# Impact of Rural and Urban Electricity Access on Economic Growth in Zimbabwe

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**ABSTRACT**

Lack of access to reliable electricity to both rural and urban Zimbabweans is negatively affecting the quality of people's life. The country has been experiencing extended hours of load shedding which result in the population having more hours without electricity per day than with electricity. Access to electricity complimented by droughts, natural disasters has impacted on production activities for the people hence causing poverty to many. The study used time series data for the period 1992-2018. The Dynamic Ordinary Least Squares (DOLS) was used as the main model of assess electricity access on economic growth. The results reveals that electricity access to urban population and electricity access to population (EAP) have positive significant impact on economic growth. However, electricity access to rural population was found to be statistically insignificant reflecting that electricity is not always available when it is needed in the rural areas. The study recommends that there is need to improve electricity access for both urban and rural population through on-grid and off-grid systems and expanded electricity generation to meet demand. This will improve socio-economic activities people would be able to carry out productive activities such as irrigation, processing and manufacturing or value addition of certain agriculture out.

**Keywords:** Urban Electricity Access, Rural Electricity Access, Economic Growth
**JEL Classifications:** C32, R11, E24

## 1. INTRODUCTION

Reliable electricity access is considered critical on people's opportunities and quality of life. Access to energy is a key driver to sustainable development. It is now widely recognized in the Sustainable Development Goals (SDGs) which specified access to affordable, reliable, sustainable, and modern energy for all by 2030 as an explicit target. Estimates have shown that 1.1 billion people world over do not have access to electricity, most of them living in rural areas (International Energy Agency, 2017). The relationship between electricity use and development is known but the local dimensions of the electricity access nexus in poor rural and urban Zimbabweans contexts are not completely captured and characterized. Thus, the study assess the impact of electricity access on economic growth in Zimbabwe.

Zimbabwe, like many Southern African countries is characterized by extreme poverty levels that accrued as a result of economic challenges in these countries. Zimbabwe has had a shocking record of recessionary levels for the past two decades. The economy of Zimbabwe during the global financial crisis was affected severely and was unable to recover until now. During the 2007/2008 global financial crisis, Zimbabwe was characterized by hyperinflation levels, high unemployment levels, balance of payment deficits, and huge unequal distribution of income. As a result of these economic challenges, it was difficult to develop the country in terms of infrastructure such as electricity developments which is required for agriculture and other uses that stimulate growth. Due to none development of infrastructure, there is always growing gap between demand and supply, with the country failing to meet demands, hence acute load shedding on a daily basis. This load

shedding is affecting all sectors of the economy and causing poverty to the Zimbabwean populace.

According to the World Bank (2019), extreme poverty was estimated to have risen from 29% in 2018 to 34% in 2019, an increase from 4.7 to 5.7 million people. The increase is driven by economic contraction and the sharp rise in prices of food and basic commodities. As a small African country with vast amount of rich land, investing in agriculture would be expected to stimulate the economy. However, agriculture has not been performing well because of various natural disasters such as poor rains in some parts of the country. For instance, 2015/16 *El-Nino* induced drought led to the reduction in agricultural activities in most rural areas in Zimbabwe. The 2019 Cyclone *Idai* worsened the situation in Zimbabwe as well, leaving many families without access to basic commodities. The droughts led by these crisis posed a negative knock off effect on electricity and water supply in both rural and urban areas, thereby reducing growth of the economy. Although access to electricity has been improving in both rural and urban parts of the country, the problem are of power outages and rising costs of electricity in Zimbabwe. This has left many people trying to substitute electricity with some non-renewable energy sources.

