

# INNOVATIONS

Content available on Google Scholar

[www.journal-innovations.com](http://www.journal-innovations.com)

## Effect of Electric Power Disturbance on Small and Medium Enterprises Business Benefit; In the Case of Gurage Zone

Hayatu Mude

Received: 16.02.2021

Revised: 23.02.2021

Accepted: 04.03.2021

### **Abstract**

*Developing countries electricity supply is highly unreliable. The main objective of this study is to analyze the Economics cost of the electric power disturbance on the SME business in a case of Guragezone, Ethiopia. Using a conditional logit and the binary logistic regression models, to be associated with consumers' willingness to pay for improve power disturbance. The result shows that power disturbance variables results reveals that (measured using frequency of power disturbance in a per days and monthly electricity expenditure) have a positive and significant effect on the estimated willingness to pay or causes for economic costs on SME, but Alternative source of power supply equipment has negative and significant at 5% level of significance effects on willing to pay for improved services. Study revealed that the power disturbance in study area has levied significant additional costs on the SMEs. Therefore, the researcher suggests that there is need for the Ethiopia government intervention on the ways to improving energy generation and supply, and proper maintenance of electricity infrastructure in the study area.*

**Keywords:** 1 Binary logistic, 2 Conditional logit, Economic cost, Electric Power disturbance, 3 and Willingness to pay.

## 1 Introduction

Small and medium enterprises contribute significantly to the economic development of many developing and developed countries in the area of job or employment creation and revenue generation by using reliable electric power supply (Gbeve Prosper Kwabla, 2015). The importance of electricity to economic development of any nation cannot be overemphasized (MusiliuOseni, 2013). Access to reliable electricity supply increases the productivity and welfare of society. To business enterprises, electricity serves as an indispensable input. Apart from its necessity for running many industrial machines, its contributions to the productivity of human capital are enormous. Virtually all business activities, especially industrial units, require constant and effective flow of electricity.

Poor electricity supply has proved to be the major constraint to the business sector in the world. Electric power interruption follows so many economic losses in Africa and has contributed to the low productivity and poor competitiveness of the manufacturing sector in the continent. Between 2006 and 2010, more than 50% of the Sub-Sahara African businesses identified electricity as a major constraint to their businesses compared to just 27.8% which face transportation as the most critical problem (World Bank, 2012).

In Ethiopia like other developing countries, electricity service is limited not only by its access but also its quality in terms of its reliability is questionable. In this country, on average, electricity interruption occurs three times per day lasting for one to two hours (EEPCO, 2014).

According to Simon off et al. (2005), there are many factors that may cause electricity interruption: Crime, equipment failure, fire, Human error, operational error, natural disaster, weather, capacity shortage. However, for many developing countries including Ethiopia, energy shortage leading to load shedding and equipment failure, which is the number one factor for interruption, causes and natural disaster, is also cause power interruption in Ethiopia (EEPCO, 2013).

Power interruption are disturb firms productivity negatively increasing firm cost by 15% from 2011 to 2015 World Bank enterprise survey data indicated that .this effect varied negatively with output levels suggesting that power interruption is particular costly for small firms (Lamessa ,2018). Electricity interruption frequencies, the duration of the interruptions and/or load curtailment have been known to cause a lot of difficulties for specific industries particularly those that use electric power as energy a sources. The electricity interruptions or fluctuations have had varying effects on businesses including but not limited to instantaneous damage to semi-finished goods, associated costs incurred in repairing equipment's and losses accrued from delayed or cancelled orders.

Certain studies have been undertaken to analyze electric power consumption for economic growth. There is a direct relationship between energy consumption and economic growth, which is known as the growth hypothesis. This hypothesis states that a country's economic growth depends on energy consumption in the economy (Ogundipe et al., 2014). Energy and the probability of making an encouraging profit and Withstanding competitive pressure in their business environment. (Musiliu et al., 2013).Same studies

deals about economic cost of electric power interruption on manufacturing areas (Fredrik et al., 2018). But still yet have not considered economic cost of electric power interruption on services sectors in Ethiopia specifically in Gurage zone. Basically this study was estimate economic cost in small and medium enterprises in services sectors in Gurage zone.

