to pay for green energy.

3. ARE INDIANS WILLINGNESS TO PAY FOR GREEN ENERGY ALTERNATIVES? A BRIEF LITERATURE REVIEW

Extensive researches investigate the willingness of consumers to adopt and invest in green energy in the last decade. A study by WWF-India surveyed 900 respondents (end consumers of electricity) and sought to understand their willingness to adopt and invest in clean energy. Although 90% of the respondents expressed willingness to invest, 70% of them felt that the acceleration of adoption should be a collaborative effort by individuals, state and the central government. Lack of sufficient information on green energy was seen as a barrier to wider adoption [27]. Most studies in India have investigated the willingness to pay among the rural consumers of electricity. India has followed the system of cross subsidization for years. Low cost provision of electricity to residential and agricultural consumers subsidized by the higher costs of electricity paid by commercial and industrial consumers. Thakur et al [28] revealed that industrial tariffs were 15 times higher than the agricultural sector in 1999-2000. However, the policy makers have shown willingness to end this practice and the same has also been advocated by the Economic Survey of India in 2016 [29].

One of these researches carried out in rural India, focused on investigating, if agricultural respondents would have any willingness to pay for agricultural pumpsets (subsidized by the local utility) without compromising/reducing the quantum of power that they consume. The results from this survey of 449 responses in the rural parts of Andhra Pradesh [30], revealed that the average subsidy costs of agricultural pumps were 84%-94% of the total utility cost, in order to serve power in the mentioned areas. The prices varied from Rs.250/hp to Rs.600/hp (prices based on the horsepower of the pumpsets) and the average cost of power usage for the farmers would be varied between Rs.0.17/Unit to Rs.0.41/Unit. This proved the expanse of subsidies. On the subject of requesting the farmers whether they had a willingness to pay a little extra for the agricultural pumps, they found that 84% of the surveyed respondents/farmers had a willingness to pay a premium over the current cost. Furthermore, 19% of them even revealed a willingness to pay a premium extra 50% over the current costs. However, the authors did not find any systematic relationship between the income levels and the willingness to pay; the farmers with the higher incomes did not reveal the higher willingness to pay.

Whereas there is an interest to investing in the green energy technologies, income and affordability plays a major deterrent. Urpelainen and Yoon [31] studied 760 rural respondents and checked their willingness to pay for solar based home systems, representing green forms of energy. They checked the gap between the actual price paid by respondents, and the price which the respondent would have a willingness to pay, for solar based home systems. It was found that while there was a big gap between the estimated price of the home system (which indicated their value) and the willingness to pay for that (indicated the affordability); there still existed a willingness to pay. Most respondents revealed a willingness to pay Rs. 10,000, which although low, is positive, and thus shows that consumers are in fact willing to pay. In another study, Lahiri and Acharjee [32] explored the willingness to pay for biomass gasifiers in rural Bihar. Biomass gasifiers are a green source of off-grid supply of power which has a higher cost per unit than power that is taken from the grid. This necessitated an investigation to the willingness of respondent to pay for the same. The study used the replacement cost method, where the willingness to pay is taken as the difference between the extra costs incurred in consuming off grid power and the applicable rate of grid tariff. Observed willingness to pay was in the range of Rs.2.77/unit - Rs.4.69/ unit (with and without subsidy). Also, residential consumers have exhibited their willingness to pay for electricity. The residential willingness to pay for power drawn from the grid had been studied in the Gujarat by Bose and Shukla [33]. They found that the agricultural and residential consumers had ability to accommodate an increase in price of electricity by Rs.1/unit/month. This implication was based on the fact that these consumers were spending more than the stated amount in the supply of electricity from other sources (such as agricultural pumpsets for agricultural users) in case of the power outage.

According to these findings, there are enough evidences which emerge showing that consumers have the willingness to pay. It is also important to highlight that not only consumers have the willingness to pay; utilities/power suppliers are interested to the idea of consumer's willingness to pay based tariff setting. Gill, Saluja and Palit [34] explored that utilities/power suppliers prefer such a tariff setting, and would like to move away from the cost-based tariff setting (which is currently applied for deciding end consumer tariffs). It was also realized that charging the consumer, a premium on existing tariffs, would eliminate partially, the revenue gap for the utilities. The willingness to pay for green electricity has not been studied earlier, and hence this study explores this research gap.