In short, they are combination of factors leading to the poor economic growth in Zimbabwe. These factors include shortages of foreign currency, fuel, electricity outages, extreme drought, occurrence of cyclones and political crisis. In addition to this, the global pandemic that has affected Zimbabwe's economy leading to more than a month of economy lock down will also have a much deeper negative impact on the economy. With abundance of land and minerals, Zimbabwe may need to improve its energy access and energy consumption in order to have a comparative advantage in production of many commodities. Improving energy access to the people living in both urban areas and rural areas of Zimbabwe can actually stimulate the economy indirectly because access to electricity induces the electricity consumption. When consumption increases that will lead to increased production in manufacturing, mining and agricultural sector. Increasing electricity access to people may result in an increase in growth in the economy. David (2015) shows that about 40% of the population in Zimbabwe receives modern energy of which 90% is electricity.

Makonese (2016) mentioned that electricity generation in Zimbabwe is through Hydro Electric Power Station that generate about 750 MW and the Thermal power stations that uses the locally available coal it constitutes the rest of the national generation capacity. However according to David (2015), Kariba Hydro Electric Power station is facing climate change challenges, with perennial droughts reducing the lake capacity. David (2015) also mentioned that the Thermal power stations have passed their life span and the equipment is now aging resulting in frequent breakdowns. Having mentioned these problems faced in the electricity generation in Zimbabwe, this has led to extreme shortages in electricity and resulted in a decline in electricity consumption by the people of Zimbabwe. Fouquet (2008) shows that electricity offers numerous advantages over other energy carriers, enabling far more efficient lighting information and

communication technologies, and more productive organization of manufacturing. In rural areas, electricity is also used for farming, particularly in irrigation systems, mining and various education systems requires electricity. In urban areas most electricity is used in production and many other industries relies on electricity as their source of energy.

The works of Rao (2013), Khandker et al. (2012), Bhattacharyya (2013), Niez (2010), Adenikinju (2005), Bhattacharyya and Ohiare (2013), van Gevelt (2014) Yang (2003), Peng and Pan (2006) supports that increasing electricity access to the people will promote economic growth. However, electricity access does not equate to utilization as accessibility could be deterred by issues such as quality and outages. Therefore, it is difficult to assume electricity access will guarantee an increase in growth. Electricity access in Zimbabwe has been improving particularly in the urban areas since 1992 as can be seen in Figure 1. However access to electricity backed up with consistent shortages of electricity can be futile towards growth.

Moreover, access to electricity by the people living in rural areas should not be compromised too if indeed access leads to growth. The majority of farmers whether small scale or large scale farmers lives in rural areas. Farming can also be used as an instrument to transform the Zimbabwean economy. However, it is devastating to see that the majority of the people living in rural areas in Zimbabwe do not have access to electricity. As can be seen in Figure 1, access to electricity expressed as a percentage of rural population has been fluctuating far below that of urban areas ever since 1992 to 2018.

The percentage of urban population that had access to electricity in Zimbabwe since 1992 has been fluctuating above 80%. The access to electricity in the urban areas during this period was great, but the economy was not performing well, which brings us to the question of whether electricity access does increase growth in Zimbabwe. They are very few studies made to investigate the effects of electricity access to the Zimbabwean economic growth. This paper employs the Dynamic Ordinary Least Squares (DOLS) by Stock and Watson (1993) to estimate the impact of electricity access on economic growth in Zimbabwe using the time series data for the period of 1992 to 2018. Contrary to other studies, we disaggregated the impact of access to electricity by people living in urban areas and by people living in rural areas.

**Figure 1:** Access to electricity: Rural versus urban population in Zimbabwe
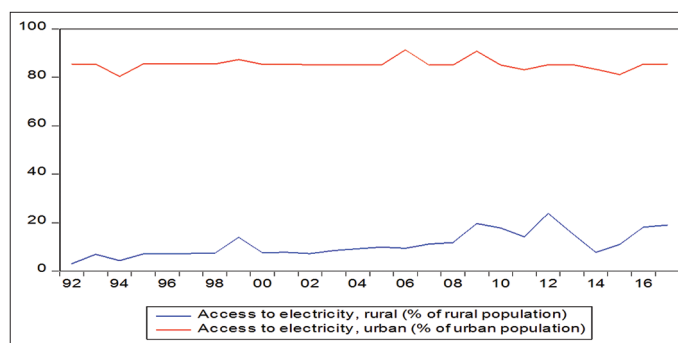
## 2. LITERATURE REVIEW