The main objective of this study was to analyze the economic cost of the electric power disturbance on the SME business in a case of Guragezone. **Specifically addressed**, To examine the effect of power fluctuations on the expenditure patterns of SMEs, To investigate factors affecting to economic cost of small and medium enterprises and to determine the cost of alternative sources of power disturbance and its impact on the effectiveness of SMEs.

## 2. Literature Review

### 2.1 Theoretical Review

According to Velasquez and Pichler, (2010) there is a symbiotic relationship between electricity and business. Energy supplies have a significant impact on economic activities (This is because it is used for varied purposes ranging from production, storage, powering of office equipment and product display. Consequently, the use of electricity serves as input for production. This makes electricity an essential commodity for all industry types- manufacturing, service and distribution. Various sectors of the economy such as manufacturing and transport use enormous amounts of electricity (Haanes et al., 2011) for operation processes including storage, production. It is a critical resource needed to make products. In this respect, electricity as a “transformed unity” serves as a commodity. Consequently, suppliers of electricity have a strong influence on the buying organization’s ability to gain a competitive advantage and provide solutions to their clients. This is because operators of Small and medium enterprise (MEs) have a high dependency on electricity as a standardized input, without it they cannot produce to satisfy their customers.

According to the UNIDO (2009) finding, only 26% of households have electricity making Africa the lowest in electricity penetration in all the continents. UNIDO (2009) reported that, an estimate of 547 million people in Africa lack access to electricity. Many reasons have been put forward by researchers and practitioners as the causes of such a predicament. In Africa in general and Ethiopia in particular, there are problems with the quantum of electricity supplied. The problems have been compounded with interruption in the supply of power which tends to affect business operations negatively. The New York Times in (2001) surmised that some business especially ICT-related businesses have suffered significant losses resulting from vulnerable electricity supply. Electricity disturbance frequencies, the duration of the disturbances or load limitation have been known to cause a lot of difficulties for specific industries particularly those that use electricity as a resource.

According to Wang, 2002 and Lai and Jones, (2008) Economic the two types of interruptions have been identified. Planned interruptions have a mitigating effect on business operations because potential damage to semi-finished goods or materials can be minimized through the switch to alternative sources of electrical power such as generators and solar panels. Cost incurred due to delayed or cancelled orders

or equipment repairs can also be avoided because production and delivery schedules can be adjusted ahead of time. However, the costs of alternate power sources such as power generators, as well as expenditure on overtime pay to staff and outsourcing service cannot be avoided (Wang, 2002). Unplanned interruptions, however, have unmitigated and sometimes unforeseeable effects on business operations often, there are damages that tend to affect product quality, semi-finished goods and costs incurred in repairing, and in delays in the delivery of orders. The cancellations in delivery are borne by businesses and that increases the operation and maintenance costs (Lai, Yik and Jones, 2008).

## 2.2 Empirical Literature

The study conducted in Indonesia, it was revealed that among the many barriers to SME development supply and price of reliable electricity was mentioned by 62% of the 180 respondents as being a major barrier to SME development (Tambunan, 2009). In the same research report, high production capacity deficiency, limitation in sales and high labor costs accounted for 21%, 36% and 18% respectively. In a another study in Indonesia, it was found that SME sector account for 99% of businesses in Indonesia making them the most significant contributor to Indonesia's economic development (Irjayanti et al., 2013). Other studies by Wang (2002) on outage costs and strategy analysis of the hi-tech industries revealed that production process spans weeks and sometimes months in planning and execution.

