The Relationship between Electricity Consumption and Economic Growth: Evidence from Azerbaijan

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ABSTRACT
Research examines the relations between GDP in Manat and Dollar and total electric energy consumption (1995-2017) for the last 22 years in the Republic of Azerbaijan. Besides, the relations between the electric energy consumption and the growth of GDP in these sectors were analysed. Autoregressive distributed lag model was used as a research methodology. Stationary tests of variables (ADF, PP, and KPSS) and Pairwise Granger Causality Tests were done. Stability of models was examined. Eviews_9 econometric software program was used to establish graphics and do calculations. Having analysed the research, there is a positive correlation not only in GDP and electric energy consumption but also electric energy consumption and GDP in different sectors of economy. We recommend to save electric energy.

Keywords: Electric Energy Consumption, GDP Growth, Autoregressive Distributed Lag

JEL Classifications: F15, B28, C23, Q43, O52

1. INTRODUCTION

The roles that hydrocarbon resources, including oil products as energy carriers, play in the economy and in the life of people are undeniable (Muradov et al., 2019). Policy development, ensuring the growth and development of complex, open and non-linear economic systems, as well as the measurement and evaluation of its results are widely discussed topics in modern economics. It is not by chance that these topics occupy a special place in the reports of international organizations and in the diaries of scientific journals. “How are the priority directions of economic policy chosen?”, “How are the needs of economic agents studied in incentives?” “How does economic policy affect the behavior of economic agents?”, “What indicators can assess the effectiveness of regulatory measures?”, “How can one measure and evaluate economic development and growth?” These and many other issues still remain “apples of discord” for economists.

Angus Deaton believes that economics can be a good tool for developing successful economic policies, but for this it needs, first of all, high-quality information. Nobel laureate, noting the fundamental importance of measurement in economics, argued that, as a means of correctly evaluating the results of economic policy, measurement could also become a source for new theoretical ideas.

Currently, in countries along with microeconomic statistics, microeconomic databases are also being developed. The creation,
Table 1: Power generation in Azerbaijan, million kVt.h

| Date             | 1913 | 1920 | 1930 | 1940 | 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 | 2017 |
|------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Generation       | 110,8| 122  | 503,9| 1827 | 2924 | 6590 | 12027| 15045| 23152| 18699| 18710| 24320,9|
| Fuel             | 1802 | 2894 | 4626 | 10893| 13825| 21399| 17069| 15003| 20445,4| 3446 | 1746,4|
| Hydro            | 24,3 | 29,5 | 963  | 1022 | 1098 | 1658 | 1534 | 3446 | 1746,4|
| Own power plant  | 111,7| 122,2| 95,6 | 83,1 | 259,7| 1899,5| 1261 | 24320,9| 1534 | 3446 | 1746,4|
| Waste            | 0,5  |      |      |     |      |      |      |      |      |      |      |      |
| Power of electricity plants, MVt | 39,8 | 56,4 | 113,4| 254,4| 401,6| 1261 | 2623 | 2882 | 5051 | 4912 | 6398 | 7941,5|

Table 2: Electric power consumption

| Countries   | kVt.h/per capita |
|-------------|------------------|
| Azerbaijan  | 2.202            |
| Armenia     | 1.962            |
| Georgia     | 2.694            |
| Turkey      | 2.847            |
| Turkmenistan| 2.679            |
| Russian Federation | 6.603 |
| Kazakhstan  | 5.600            |
| Ukraine     | 3.419            |
| Iran        | 3.022            |

preservation, systematization and processing of such scientific and labor-intensive microeconomic databases requires large financial resources. And the quality of macroeconomic data is reduced under the influence of the variability of monetary units of measurement. To eliminate the above deficiency, universal natural indicators are used, one of which is the electricity consumption.

Some studies have found a statistically significant (Dhungel, 2010; Lu, 2017; Aslan, 2014) and a bi-directional causal relationship (Kasperowicz, 2014; Ogundipe and Apat, 2013; Motlokoa, 2016) between electricity consumption and economic growth.

Other studies show us that the nature of the relationship between electricity consumption and economic growth differs depending on the type of activity. There exists bidirectional causality between electricity consumption and real output in the services sector and unidirectional causality running from real output in the industrial sector to electricity consumption. However, there is no causal relationship between electricity consumption and real output in the agricultural sector (Ibrahiem, 2018).

In addition, it is believed that the living standard of the population and the economic development degree in the country also affect the relationship between electricity consumption and economic growth (Mahfoudh and Ben Amar, 2014). The results of these studies do not give us full grounds for adopting electricity consumption as an unequivocal indicator of economic growth.

Preponderance of industrial states is completely dependent on energy to fuel their economies. Besides, globalization has made the world to be so interconnected and interdependent that the energy industry is the biggest contributor of the climate change which doesn’t affect a single country but have far wider implications (Vidadili et al., 2017).