### 2.1. Theoretical Literature

The role of energy until recently was highly disregarded within mainstream economic literature. Though empirical studies have ensued, energy is excluded within several growth theories with limited consideration in ecological economics and extensions by Stern and Kender (2012). According to Stern (1997), ecological economic theory referred to as the biophysical economics approach considers substitution between capital and resources which include energy as playing a limited mitigation role in resource scarcity. Moreover, inclusion of energy within the growth models leads to reduction of the role posited by technological change (Hall et al., 2001). Contrarily, Stern and Kender (2012) integrate this model within the mainstream Solow growth model arguing that the impact of energy on growth is dependent on the level of scarcity. Since the Solow growth model posits that economic growth is explained by labour and capital whilst the sustainability thereof depends on technological progress, the augmented model argues that energy impacts growth if scarcity is relatively high (Stern et al., 2016). Despite a leap in theoretical formulations of energy benefits, empirical literature has played a major role in the debate on growth effects of energy. Literature has mostly been based on issues of electricity access, electric power consumption and pricing effects and these are discussed in the next sections of the paper.

### 2.2. Electricity Access and Economic Growth

Electricity access and economic growth nexus has been one of the most empirically undertaken evaluations in the role of energy as a growth determinant. Khandker et al. (2012) evaluated the outcomes of electrification within Bangladesh households using Probit and Instrumental Variable (IV) quantile regressions and found that electrification lead to increased incomes and reduced expenditure amongst households connected to the grid. These findings are supported by within community and household studies in other developing countries which found higher expected economic activity and incomes due to access (Rao, 2013; Bensch et al., 2011; Khandker et al., 2013). Rao (2013) and Bensch et al. (2011) utilized multivariate regressions in India and Rwanda respectively. The findings supported prior works on the income benefits arising from electrification projects in deprived areas. Furthermore, non-connected areas were found to benefit by margins due to increased electrification of areas within proximity as shown by the Vietnamese communes.

Though findings in several studies show the benefits that have spurred across different countries, the benefits have not been uniform within the global community. Countries in sub-Saharan region which face lack of quality electricity and increased outages face depleted growth thereby rendering electrification of communities ineffective (Andersen and Dalgaard, 2013). According to a study by Moyo (2013), such increased outages within the region have deterred productivity and manufacturing. This was additionally expressed by Andersen and Dalgaard (2013) who adopted lightning strikes as instruments of outages in their study. Additional studies adopted a cost approach to outages with findings revealing increased costs in terms of damage, lost production and movement towards alternative energy sources off the grid (Adenikinju, 2005; Cissokho and Seck, 2013).

Adenikinju (2005) investigated the costs associated with power outages on companies within the Nigerian economy and found that companies experienced prevalent costs due to investment in backup generators. The findings support Adenikinju (2005) who argued that outages in the country lead to insufficient growth and production losses which cripple exports. Bhattacharyya (2013) and Niez (2010) support the findings by Adenikinju (2005) basing on South Africa where electricity access has rapidly increased from 30% to 86% leading to improvement towards entrepreneurship and security yet quality of infrastructure has deteriorated leading to reduced economic growth.

The argument in literature on the lack of benefits from access to electricity within the African regions is clear when considering countries that have gained success through access and improved quality. Several research in China and South Korea shows that rural and urban access to energy has increased from rates below 12% to over 97% with increased reduction in poverty and increased growth in incomes (Bhattacharyya and Ohiare, 2012; van Gevelt, 2014; Yang, 2003; Peng and Pan, 2006). Thus, issues of degrading supply and increased load shedding could inherently show differences in gains and explain the increased costs identified in the mining sector study in Zimbabwe by Kaseke and Hosking (2012). According to the study, Zimbabwean's mining sector continues to experience reduced output and increased costs due to load shedding as energy cannot be utilized or consumed for daily use within mining sector.