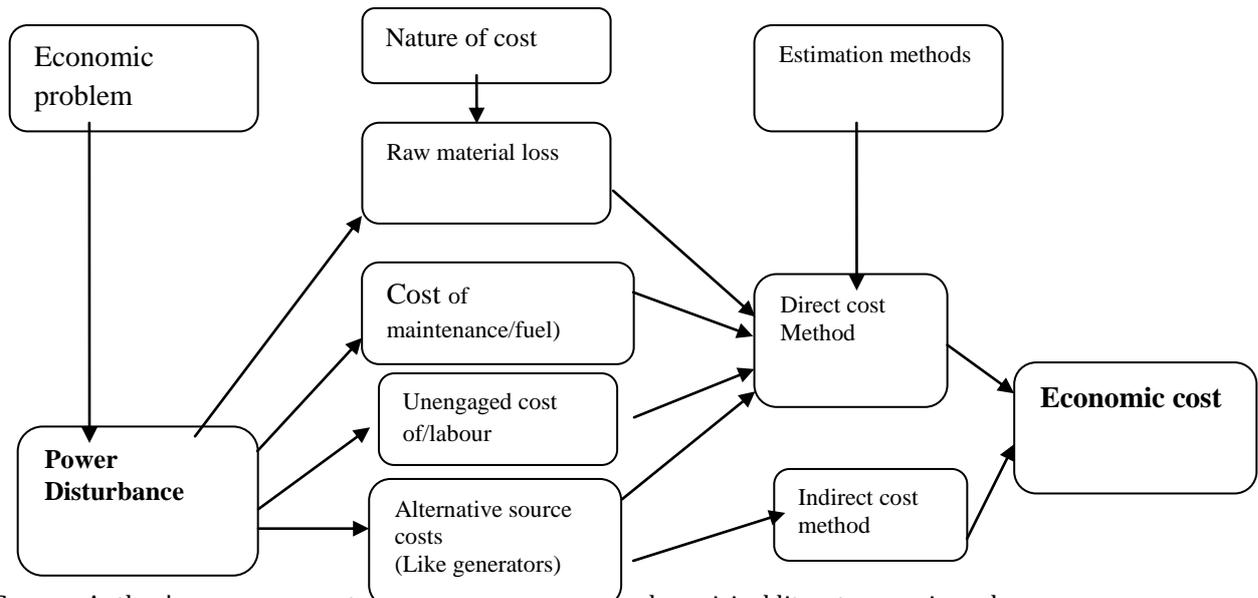
Oke (2006) attributed the non-competitiveness of Nigeria's export goods to poor infrastructure, especially electricity supply, which drives the running cost of firms. Ndebbio (2006) argued that electricity supply drives the industrialization process. He submitted that one important indicator, whether a country is industrialized or not, is the megawatt of electricity consumed. He further argued that a country's electricity consumption per-capita in kilowatt hours (KWH) is proportional to the state of industrialization of that country.

Velasquez and Pichler (2010) also reiterated that sufficient and affordable supply of energy (in this case, electricity) has had a decisive significance for economic activities and economic growth can or may be restricted by resource energy. Since a country's economic growth is a composite of economic activities of small and medium enterprises, the less cost they have to tolerate, the better a country's chance at harnessing their input towards greater levels of gross domestic product and growth.

The most significant effect vulnerable supply of electricity has on small business' operations is cost. Cost is a variable input in the measurement of profit. Profit is only realizable where cost of production is less than revenue. As a fixed cost therefore, SMEs' access to sufficient and affordable supply of electricity is therefore a crucial determinant of profitability and growth. SMEs suffer operation and maintenance costs arising out of power fluctuations (Lai et al., 2008).

The Figure illustrates that to estimate the economic costs of power Economic problem, consideration must be taken of the effect of power Interruption on economic costs, the estimation method used to quantify the costs, and the affected sectors of the economy.

**Work for assessing economic cost of electric power interruption**



Source: Author’s own representation from theoretical and empirical literature reviewed

**3. Methodology of the Study**

**3.1 Description of the study area**

Garage Zone found in SNNPR region, it shares common boundaries with Oromia region and Hadiya Zone and Yem Special Wereda.

As stated in the introduction part the main objective of this study was analysis the effect of electric power disturbance on SMEs economic benefits in Garage zone. The researcher would be focused on the selected three Towns such as wolkite, butajira and Endber. The total number of SMEs within three town have 801 formed the population for the study.

**3.2 Sample size**

To determine the sample size variability, confidence level and margin of error is considered the simple size determined by using the following formula (Yamane, 1967).