Each country with its own economic structure, development level and security of natural energy resources, mechanisms for regulating energy markets, climatic, geographical and demographic conditions is a unique object of research. Conducting such studies in different countries can clarify the relationships between factors that influence the nature of the relationship between electricity consumption and economic growth. On this basis, the study of the relations between these indicators in Azerbaijan was adopted as the goal of this study.

We think that the results of our research are of scientific and practical importance in the following areas:

1. Research provides some empirical information about the relationship between energy consumption and economic growth in an energy-rich country;
2. Shows the behavior of energy consumption and growth in different sectors of the Azerbaijan economy;
3. The results can be used to predict the electricity demand throughout the economy, and by its branches in countries with similar conditions.

2. GENERAL CONDITIONS OF POWER SUPPLY IN AZERBAIJAN

Electricity production in Azerbaijan dates back to the first years of the 20th century - from the time of the first oil boom. Subsequent industrialization processes and the possession of rich hydrocarbon resources led to an accelerated growth in demand for electricity. In the last 50 years alone, the production of electricity has almost doubled (Table 1).

It can be seen that almost 90% of the total energy produced is accounted for by thermal power plants. Despite the country’s huge potential for renewable and alternative energy sources, it was only in the last decade that solar and wind energy began to be used for production.

In Azerbaijan, production facilities, transmission lines and distribution of electricity are fully owned by the state and electricity tariffs are regulated by the state. The volume of production capacity is far ahead of the volume of domestic demand for electricity. Today, Azerbaijan is an exporter of electric energy to neighboring countries. Despite the fact that all parts of Azerbaijan are fully and continuously supplied with electricity, we occupy one of the last places in the region in terms of the use of electricity per capita (Table 2).
### Table 3: Summary of similar empirical studies in the literature

| Data period     | Reearched countries                                                                 | Method(s)                                                                 | Results                                                                                                                                                                                                                                                                                                                                 |
|-----------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Marius-Corneliu et al. (2018) | Annual, 1990-2014 Ten European Union (EU) member states from Central and Eastern Europe | ARDL                                                                     | The result shows that there is no relationship between renewable energy consumption and GDP in Romania and Bulgaria. However, there is resurgence in renewable energy consumption in Hungary, Lithuania and Slovenia. To sum up, cause-effect relationship between renewable energy consumption and GDP was confirmed in both states. The confirmation is true for each studied state separately. |
| Rafał Kasperowicz (2014) | First quarter of 2000 to the fourth quarter of 2012 Poland | C.W.J. Granger, ADF, KPSS test                                           | Achieved results reveals that there is a relationship between electricity consumption and economic growth in Poland. Direction is divided into 2 parts. Dependency of economic growth on electricity is expressed in Poland. Results confirm that there is a single-direction nonlinear causal relationship between income and electricity consumption. Besides, we can see the followings: 1. Single-direction linear approach to electricity consumption spent on residential, commercial and street lighting 2. Single-direction nonlinear causal relationship directed from electricity consumption to GDP in residential, commercial fields 3. Single-direction nonlinear causal relationship directed from income to electricity consumption in street lighting. to GDP in residential, commercial fields. |
| Maria Pempetzoglou (2014) | 1945-2006 Turkey | Standard linear Granger causality test and the nonparametric Diks and Panchenko causality test | Results confirm that there is a single-direction nonlinear causal relationship between income and electricity consumption. Besides, we can see the followings: 1. Single-direction linear approach to electricity consumption spent on residential, commercial and street lighting 2. Single-direction nonlinear causal relationship directed from electricity consumption to GDP in residential, commercial fields 3. Single-direction nonlinear causal relationship directed from income to electricity consumption in street lighting. to GDP in residential, commercial fields. |
| Wen-Cheng Lu (2017) | 1998-2014 17 industries in Taiwan | Granger causality                                                         | Results confirm the double-direction Granger causal relationship and long-term balance between electricity consumption and GDP. So, the growth of electricity consumption by 1% causes to increase 1.72% in GDP. |
| Slim and Mohamed (2015) | 1990-2010 19 African countries | Solow model, Granger test                                                  | There is a strong correlation between electricity consumption and rich countries. There is also a correlation relationship between the lack of using modern service of energy and the people who work for 2 dollars per day. Based on the results of individual and group states, there is a positive and statistically significant relationship between electricity consumption and GDP in a long term. Thus, electricity consumption causes GDP growth. |
| Ömer and Bayrak (2017) | 1990-2012 75 net energy-importing countries | CADF DOLS and FMOLS estimators                                            | The influence of GDP on oil consumption is tremendously downsizing. However, hydroelectric stations impact on electricity consumption positively and surges significantly. Coal has no any influence on economic growth. Based on the results of individual and group states, there is a positive and statistically significant relationship between electricity consumption and GDP in a long term. Thus, electricity consumption causes GDP growth. |
| Uyar and Gökçe (2017) | Annual, 1985-2013 Vietnam, Indonesia, South Africa, Turkey and Argentina | Panel Quantile Regression                                                  | Cointegration test proves the positive relationship and balance between electricity consumption and GDP in a long term. The electricity consumption coefficient is 1.3%. It reveals that the increase of electricity consumption by 1% causes the growth of GDP by 1.31%. Thus, electricity consumption has a significant influence on economic development in South Asia. |
| Kamal (2017) | 2000-2011 Five south Asian countries | Granger causality, VARM                                                    | There is a positive and statistically significant relationship between electricity consumption and GDP in Turkey. Results prove the following relationships: 1. There is a double causal relationship between electricity consumption and real product in service sector 2. There is a single-direction causal relationship from real product to electricity consumption 3. There is no causal relationship between real product and electricity consumption in agrarian sector. |
| Aslan (2014) | 1980-2008 Turkey | Granger causality                                                           | |
Table 3: (Continued)