### 2.3. Electricity Consumption and Growth

Initiated by Kraft and Kraft (1978), the evaluation of energy-growth nexus by proxying consumption provided an in-depth analysis of how utilization as opposed to simply access catalyse growth. This is due to the presumption that access does not equate to utilization as accessibility could be deterred by issues such as quality and outages. The study by Kraft and Kraft (1978) showed that within the United States of America's (USA) context, gross national product (GNP) contributed to energy consumption, but such relationship was not existent from energy consumption using Granger-Sims causality. Further studies which followed showed different findings across regions, reflecting structural differences within the countries (Hossein et al., 2012; Sweiden, 2012; Sebri and Abid, 2012; Bruns et al., 2014).

Sweidan (2012) analysed the impact of energy consumption in United Arab emirate (UAE), adopting the bounds test and granger causality. Results from the study supported a bidirectional relationship between energy consumption and growth within the short run and unidirectional relationship in the long run as found in USA by Kraft and Kraft (1978). Interestingly, Hossein et al. (2012) in a broader study within Oil Producing and Exporting Countries (OPEC) countries identified that UAE and other OPEC countries specifically Iran, Iraq, Qatar and Saudi Arabia showed a short run unidirectional relationship from income to energy consumption.

In African economies, several studies on the consumption-growth framework continue to expand. These studies have mostly

applied panel regressions with few country specific evaluations particularly South Africa (Wolde-Rufael, 2009; Akinlo, 2008; Odhiambo, 2010; Kouakou, 2011; Bildirici, 2013). Akinlo (2008) adopted the vector error correction model in analysis of the eleven sub-Saharan countries. The study shows that amongst the eleven analysed countries, significant long run growth impact due to electricity consumption exists in Ghana, Kenya, Senegal and Sudan. Moreover, bidirectional relationship was identified for Gambia, Ghana and Senegal whilst Sudan and Zimbabwe showed a growth to consumption effect. Interestingly, neutrality was found to exist with respect to Cameroon, Cote D'Ivoire, Kenya and Togo. A study by Wolde-Rufael (2009) within the same region supports mixed results in the prior studies but finds contradictory results for Ghana and Sudan. Thus, findings show that in some countries, the relationship differs but with regards to Ghana and Sudan, the relationship is unidirectional and neutral respectively.

Furthermore, studies by Bildirici (2013) and Okafor (2012) in two African economies and seven countries respectively showed differences in terms of causal direction results. Bildirici (2013) explored electricity consumption in South Africa, Zimbabwe, Code d'Ivoire, Cameroon, Togo and Brunei. The results showed that bidirectional causality exist between consumption of electricity and growth. In Zimbabwe, Runganga and Mishi (2020) found that electric power consumption has a long run impact on economic growth. Thus, with reference to Zimbabwe, electric power consumption plays a critical role in ensuring growth *visa vis*. Using Hslao's Granger causality, Okafor (2012) found that economic growth led to electricity consumption in South Africa in the long run while a uni-directional causality from electricity consumption to economic growth was found in Nigeria. Thus, the issue of consumption and growth differs across economies and period of analysis, but most studies agree that consumption posits a positive or causal effect on growth. Moreover, surety of electricity consumption can be enabled by quality supply and access, but the issues of costs can deter consumption. Hence, from the onset, the issue of pricing as a possible barrier to the benefits of electricity consumption-led growth arise.