4. PREMIUMS FOR GREEN ENERGY IN INDIA – EXPLORING THE WILLINGNESS TO PAY

In order to evaluate the willingness to pay the renewable based electricity, interviews were undertaken with 65

respondents. Samples were selected based on convenience, to cover a variety of respondents. The surveyed respondents were either "residential" or "commercial", based on the consumer category that was mentioned in their monthly bills. The monthly electricity bills of Rs. 10,000 or less were categorized as small users and others as large users, specifically in the "commercial" sub-section. The objective was to evaluate the willingness to pay for renewable energy among the end consumers of electricity or otherwise. It was observed that the users of residential connection and commercial (low tension) connections paid lesser, for their monthly consumption of electricity. However, the commercial (high tension) users had to pay heavier amounts of the bill, often more than Rs. 25,000 per month. Demographics of the selected sample are summarized in Table 2.

TABLE 2. Summary of demographics of interviewed respondents to evaluate the willingness to pay for renewable based electricity

	Residential	Commercial (Small[8])	Commercial (Large[9])
Number of respondents	53	5	7
Female	30	2	1
Male	23	3	6
Average age of respondent	36	36	48
Monthly electricity bills (in Rs. per month)			
Average	1,565	2,080	173,206
Minimum	400	1,200	21,000
Maximum	7,000	3,000	400,000

A semi-structured survey questionnaire was used to gather the data (the detail of the used instrument in survey has been attached in the appendix). The instrument was designed according to the guidelines by the panel of National Oceanic and Atmospheric Administration (NOAA) [35]. Contingent valuation method was employed to evaluate the willingness to pay. This is a method which is widely used in the area of non-market valuation and it was made popular by the important work of Carson and Hanemann [36]. According to the assessment technique, the respondent was asked to state their maximum willingness to pay, based on some prior information provided about the product, on the basis of which their value was being asked. These studies are known to be one of the most difficult studies to conduct, especially in developing economies, due to inability of the population to understand the problem. Dale Whittington [37] provided recommendations to make such studies robust in developing countries. Revisions in the survey instrument used were made, based on such recommendations, overtime.

The instrument for survey was structured in four sections. Section 1 presented questions that captured the respondent's perspectives on environment and renewable energy. Information about renewable energy in India was presented in section 2. Section 3 presented the question for evaluating the willingness to pay based on the information provided to respondents, presented in section 2. Finally, section 4 recorded socio-demographic details.

In the following section, observations from the survey are presented. However, it is stated that the presented data should be regarded as indicative. Due to the exploratory nature of the survey, no attempts were made to perform advanced statistical analysis. It will be performed in the later part of this study.

63 respondents of the 65 respondents interviewed, revealed their level of education in this study. 18 respondents had completed an undergraduate degree level course and the others (45of 63) had achieved higher educational levels (post-graduation and higher degrees). This indicated that our respondents were well-educated. About the income levels, 28 respondents reported their annual income was less than USD 14,000 (43% of respondents), 14 respondents earned in the range of USD 14,000-36,000 annually (21% of respondents) and only 12 respondents earned more than USD 36,000 annually (18% of sample). Also, 11respondents refused to reveal their income levels. This helps us to understand that the respondents had an equal split of low income and high income levels.

Although, the data provided a quick understanding of the demographic profile, the impact of varying levels of income and education on willingness to pay could not be verified due to lack of data. A question was also presented to check whether consumers had any alternative sources of electricity for protecting themselves in cases of power backdowns. This would help to evaluate whether the consumers relied on renewable based systems or otherwise. Majority of the residential consumers (44 of 53 residential consumers) relied solely on the grid supplied electricity. 6 of 7 large consumers of electricity (paying an average electricity bill of Rs. 1,78,000 per month) had alternative electricity supply arrangements, either in form of generator sets, battery backups or solar rooftops and sometimes, all of these. The small commercial consumers (paying average monthly electricity bills of Rs. 2,000 per month) invested either in the generator sets or battery based backup systems. This suggested that adoption of solar rooftops (renewable based

8: Commercial(Small): Categorized as consumers with a monthly electricity bill amount of less than Rs.10,000 per month