$n = \frac{N}{1 + Ne^2}$  Where,  $n$  =required sample of size study,  $N$ = total number of Targeted Small and medium enterprise,  $e$  = margin of error, at confidence level is 95%, and then margin of error is (e) is 0.05.Total sample size of the study (n)

$$n = \frac{N}{1 + N(e^2)} \quad n = \frac{794}{1 + 801(0.05^2)} \quad n = \frac{801}{3.0025} \quad n = 267$$

To determine the Proportional allocation of total sample in each three town the following formula has been applied.  $n_i = \frac{n \times N_i}{N}$  Where,  $n_i$  = required Sample sizes of each town's (sample of  $i^{th}$  towns)  $N_i$  = the number of SME in each selected Town (SME in  $i^{th}$  town)

Table 1 : **Proportional allocation of sample small and medium enterprise by town**

No_	Sample Town	Total Number of enterprise in selected town	Sample size	Method of selection
1	Wolkitetown	386	$n_1 = \frac{267 \times 386}{801} = 128$	Simple Random sampling method
2	Butajiratown	326	$n_2 = \frac{267 \times 326}{801} = 110$	
3	Endbertown	89	$n_3 = \frac{267 \times 89}{801} = 29$	
	Total	801	267	

Source, our survey, 2020

### 3.3. Techniques of Data Analysis

To analyzed the data by using descriptive and inferential statistics. Descriptive statistics method would apply to analyze quantitative data where data was score by calculating the tables, graphs, percentages. In inferential statistics the econometrics model of conditional logit and Binary logistic regression model were used. This would be done by using STATA version 13 computer software.

#### 3.3.1 The conditional logit model

##### 1. Model Specification

The Conditional Logit Model is closely related to the better-known MLM model, but it derives from different behavioural assumptions and is estimated in different form. The CLM model is appropriate whenever it is reasonable to assume that individual choices among available alternatives are a function of the relevant characteristics of those alternatives, rather than the characteristics of the individual. Like MLG model, the CLG model are based on the independently and identically distributed assumption .I.e. error terms follow an extreme value distribution and are independent across alternative.

The natural model formulation would be

$$\text{prob} \left( y_i = \frac{j}{x_{i1}}, x_{i2}, \dots, x_{ij} \right), \text{prb} \left( y_i = \frac{j}{x_i} \right) = p_{ij} = \frac{\exp x_{ij} \beta}{\sum_1^j \exp x_{ij} \beta}$$

## 2 Binary Logistic Regression

A binary logistic regression was used to capture the net effect of the different possible factors on the choice of willingness to pay for improved electricity supply. There were two categories which formed the binary outcome of willing to Pay (WTP) coded as 1, or not willing to Pay (NWTP) coded as 0. Odds ratio were used to interpret the associations between the outcome variables and independent variables. The probability of an enterprise being willing to pay for improved power can be written as follows:

$$P_i = \frac{E(y = 1)}{X_i} = \left( \frac{1}{1 + e^{-(\beta_0 + \beta_i X_i)}} \right)$$

## 4 The results and discussion

A total of 2 interviews were discarded as incomplete due to poor completion or respondent unwillingness to complete the interview having 265 completed surveys to be included in the analysis.

### 4.1 Effect of electric power interruption and duration on cost of production

Damage to sort able products was due to high power disturbance in day time which seems to be a higher problem than during night time. Due to the disturbance of power systems, cost of material like additional and unexpected costs for energy was increased. From the sample respondent data indicate that out of SMEs 265 out of 42(15.8%) of the respondents raw material cost, 12(5.3 %) of additional electricity tariff cost, 84(31.7%) of respondents labour cost expense, 97(36.3%) of respondents additional fuel cost were increased and SMEs to increase customer satisfaction and to increase their production, due to electric power disturbance.

This percentage would most likely in a developed country as security systems such as alarms may stop working and it describes the relationship between the duration of outage electricity and the perceived negative effect on business.

Table 4.1: Effect of electric power disturbance and duration on cost of production

Effects of electric power disturbance			Duration of electric power disturbance		
Cost of production	Frequency	Percentage (%)	Period disturbance	Frequency	Percentages (%)
Increase in raw materials costs	42	15.8	Night time	30	11.3
Increase in electricity tariffs	14	5.3	Day time	167	63.0
Increase in the cost fuel	97	36.6	Both night and day	68	25.7
Increase in labor expenditure	84	31.7	Total	265	100.0
Others costs	28	10.6			
<b>Total</b>	265	100.0			

Source: Survey data, 2020.