## 2.4. Electricity Pricing and Economic Growth
Studies on the causal effect of energy pricing on economic growth have been limited and mostly focused electricity consumption with pricing included as a third variable. Berk and Yetkiner (2014) developed a two-sector endogenous growth model using the error correction cointegration model and panel ARDL to evaluate the interaction between energy prices and economic growth. The findings support a negative relationship between pricing and economic growth. Moreover, consumption of energy was found to be reduced due to increased prices (Berk and Yetkiner, 2014). Belke et al. (2011) and Asafu-Adjaye (2000) present similar findings within 25 Organisation for Economic Co-operation Development (OECD) countries and 4 Asian economies. Belke et al. (2011) adopted the Granger-causality and found that increased levels of energy costs led to reduced energy consumption which further reduced growth. Moreover, a bidirectional relationship between prices and energy consumption within the Philippines and a bi-directional causality from consumption to income in India and Indonesia was found by Asafu-Adjaye (2000).

Studies that have examined limited countries continue to emerge as opposed to panel studies and these studies include earlier research by Masih and Masih (1998), Chandran et al. (2010), Odhiambo (2010) and Khobai et al. (2017). Masih and Masih (1996) and Chandran et al. (2010) adopted the Vector Error Correction Model (VECM) and ARDL models for analysis of Thailand, Sri Lanka and Malaysia respectively. The results showed that a long run causal relationship existed from energy consumption to income and prices. Interestingly, electricity price was found to have no causal relationship on income.

Odhiambo (2010) explored the consumption and economic growth relationship with inclusion of the electricity price variable in three Sub-Saharan African countries. The study utilized ARDL bounds test and granger causality test with findings supporting a unidirectional relationship from prices to economic growth in Kenya. Moreover, within the Democratic Republic of Congo (DRC), energy consumption was found to have a causal effect on prices in the short run and pricing to growth relationship in the long run. Khobai et al. (2017) examined the relationship between, electricity supply, electricity price and growth using ARDL model and found that electricity prices negatively affect growth whilst the supply thereof was positive. Thus, increased prices regardless of access could lead to negative growth rendering supply within affordability levels critical. Although several studies in African context continue to evaluate the energy problem, studies on the accessibility in Zimbabwe is lacking, particularly comparative analysis on urban and rural electrification impact on economic growth.

## 3. DATA SOURCES AND METHODOLOGY

### 3.1. Data Source
The study used time series data for the period 1992-2018 and it was collected from World Development Indicators (WDI). Table 1 presents the variables used in the study as well as the explanation and source.

### 3.2. Empirical Model
In order to examine the impact of electricity access on economic growth, some studies used Ordinary Least Squares (OLS) method. This study used the Dynamic Ordinary Least Squares (DOLS) by Stock and Watson (1993) which improves on OLS by coping with small sample size and dynamic sources of bias. The DOLS was also used for it correct for regressor endogeneity by inclusion of the leads and lags of first differences of the endogenous regressors, and is robust to serial correlation using the Feasible Generalised Least Squares. The DOLS regression equation was specified as follows:

$$LogGDP_t = X_t M' + \sum_{i=-m}^{i=m} \Phi_i \Delta EARP_{t-i} +$$

$$\sum_{i=-n}^{i=n} \Psi_i \Delta EAUP_{t-i} + \sum_{i=-l}^{i=l} \theta_i \Delta EAP_{t-i} + \varepsilon_t \qquad (1)$$

**Table 1: Description of variables and data sources**

| Variables | Explanation | Data source |
|---|---|---|
| Real GDP | Real gross domestic product | WDI |
| EARP | Electricity access to rural population | WDI |
| EAUP | Electricity access to urban population | WDI |
| EAP | Electricity access to population | WDI |