9 Commercial(Large): Categorized as consumers with a monthly electricity bill amount of equal to or more than Rs.10,000 per month

electricity supply) were seen only in large consumers. It could be attributed to the large scale of required investment for installing these systems. Among the residential consumers, only 3 consumers had installed solar rooftops, indicating the limited penetration of the solar based electricity in this segment. Literature suggested that the lack of sufficient subsidies and unavailability of trusted module suppliers played an important role in ensuring the adoption of more solar based electricity supply [38].The awareness of respondents on renewable energy and their own electricity consumption were also studied through suitable questions. 49 respondents revealed that they had heard of renewable energy while only 14 consumers revealed that they were unaware. It was encouraging to note that almost 73% of the respondents classified "wind energy" as renewable sources and 81% of them also identified "solar energy" as renewable energy. At the same time, 17 respondents (all residential consumers) also believed "natural gas" would be qualified in the same category. This suggested that more awareness about renewable energy sources may be warranted, with specific focus on the residential consumers. Furthermore, it could be interesting to determine whether the consumers were aware about the subsidies that were provided on their electricity consumption, by government or any other subsidizing agency. This would provide deeper insights on the awareness of consumer, towards their own consumption of electricity. 53 respondents of 65 studied respondents were residential consumers ("subsidized" consumers). Only 8 (15%) of them were aware about their "subsidized bills". 12 (22%) of them did not know about it and a majority of them (62%) believed their bills didn't contain any subsidies. This investigation revealed that residential consumers were clearly unaware that their consumption of electricity was, in fact, at a lower cost and the major burden of supply cost was paid by other sections of the population. Bose and Shukla [33] found that the Indian residential consumed electricity at the lower tariffs and it was sometimes even less than the cost of supply for the utilities. It is apparent that the knowledge of subsidized electricity consumption by some section of the population is not widespread among the relevant consumers, even today.

Following the first section of the survey instrument, information about renewable energy in India was then presented to the respondents. The provided information would help to shape the willingness of the consumer to pay for renewable based electricity generation. Information/data was presented to the respondent in a single page format with the aid of pictures and explanatory text (detailed survey form attached as appendix). Although, more detailed information could have been in the information page, it was avoided to reduce the exhaustion of respondents. The colorful photographs aided to make a more engaging and interesting survey.

In section 3 of the survey instrument, the questions about the willingness to pay were presented. Albernini [39] suggested that Double-bounded dichotomous choice model was suitable to explore the willingness to pay. According to this method, an initial bid value was presented to the respondent who could have a dichotomous response of Yes/No. If the response to the first bid value was "Yes", a higher bid value would be suggested which should be answered in Yes/No. If the response to the first bid value was "No", the respondent would be suggested with a lower bid value which should be answered in Yes/No. The method is presented graphically in Fig. 4.

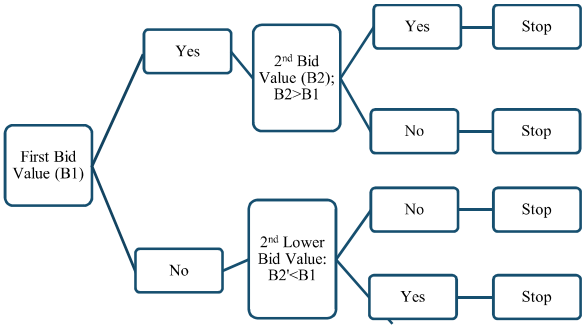

Figure 4. Double-bounded dichotomous choice model

This model could result in one of the following responses:

Scenario 1: Yes (B1)-Yes (B2)
Scenario 2: Yes (B1)-No (B2)
Scenario 3: No (B1)-Yes (B2')
Scenario 4: No (B1)-No (B2')

According to the NOAA panel [35], scenario 4 should be defined as "Protest values". Protest values are a set of zero values, expressed by those people who are not willingness to pay anything, since they don't believe in the hypothetical program/product, which they are asked to value. In the other scenarios, the value placed by the respondents on the program can be achieved/arrived at. Furthermore, the statistical efficiency of this method was established by Hanemann, Loomis and Kanninen [40].

In this study, the bid question was presented in the following format:

"Imagine if a program is implemented in India, where your monthly electricity bill is charged with a premium, over and above your current bill amount. This premium will be known as renewable energy premium. Collected budgets from this premium will be used to finance renewable energy projects in the country".