#### 4.2 Alternative Energy and Its Cost and the competitiveness of SMEs

This study is aimed at finding out the effect of the electric power interruption on economic cost of SMEs in the Guragezone. Majority of the SMEs surveyed revealed that most of the small and medium enterprises relied on electric power supply from the national grid or electricity power for their daily operations. However, the table below indicates that apart from electricity, a variety of other sources of energy are used by SME businesses to power their operations. For most SMEs, power outage does not mean stop page in production as their ability to produce and sell brings income for self-sustenance.

From Table 4.2 below, it could be seen that 106(40%) out of the total of 265 SMEs were used generator constitutes the largest proportion of the alternative sources of power though necessary to keep their businesses running and it was generally very expensive and costly; Also 103(38.9 %) of the respondents claimed they use solar energy to their operations which is relatively cheaper. while 56(21.1%) out of the total of 265 SMEs surveyed indicates that they use others types of energy. above indicate that the use of Generator and solar energy source increasing cost of energy particularly operation and maintenance cost to be expensive. Thus interruption of electric power has forced SMES businesses to spend additional funds to procure another’s energy source for the effective and efficient running and survival of their businesses and increasing their cost of operations and thereby lowering profits.

Table 4.2: Sources of Energy used by SMEs

others Energy Sources	Other energy sources		Purchase Cost of other source			Fuel and maintenance costs		
	Frequenc y	Percentag es (%)	Cost by birr	Freq uenc y	Percent ages (%)	Cost by birr	Freque ncy	Percenta ges (%)
Generators	106	40.0	Greater than 10000	106	40	>600	108	48.7
Solar Energy	103	38.9	5000-10000	103	38.9	300-600	147	55.5
Others type of energy	56	21.1	Up to 5000	103	38.9	up to 300	10	3.8
<b>TOTAL</b>	265	100.0	Total	265	100.0	Total	265	100.0

Source: Surveyed data 2020.

### 4.3 The Econometric model Analysis and discussion Part

#### 4.3.1 The Conditional Logit Model Results

Table 4.3 shows the results of the conditional logit model, which indicates that, the attributes such as Frequency power off per day, Time duration/time of day and Cost of alternative source is significant at 5% level of significance. The mean coefficients of the attributes such time duration of interruption (day time interruption) and cost of alternative source is positive effect on economic cost and significant at 5% level of significant. Therefore day time power interruption was main cause of economic cost of SMEs.

In addition, the mean coefficients of the attributes such Frequency power off per day is negatives and 5% level of significant effect economic cost. Respondents preferred fewer outages as indicated by the negative and significant signs for frequency. The positive coefficient of time of interruption (days) was shows that the respondents do not prefers the interruption that occurs during the day time. For the Cost of alternative source, this coefficient is positive, because the electric power interruption of selecting an increase in service reliability decreases and addition cost increased with higher in alternative source cost payments. Moreover, the base case scenarios for each of these two attributes are simulated where the ratio of each attribute mean to the cost coefficient yields the implicit economic cost estimates.

Table 4.3. The Conditional logit model out put

Conditional(fixed effects) logistic regression				
	Coefficient	Std.err	z- value	P-value
duration of disturbance day time	0.8117173	0.3521661	2.30	0.021
Frequency power off per day	-1.200642	0.4511172	-2.66	0.008
Alternative source cost	5.182814	0.8118771	6.38	0.000
Pseudo $\rho^2$	0.4758			
Log likely hood	-87.012168			
NQobs.	265			

Source: Own survey, 2020

#### 4.3.2 Binary Logistic Regression Model Results

To begin with, a likelihood ratio or Wald test and Hosmer and Lemeshow test were used to check if the binary model is a good fit to the data provided. The result of the binary logit model is given below.