where $M=(c, \alpha, \beta, \gamma)$, $X = (1, EARP_t, EAUP_t, EAP_t$ and $m$, $n$ and $l$ are the lengths of leads (futures) and lags (past) of the covariates, $LogGDP_t$ is the logarithm of gross domestic product, $\Delta EARP_{t-i}$ is the differenced electricity access to rural population, $\Delta EAUP_{t-i}$ is the differenced electricity access to urban population, $\Delta EAP_{t-i}$ is the differenced electricity access to population, $\Phi_i$, $\psi_i$ and $\theta_i$ are the coefficients of leads and lags of $EARP_t$, $EAUP_t$ and $EAP_t$ respectively and $\varepsilon_t$ is the error term. $EARP$, $EAUP$ and $EAP$ were not transformed by using logarithms as done by Rehman et al. (2018) because these variables are already in percentage form and applying logarithms will make interpretation of results difficult. Following the estimation of Equation 1, Engle-Granger test was used to determine if the series are cointegrated or multicointegrated.

### 3.3. Pre-estimation and Post-estimation Tests

In order to examine if the series are stationary, Augmented Dickey-Fuller (ADF) unit root test proposed by Dickey and Fuller (1979) was used. The ADF unit root was preferred because it accommodate some form of serial correlation, thus can accommodate some higher order autoregressive process in the error term (Greene, 2003). Serial autocorrelation was tested using Breusch-Godfrey test while test for heteroscedasticity was done using Breusch-Pagan-Godfrey test. Jarque-Bera test for normality was used while Ramsey Regression Error Specification Test (RESET) was used to test for model mis-specification. Parametric econometric model described by its parameters, model stability can be equivalent to parameter stability. Therefore, the Cumulative sum of squared recursive residuals (CUSUMSQ) tests was used to check for model parameter stability.

Prominent cointegration tests in literature exist and these include Engle-Granger cointegration test, Johansen cointegration test and Bounds cointegration test. While the Johansen and Engle-Granger cointegration tests are applicable if all the series are integrated of order one, Autoregressive Distributed Lag (ARDL) bounds test is applicable for series integrated of different orders.

## 4. ECONOMETRIC RESULTS

The Augmented Dickey-Fuller unit root test was used to determine if the series are stationary and the results are shown in Table 2. The

unit test results shows that electricity access to urban population (EAUP) and electricity access to population (EAP) are stationary in levels while electricity access to rural population (EARP) and logarithm of gross domestic product (logGDP) are stationary after the first difference. Thus, EAUP and EAP are $I(0)$ while LogGDP and EARP are $I(1)$.

In the multiple regression analysis, it is assumed that the series are stationary in levels that is they are all integrated of order zero, $I(0)$. When some of the variables are non-stationary in levels, application of Ordinary Least Squares on such series may lead to fitted coefficients that are statistically significant when in actual fact, there is no true relationship between the variables as they drift away from equilibrium (Salisu, 2017). Thus, performing OLS may lead to prototypical spurious regression as there can be a linear combination or long run relationship or equilibrium among the variables. If series has a unit root, it means that the series are unstable or unpredictable and therefore, may not be valid for forecasting. As a result, application of OLS on nonstationary series would not be appropriate since OLS is static and differencing the data to avoid spurious regression will result in losing information concerning the behaviour of series over time. Since some of the variables are $I(1)$, the conventional OLS cannot be used because these variables will not behave like constants which is required in the OLS. In addition, the outcome of the unit root testing matters for the empirical model to be estimated and since some of the variables are $I(1)$, there may be a long run relationship between the series despite the fact the series may drift away from each other in the short run (Salisu, 2017). Therefore, the study used DOLS to examine the impact of electricity access in rural as percentage of rural population, electricity access in urban as a percentage of urban population and electricity access as a percentage of population on economic growth. The results for DOLS after applying heteroscedasticity and autocorrelation consistency standard errors[1] are shown in Table 3.

The results shows that electricity access to urban population and electricity access to population have significant impact on economic growth. Electricity access to population (EAP) was found to have a positive and statistically significant coefficient at 5% level, meaning that a 1% increase in total population with access to electricity result in approximately 4.7% increase in economic growth, holding other things constant. This is consistent with the findings of Stern et al.