Following this question, the value of initial bid (B1) was presented as Rs.0.50/unit/month. The value of the

higher bid (B2) and the lower bid were presented as Rs.1.00/unit/month and Rs.0.25/unit/month, respectively. The mentioned values of bid were selected based on the latest regulatory order, and were fixed at 2.5%, 5% and 10% of current tariffs which were paid by end consumers, currently [41].

Responses to questions about the willingness to pay are represented in Fig. 5.

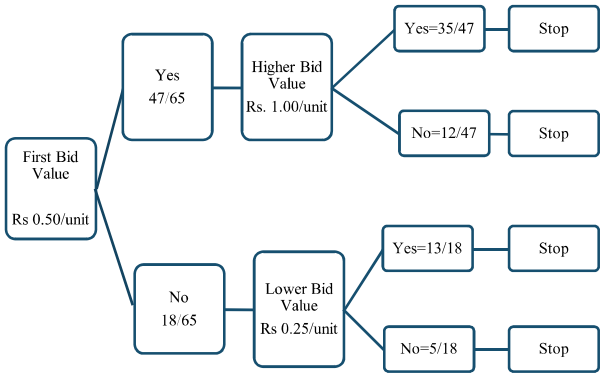

Figure 5. Willingness to pay as revealed in the Double-bounded dichotomous choice framework

5. KEY REULTS

According to the collected data, it was observed that consumers were aware of renewable energy and a few of them (larger users of electricity) were even using renewable based electricity. Most consumers had the willingness to pay extra for renewable based electricity due to the several benefits. Over 50% of the studied respondents had the willingness to pay Rs. 0.50/unit/month as the proposed "green energy premium", and most of them had the willingness to pay upto Rs. 1.00/unit/month. For a better understanding of consumer's perceptions to the proposed program, it was felt that more qualitative data should be collected, such as respondent's opinions. Residential consumers stated that similar surveys contribute to increasing the awareness levels about the renewable energy. The proposed premium should be implemented where the end consumer is required to pay extra and thus contribute to increasing renewable footprint in the country, but only for willing citizens. The larger consumers of electricity, such as the commercial consumers, ***should*** pay extra attention to greener forms of energy, since they were causing more pollution in the environment due to the high levels of electricity consumption. A "non-linear green energy premium" was also suggested, where the higher units of electricity consumption attracted a higher premium value (exemption for consumers who used less than 100 units per month and/or belonged to the weaker section of the population). Furthermore, the gradual increasing of such a premium, beginning from Rs.0.25/unit/month and increased thereafter was also suggested by some respondents.

Furthermore, negative opinions were also observed on the program. 5 respondents of the total 65 respondents interviewed, were categorized as "Protestors", with no belief to the good use of collected funds, and no support of any new governmental program. These 5 respondents had not expressed any willingness to pay at all. These consumers, who were residential consumers, did not express any willingness to pay and widely believed that their electricity bills were too high already. This clarified that certain sections of the consumer (residential ones) were unaware that they actually consumed electricity at the subsidized rates. Additionally, increasing consumer tariffs and hence a higher monthly electricity bills which can then finance renewable energy projects, were not seen as a comprehensive solution to increasing renewable installations in the country. The lack of a concrete action plan for implementing such a program was also discouraging the consumers to pay.

6. CONCLUSION

Indian power suppliers/DISCOMs (distribution companies) are going through stressed times. One of the contributing factors has been the high cost of power supply. Data suggests that many distribution companies are unable to recover these high costs of supply from their end consumers and hence continue to be in losses. A solution can be found in charging "green energy premiums" to the end consumer of electricity. The mentioned "green energy premium" can contribute to financing the renewable projects, which will help India achieve 175 GW of renewable power by 2022. On empirical investigation, evidences have emerged that consumers have the willingness to pay. A study conducted on 65 end consumers of electricity in Pune revealed that such a charge, in the range of Rs.0.50/ Unit - Rs. 1.00/Unit, will be acceptable .However, reluctance to accept the mentioned "green energy premium" was observed as well. It is assumed that the acceptance levels can be increased if more awareness is created about the benefits of green forms of electricity. Although, many consumers are in the "subsidized" consumer category, they feel that they are paying a lot for electricity. This may be due to the fact that most of them are not aware that their electricity consumption is cross subsidized. The knowledge that the practice of cross – subsidizing electricity consumption exists, is essential to change perceptions. Therefore, it is recommended that the raising awareness, about costs of electricity consumption and benefits of renewable based electricity, should be undertaken for all segments of the society. This can be an area for future research and it will go a long way to ensure that India progresses on the

green path of achieving 175 GW of renewable power by 2022.