The test statistics to evaluate the validity and significance of the model parameters are the likelihood ratio or Wald test (for overall joint test). The hypothesis that all coefficients are simultaneously equal to zero in the binary logit model was tested using chi- $\chi^2$  statistics. The tabulated wald  $\chi^2$  statistics at 5% significance level for each model using degrees of freedom equal to the number of attributes/coefficients to be estimated, in this case, eleven is 54.79; leading to rejection of the null hypothesis. Furthermore, just using the probability of chi2 value reported in Table 4.4, we could reject the null hypothesis mentioned

bellow. This indicates that the model is efficient for explaining the variation in willingness to pay for electricity service connection.

Table 4.4 Binary Logistic Regression Model Results

Factors of WTP	Coefficient	Std.err	z-value	P> Z	Odds Ratio
education level	<b>1.648704</b>	0.1570572	1.05	<b>0.294</b>	1.17924
family size,	0.1709326	0.5394741	0.32	0.751	1.12740
size of enterprise	0.3574303	0.4321306	0.83	0.408	1.42124
average monthly income	0.1878027	0.2019969	0.93	0.353	1.20507
monthly electricity expenditure,	2.221138**	0.8775282	2.53	0.011	9.14482
duration of disturbance day time	-0.554188	0.3943516	-1.41	0.160	0.58988
frequency of power disturbance in a per day	5.117073***	1.682806	3.19	0.001	170.793
alternative of source power supply equipment	-2.260665***	0.714431	-3.16	0.002	0.10359
the maintenance cost of alternative source	-0.13577	0.2483292	-0.05	0.956	0.99094
satisfaction with electricity services	-0.0054855	0.2659901	-0.02	0.984	1.02659
distance manufacturing area to sales /services	0.0193689	0.2689168	0.07	0.943	1.03144
Constant	-2.89428***	0.801634	-3.61	0.000	0.03445
Wald chi2 (11)	54.79				
Prob>chi <sup>2</sup>	0.0000				
Pseudo R <sup>2</sup>	0.62689				
Log pseudolikelihood	-61.984				
Hosmer and Lemeshow	18.34				

Source: Authors' Estimation, 2020. Notes: \*Significant at 10%, \*\*Significant at 5%, \*\*\*Significant at 1%

From table 4.4 the results, the family size, size of enterprise, the average monthly income, the monthly electricity expenditure, the frequency of power disturbance in a per day and distance manufacturing area to sales or services have a positive relationship with the enterprise's willingness to pay for improved service whilst the duration of disturbance day time, the alternative of source power supply equipment, the maintenance cost of alternative source equipment and the satisfaction with electricity services have a negative relationships. Specifically, the results mean that as the frequency of power disturbance in a per day experienced by the enterprise increase, the more likely that a enterprise will be willing to pay for improved electricity service and the coefficient or odds of this happening are 5.117 times greater than enterprises who experience lower incidents of power interruptions. Also, the frequency of power disturbance in a per days positively and marginal effect on economic cost at 5% level of significant. The result was in line with Foster& Stein bucks (2008). As the enterprises' the alternative of source power supply equipment decreases, the more likely that they will be willing to pay for interrupted electricity supply increased. The alternative of source power supply equipment has experienced by the enterprise increase one unit, willingness to pay of enterprise decreased by 2.26 at 5% level of significant, when things remain constant.

On the other hand, the marginal effect coefficient of the alternative source of power supply equipment has negative significant influences on the enterprises' willingness to pay for electricity service connection in all models. This result is also in line with the economic theory particularly the law of demand, which implies that the higher the money amount the respondents were additional costs to pay, the less likely they would agree to pay for electricity service. This is because of the fact that if enterprise do not afford they would not have willingness to pay for an expensive services compared to the cheaper one. This result coincides with the findings of Abdullah and Jeanty (2011).

The monthly electricity expenditure has positive role to willing to pay for improved services, enterprise will be willing to pay for improved other electricity service and monthly electricity expenditure are positive marginal effect and significant at 5% level of significance. With the observed values in the sample, a one percentage point higher monthly electricity expenditure causes a 2.22 percentage point fewer connected willingness to pay of enterprise for secure power interruption. This result provides evidence that an unreliable electrical service acts as an obstacle to subscriptions production or effects of economic costs and that the impact of low reliability could be greater than that of enterprise not willing to pay for alternative power sources. The result indicates that the enterprises willingness to pay alone is not sufficient to recover the cost of electricity connection it is coincides with According to the ErGEthio research Group (2012) the average cost of grid line electricity service connection for enterprises within 1 km radius of grid line transformation is estimated to be approximately around 5000 birr.