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**Table 2: Stationarity test for series using Augmented Dickey-Fuller unit root test**

| Variable | ADF statistic | Critical value at 5% | Critical value at 10% | Probability |
|---|---|---|---|---|
| | | **Unit root for series in levels** | | |
| LogGDP | −1.6009 | −2.9862 | −2.6326 | 0.4673 |
| EARP | −2.2034 | −2.981 | −2.6299 | 0.2098 |
| EAUP | −4.8247 | −2.981 | −2.6299 | 0.0007 |
| EAP | −2.673 | −2.981 | −2.6299 | 0.0922 |
| | | **Unit root for series in first differences** | | |
| LogGDP | −2.8814 | −2.9862 | −2.6326 | 0.0618 |
| EARP | −5.5683 | −2.9919 | −2.6355 | 0.0001 |

*LogGDP* is logarithm of gross domestic product, *EARP* is electricity access to rural population, *EAUP* is electricity access to urban population, EAP is electricity access to population

**Table 3: Dynamic ordinary least squares econometric results**

| Variable | Coefficient | SE | t-Statistic | Prob. |
|---|---|---|---|---|
| EARP | −0.018174 | 0.012332 | −1.473737 | 0.1686 |
| EAUP | −0.070805** | 0.016505 | −4.289977 | 0.0013 |
| EAP | 0.047338** | 0.019379 | 2.442702 | 0.0327 |
| C | 14.70346*** | 0.967857 | 15.19177 | 0.0000 |
| R-squared | 0.921696 | Mean dependent var. | | 10.16419 |
| Adjusted R-squared | 0.836274 | SD dependent var. | | 0.090006 |
| S.E. of regression | 0.036419 | Sum squared resid. | | 0.01459 |

*EARP* is electricity access to rural population, *EAUP* is electricity access to urban population, EAP is electricity access to population, (***) indicate significance at 1% and (**) indicate significance at 5%

(2016) who found that electricity access promote economic growth. Surprisingly, the coefficient of electricity access to urban population (EAUP) was found to be negative and statistically significant at 5%, meaning that a 1% increase in urban population with access to electricity result in approximately 7.1% decrease in economic growth. This result is contrary to our expectations but might be a reflection of the nature of the Zimbabwean economy. The Zimbabwean economy has been dominated by the informal economy[2] especially in urban areas and although the majority of urban residence have access to electricity, the electricity is being in the informal economy whose production activities do not contribute to the official estimates of gross domestic product. Thus, the high usage of electricity in the informal economy in urban areas may be the one attributing to negative effect on economic growth. However, the coefficient of electricity access to rural population was found to be statistically insignificant. This might be explained by limited access to electricity in rural areas as well as electricity outages which eventually cancels the benefits of having access and use of electricity. These results may be a reflection of the electricity supply in Zimbabwe because although majority of urban residence have access to electricity, electricity is not always available when it is needed. Although theory suggest that electricity access is likely to be an important enabler of economic growth, with most studies supporting that electricity access and growth are related, electricity outages and blackouts play a major role in reducing the benefits of access to electricity. Thus, electricity consumption matters because even if access has increased, outages cancel the benefits, translating to negative impact on economic growth. Blimpo and Malcolm (2019) argue that access to reliable electricity is a prerequisite for the economic transformation of economies in Sub-Saharan Africa yet access to electricity is even substantially low in the region, and Zimbabwe is an extreme case. The residuals were found to be normally distributed using the Jarque-Bera test while the Ramsey Regression Error Specification Test (RESET) shows that the estimated model is correctly specified. Cumulative sum of squared recursive residuals (CUSUMSQ) showed that the estimated model is stable[3]. The Engle-Granger[4] cointegration test was used to examine the possibility of cointegration between the variables and the results are shown in Table 4.