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REFERENCES

1. Janssens-Maenhout, G., Crippa, M., Guizzardi, D., Muntean, M., Schaaf, E., Olivier, J.G.J., Peters, J.A.H.W. and Schure, K.M., "Fossil CO_2 and GHG emissions of all world countries," Publications Office of the European Union, Luxembourg, (2017).
2. Olivier, J.G.J., Janssens-Maenhout, G., Muntean, M. and Peters, J.A.H.W., "Trends in Global CO2 Emissions - 2016 Report", PBL Netherlands Environmental Assessment Agency, (2016).
3. Ministry of Power. (2017, March) Central Electricity Authority. [Online].http://www.cea.nic.in/reports/monthly/nstalledcapacity/2017/installed_capacity-03.pdf
4. Conservation Action Trust, "Coal kills- Health impact of air polllution from India's coal power expansion", Conservation Action Trust, Mumbai, (2012).
5. Guttikunda, S. and Jawahar, P., "Atmospheric emissions and pollution from the coal-fired thermal power plants in India", ***Atmospheric Environment***, Vol. 92, (2014), 449-460.
6. United Nations Framework Convention on Climate Change. (2008, March) UNFCCC. [Online]. https://unfccc.int/resource/docs/2007/cop13/eng/06a01.pdf.
7. Government of India. (2008) Ministry of Environment, Forest and Climate Change. [Online]. http://www.moef.nic.in/downloads/home/Pg01-52.pdf.
8. Field, C.B., Barros, V., Stocker, T.F. and Qin, D., "Special Report of the Intergovernmental Panel on Climate Change", Intergovernmental Panel on Climate Change, (2012).
9. Kumar, A., Kumar, K., Kaushik, N., Sharma, S. and Mishra, S, "Renewable energy in India: Current status and future potentials", ***Renewable and Sustainable Energy Reviews***, Vol. 14, No. 8, (2010), 2434-2442.
10. Ministry of New and Renewable Energy. (2010) Ministry of New and Renewable Energy Solar Mission. [Online]. http://www.mnre.gov.in/solar-mission/jnnsm/mission-ocument-3/.
11. Ministry of Power. (2017, December) Central Electricity Authority.[Online].http://www.cea.nic.in/reports/monthly/installedcapacity/2018/installed_capacity-01.pdf.
12. Ministry of Finance. (2015-16) Union Budget. [Online]. https://www.indiabudget.gov.in/budget2016-2017/survey.asp.
13. Central Electricity Regulatory Authority. (2003, May) Central Electricity Regulatory Authority. [Online]. http://www.cercind.gov.in/Act-with-amendment.pdf.
14. International Renewable Energy Agency. International Renewable Energy Agency. [Online]. http://resourceirena.irena.org/gateway/dashboard/?topic=18&subTopic=50.
15. Government of India. (2010, January) Ministry of New and Renewable Energy. [Online]. http://www.mnre.gov.in/solar-mission/jnnsm/resolution-2/.
16. Ministry of Power. (2012, October) Ministry of Power, Government of India. [Online]. http://powermin.nic.in/sites/default/files/uploads/Financial_restructuring_of_State_Distribution_Companies_discoms_Oct2012.pdf.
17. Power Finance Corporation. (2016, June) Power Finance Corporation Ltd. [Online]. http://www.pfc.gov.in/Default/ViewFile/?id=1490186954263_Report%20on%20Performance%20of%20State%20Power%20Utilities%202012-13%20to%202014-15.pdf&path=Page.
18. Government of India - Ministry of Power. (2015, November) Ministry of Power. [Online]. http://powermin.nic.in/pdf/Uday_Ujjawal_Scheme_for_Operational_and_financial_Turnaround_of_power_distribution_companies.pdf.
19. Beck, F. and Martinot, E., "Renewable Energy Policies and Barriers", ***Encyclopedia of Energy***, Vol. 5, (2004), 365-383.
20. Press Information Bureau. (2017, October) Press Information Bureau.[Online].http://pib.nic.in/newsite/PrintRelease.aspx?relid=171394.
21. Sara, S. and Lin, A., "Chinese Renewable Energy Law and its impact on renewable power in China: Progress, Challenges and recommendation for improving implementation", ***Energy Policy***, Vol. 51, (2012), 89-109.
22. Bohringer, C., Nicholas, J., Rivers, T. Rutherford, and R. Wigle, "Green Jobs and Renewable Electricity Policies: Employment Impacts of Ontario's Feed-in-Tariff", ***The B.E. Journal of Economic Analysis & Policy,*** Vol. 12, No. 1, (2012), 1-40.
23. Brian Hill, (2016, December) Global News. [Online]. https://globalnews.ca/news/2839995/what-is-the-global-adjustment-fee-the-mysterious-cost-ontario-hydro-customers-must-pay/.
24. Busgen, U. and Durrschmidt, W., "The expansion of electricity generation from renewable energies in Germany - A review based on Renewable Energy Sources Act Progress Report 2007 and the new german feed - in legislation", ***Energy Policy***, Vol. 37, No. 7, (2009) 2536 - 2545.
25. Sören Amelang, (2015, February) Clean Energy Wire. [Online]. https://www.cleanenergywire.org/factsheets/balancing-books-germanys-green-energy-account.
26. British Petroleum, (2018) BP Global. [Online]. https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html.
27. Joy, J., Joy, D. and Panwar, T.S., "People's Perception Study: Renewable energy in India 2014", WWF-India, (2015).
28. Thakur, T., Deshmukh, S.G., kaushik, S.C. and Kulshrestha, M., "Impact assessment of the Electricity Act 2003 on the Indian Power Sector", ***Energy Policy***, Vol. 33, No. 9, (2005), 1187-1198.
29. Government of India, "Powering "One India", Office of Chief Economic Advisor, Delhi, Economic Survey 2016.
30. Dossani, R. and Ranganathan, V., "Farmers willingness to pay for power in India: Conceptual Issues, Survey results and implication for pricing", ***Energy Economics***, Vol. 26, No. 3, (2004), 359 - 369.
31. Urpelainen, J. and Yoon, S., "Solar home systems for rural India: Survey evidence on awareness and willingness to pay from Uttar Pradesh," ***Energy for Sustainable Development***, Vol. 24, (2015), 70 - 78.
32. Lahiri, D. and Acharjee, G., "Biomass gasifier electricity and study of willingness to pay," ***International Journal of Renewable Energy Resources***, Vol. 3, (2013), 16-18.
33. Bose, R.K. and Shukla, M., "Electricity tariffs in India: an assessment of consumers' ability and willingness to pay in Gujarat," ***Energy Policy***, Vol. 29, No. 6, (2001), 465-478.
34. Gill, B., Saluja, S. and Palit, D., "Charging Power: Understanding Electricity Pricing and Willingness to Pay for