## **5 Conclusion and Recommendation**

### **5.1 Conclusion**

Econometric model result shows that education level of enterprise, family size, size of enterprise, average monthly income and distance manufacturing area to sales or services are positive marginal effects of cost of power disturbance in SMEs, but not statistically significant for cost of electric power disturbance. Also alternative source of power supply of equipment, maintenance cost of alternative source and satisfaction with electricity service are negative marginal effects of cost of power disturbance and not statistically significant. In contrast, monthly electricity expenditure, frequency of power interaction in day a time and Duration of disturbance in day time are positive marginal effects of cost of power disturbance in SMEs at 5% level of significant.

### **5.2 Recommendations**

The study required to quantify the economic costs of power disturbances on the business sector in a bid to provide possible policy solutions to curb electricity unreliability. Economic progress, enterprise services or manufacturing development and other energy consumption policies cause increase productivity and increase economic costs. With increase in increasing product cost, the sources of alternative energy are also increasing that give enterprise an opportunity to choose more preferable energy sources or to choose willingness to pay alternative costs. Furthermore, as the results of our analysis have shown, small-scale operators are more heavily affected by the infrastructure failures. In many instances they are unable to finance the cost of backup necessary to mitigate the negative impact of

frequent outages. Hence, they have to bear the full burden of electricity failures. Small-scale operators that could afford to back up their operations have to spend a significant proportion of their investment outlay on this.

- The nation's power transmission and distribution infrastructures should be urgently upgraded. The number of power generating stations should be increased also to meet the ever increasing demand for electricity while the power stations should be rehabilitated and the weak transmission lines replaced in order to further strengthen the network.
- Government should encourage investment in generation capacity expansion and strengthening of the sector infrastructure facilities to ensure efficient delivery of electricity to the consumers.
- The country should fast track the comprehensive nationwide energy resource assessment in order to inform investment decisions.
- Therefore, the paying alternative costs to secure electric power interruption by alternative energy source like generators, solar energy are used to increase productivity or increasing per capita income increases.

## References

1. Abdullah, S., Jeanty, P.W., 2011. Willingness to pay for renewable energy: evidence from a contingent valuation survey in Kenya. *Renew. Sustain. Energy Rev.* 15 (6), 2974–2983.
2. Bloomberg New Energy Finance, Ethiopian Electric Power Corporation, Ministry of Water, Irrigation and energy, Ethiopian Sugar Corporation.
3. Doe Frederick, Asamoah Emmanuel Selase(2014) :The Effect of Electric Power Fluctuations on the Profitability and Competitiveness of SMEs: A Study of SMEs within the Accra Business District of Ghana *Journal of Competitiveness* Vol. 6, Issue 3, pp. 32-48, September 2014
4. ErGEthio research Group, 2012. Solar energy vision for Ethiopia: opportunities for creating a photovoltaic industry in Ethiopia, international solar energy institute. Freiburg Addis Ababa.
5. Ethiopian Electric Power Corporation (EEPCO). (2014/15) Electricity Supply and Demand Plan. Addis Ababa, Ethiopia. Ethiopian Electric Power Corporations, 'Facts in Brief 2015.'
6. Foster, V., & Steinbuks, J. (2008). Paying the price for unreliable power supplies: In-house generation of electricity by firms in Africa. *Paying the price for unreliable power supplies: In-house generation of electricity by firms in Africa*
7. Gollagari Ramakrishna (2015):Energy Consumption and Economic Growth: The Ethiopian Experience *Journal of Economic and Financial Modelling: Vol.2 No.2* , pp35-47 Article .
8. Hachimenum, A. (2015). Impact of Power Outages on Developing Countries: Evidence from Rural Households in Niger Delta, Nigeria. *Journal of Energy Technologies and Policy*, 27-38.
9. Kaseke, N. (2014). Comparative Cost Assessment Of Electricity Outages And Generation Expansion In Zimbabwe. *International Journal of Advanced Research in Management and Social Sciences*, 2278-6236.