Since the probability value is greater than the minimum significance level of 10%, we may fail to reject the null hypothesis and conclude that the series are not cointegrated. Thus, although some of the series are *I(0)* and others are *I(1)*, there is no long-run equilibrium relationship between the variables.

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2   A study by Medina and Schneider (2018) on shadow economies around the world showed that Zimbabwe and Bolivia have the largest average size of the shadow economy of 60.6 per cent and 62.3 per cent of gross domestic product (GDP), respectively.

3   See Table 1 in the appendix section on normality results, Ramsey Regression Error Specification Test (RESET) results, and the Cumulative sum of squared recursive residuals (CUSUMSQ) results in Figure 1.

4   Engle-Granger cointegration test was used for it is suitable for single equation model as opposed to Johansen cointegration test which is suitable for multiple equation model.

**Table 4: Engle-Granger cointegration test results**

|  | Value | Prob.* |
|---|---|---|
| Engle-Granger tau-statistic | −1.478613 | 0.9627 |
| Engle-Granger z-statistic | −4.535726 | 0.9705 |

## 5. CONCLUSION AND POLICY IMPLICATIONS

In Zimbabwe, a significant proportion of the population do not have reliable electricity access. This lack of access is considered a limiting factor to the socio-economic development of the country, especially, the rural poor communities. This is despite the efforts that the government is making to expand electricity generation in order to increase supply. Donors, NGOs and Private companies have put forward solar system in different areas and communities as a way of improving energy to the marginalised areas.

Existing literature shows that the electricity access has potential of improving both productive and social opportunities for both people in urban and rural communities. However, the application of linear or pre-defined sets of relations of cause and effect by different researchers fail to accurately describe, or predict, the impacts with any level of precision that such results are useful for planning and making electricity access work in practice, at different country levels. In the context of electricity access, the impact of electricity access have seen to be negatively affecting local socio-economic development. Electricity access is interconnected with multiple dimensions of socio-economic development: income generating activities, production activities, household's economy, education and social networks.

The study results revealed mixed results for the urban and rural people. The results shows that access to electricity to urban population and electricity access to population have significant impact on economic growth. From these results it can be concluded that, electricity access is critical for improving the different productive and social opportunities of people. However, due to low access network of electricity and availability of electricity supply due to load shedding in rural areas, electricity access to rural population was found to be statistically insignificant. It can be concluded that, electricity access to rural areas is not really playing a critical role in improving rural social-economic development.

In order to improve social-economic development through electricity access, the study recommends that there is need to improve electricity supply and access through on-grid and off-grid systems. This will improve people's socio-economic activities as they would be able to carry out productive activities such as irrigation, processing and manufacturing or value addition of certain agriculture out. Such developments are critical as they result in income generating activities, improved communications, linking to markets, food supply, improved food preservation, reduce post-harvest losses and reduces poverty of both rural and urban population.

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# APPENDIXES

**Appendix Table 1: Post-estimation test results**

| Ramsey regression error specification test | | |
|---|---|---|
| **Value** | **df** | **Probability** |
| t-statistic | 0.882271 | 10 | 0.3983 |
| F-statistic | 0.778402 | (1, 10) | 0.3983 |
| Likelihood ratio | 1.799022 | 1 | 0.1798 |
| Breusch-Godfrey serial correlation LM test | | | |
| F-statistic | 2.858694 | Prob. F(2,9) | 0.1094 |
| Obs*R-squared | 9.323483 | Prob. Chi-square 2 | 0.0094 |
| Heteroscedasticity test: Breusch-Pagan-Godfrey | | | |
| F-statistic | 1.886595 | Prob. F(12,11) | 0.1514 |
| Obs*R-squared | 16.152 | Prob. Chi-Square(12) | 0.1844 |
| Normality test results | | | |
| Jarque-Bera statistic | 0.073771 | | |
| Probability | 0.963786 | | |

**Appendix Figure 1:** Cumulative sum of squared recursive residuals (CUSUMSQ) results