Electricity in India", The Energy Resources Institute, Delhi, Technical Report (2017).

35. Arrow, K., Solow, R., Portney, P.R., Leamer, E.E., Radner, R. and Schuman, H., "Report of the NOAA panel on Contingent Valuation", (1993).
36. Carson, R. and Hanemann, M., Contingent Valuation, 2nd ed., K G Maler and J R Vincent, Eds. USA: Elsevier, 2005.
37. Whittington, D., "Administering Contingent Valuation Surveys in Developing Countries", ***World Development,*** Vol. 26, No. 1, (1998), 21-30.
38. Abdullah, Zhou, D., Shah, T., Jebran, K., Ali, S. and Ali, A., "Acceptance and willingness to pay for solar home system: Survey evidence from northern area of Pakistan", ***Energy Reports,*** Vol. 3, (2017), 54 - 60.
39. Albernini, A., "Optimal Designs for Discrete Choice Contingent Valuation Surveys: Single-Bound, Double-Bound and BiVariate Models", ***Journal of Environmental Economics and Management,*** Vol. 28, No. 3, (1995), 287-306.
40. Hanemann, M., Loomis, J. and Kanninen, B., "Statistical Efficiency of Double-Bounded Dichotomous Choice Contingent Valuation", ***American Journal of Agricultural Economics,*** Vol. 73, No. 4, (1991), 1255-1263.
41. Maharashtra Electricity Regulatory Commission. (2016, November) MERC India. [Online]. http://www.mercindia.org.in/pdf/Order%2058%2042/Order-48%20of%202016-03112016.pdf.