10. Lamessa Tariku Abdisa (2018): Power Outages, Its Economic Cost and Firm Performance: Evidence From Ethiopia February
11. Lay, J., Ondraczek, J., Stoeber, J., 2013. Renewables in the energy transition: evidence on solar home systems and lighting fuel choice in Kenya. *Energy Econ.* 40, 350–359.
12. National Centre for Research Methods. (2011). Using Statistical Regression Methods in Education Research-The SPSS Logistic Regression Output.
13. P. J. Balducci J. M. Roop L. A. Schienbein J. G. DeSteele M. R. Weimar (2002). Electrical Power Interruption Cost Estimates for Individual Industries, Sectors, and U.S. Economy.
14. SinanKufeoglu (2015) economic impacts of electric power outages and evaluation of customer .
15. ToleshiWakjiraAdugna (2016): households' willingness to pay for reliable electricity services in kuyuworeda, ethiopia: an application of choice experiment method .
16. Zarnikau, J., 2003. Consumer demand for 'green power' and energy efficiency. *Energy Pol.* 31 (15), 1661–167.

### Appendix 1. Conditional logit model

Conditional (fixed-effects) logistic regression

	Number of obs	=	265	
	LR chi2(3)	=	188.15	
	Prob > chi2	=	0.0000	
Log likelihood = -59.215182	Pseudo R2	=	0.6137	

wtp	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
frequencyofinterruptionperday	6.753299	.8871791	7.61	0.000	5.01446	8.492138
durationofinterruptiondaytime	-.238628	.4156427	-0.57	0.566	-1.053273	.5760168
alternativesourceofpowersupply	-1.710791	.4367438	-3.92	0.000	-2.566793	-.8547887

### Appendix 2. Binomial logit regression

Logistic regression	Number of obs	=	265	
	Wald chi2(11)	=	54.79	
	Prob > chi2	=	0.0000	
Log pseudolikelihood = -61.984041	Pseudo R2	=	0.6289	

wtp	Coef.	Robust Std. Err.	z	P> z
educenterprises	.1648704	.1570573	1.05	0.294
familysize	.1199171	.5586876	0.21	0.830
sizeofenterprise	.3515304	.4322846	0.81	0.416
averagemonthlyincome	.1865419	.2057973	0.91	0.365
monthyelectricityexpenditure	2.213188	.8790733	2.52	0.012
durationofinterruptiondaytime	-.5278257	.3899937	-1.35	0.176
frequencyofinterruptionperday	5.140454	1.667824	3.08	0.002
alternativesourceofpowersupply	-2.267236	.7301566	-3.11	0.002
maintenancecostofalternativesour	-.0091004	.2446613	-0.04	0.970
satisfactionwiththeelectricityservi	.0262484	.2590399	0.10	0.919
distancefrommanufacturingareatos	.0309643	.2711426	0.11	0.909
_cons	-3.368123	1.021931	-3.30	0.001

## Innovations, Number 64 April 2021

Logistic regression	Number of obs	=	265
	Wald chi2(11)	=	54.79
	Prob > chi2	=	0.0000
Log pseudolikelihood = -61.984041	Pseudo R2	=	0.6289

wtp	Odds Ratio	Robust Std. Err.	z	P> z
educenterprises	1.17924	.1852083	1.05	0.294
familysize	1.127403	.6298663	0.21	0.830
sizeofenterprise	1.421241	.6143806	0.81	0.416
averagemonthlyincome	1.205075	.2480012	0.91	0.365
monthlyelectricityexpenditure	9.144826	8.038972	2.52	0.012
durationofinterruptiondaytime	.5898862	.2300519	-1.35	0.176
frequencyofinterruptionperday	170.7933	284.8531	3.08	0.002
alternativesourceofpowersupply	.1035981	.0756428	-3.11	0.002
maintenancecostofalternativesour	.9909409	.2424449	-0.04	0.970
satisfactionwithelectricityservi	1.026596	.2659293	0.10	0.919
distancefrommanufacturingareatos	1.031449	.2796697	0.11	0.909
_cons	.0344542	.0352099	-3.30	0.001