| Data period   | Reareched countries | Method(s)                          | Results                                                                 |
|---------------|---------------------|------------------------------------|-------------------------------------------------------------------------|
| Junsheng et al. (2018) | 1953-2013           | China                              | Granger causes, Toda-Yamamoto test                                      | The result confirms the positive relationship between electricity consumption and economic growth |
| Basiru (2014)  | 1980-2011           | 18 Sub-Saharan Africa countries    | Panel Unit Root Test                                                    | There is no any causal relationship between electricity consumption and economic growth in the studied states |
| Adeyemi and Ayomide (2013) | 1980-2008           | Nigeria                            | VECM, Pairwise Granger Causality test                                  | The research result confirms the cointegration relationship between electricity consumption and economic growth and sets the double-direction causal relationship between electricity consumption and economic growth |
| Ranjan et al. (2017) | 1990-2012           | BRICS countries                    | The Pedroni (1999-2004) Panel cointegration test, PECM ARDL            | There is no any strong relationship between GDP and electricity consumption. The growth of GDP is a key factor that causes the increase of electricity consumption in the studied states |
| Muhammad and Nur-Syazwani (2018) | 1971-2014           | Malaysia                           | ARDL                                                                   | There is a cointegration relations between real GDP and electricity consumption. Electricity consumption influences positively on economic growth in a short term |
| Lira and Momofokeng (2016) | 1982-2013           | Uganda                             | Granger causality test                                                 | The result confirms the double-direction causal relationship between electricity consumption and economic growth in a long term |
| Ozturk et al. (2019) | 1970-2012           | Denmark                            | ARDL, Granger causality test                                           | The result confirms the neutrality of the relationship between electricity consumption and economic growth in Denmark |
| Bekareva et al. (2017) | 2000-2014           | United States                      | Arellano-Bond method                                                   | The result confirms the positive relationship between renewable energy consumption and economic growth. |
| Molem and Ndifor (2016) | 1980-2014           | Cameroon                           | Generalised Method of Moments                                          | The result confirms that there is a relationship among electricity consumption, economic growth, population and electricity price |
| Mukhtarov et al., 2017 | 1990-2015           | Azerbaijan                         | Toda-Yamamoto causality test, VAR                                      | The results of this test show that there is bidirectional causality between energy consumption and economic growth. Findings of the study |
| Mukhtarov et al., 2018 | 1992-2015           | Azerbaijan                         | Gregory–Hansen test, VECM                                              | The results confirm the existence of a long-run relationship among the variables (between energy consumption, financial development, and economic growth). Find that there is a positive and statistically significant impact of financial development and economic growth on energy consumption in the long-run |

The availability and relatively low tariffs of natural gas in all regions of Azerbaijan are the main argument for explaining this paradoxical situation.

3. LITERATURE REVIEW

The research of the relationships between energy consumption and economic growth has been a focal issue among scientists (Table 3). During research, a number of methods were employed. We can classify them as the following: for example, the relationships between energy consumption and economic growth has been analysed through autoregressive distributed lag (ARDL) method (Lefteris and Theologos, 2011; Ozturk and Ali, 2011; Ramazan et al., 2008; Nicholas, 2009; Fuinhas et al., 2012). However, other scientists researched the relationships between energy consumption and economic growth by Granger test (Narayan et al., 2010; Yemane, 2014; Śmiech and Monika, 2014; Appiah, 2018; Mutascu, 2016; Turgut and Resatoglu, 2016; Masako and Zijian, 2016; Muhammad et al., 2011; Richard and Jonathan, 2015; Muhammad and Hooi, 2012).

4. MATERIALS AND METHODS

4.1. ARDL Model

ARDL model was used for the research. Through this model, cointegration between electric energy and GDP was estimated. To be exact, research assessed the influence of total electric energy production to GDP and the impact of electric energy consumption in different fields to GDP in Azerbaijan Republic (A.Figure 1). The relations in long and short term were researched.

4.2. Unit Root Tests

It is essential to check the stationary variables through Unit Root before the assessment of regression equations. Because, keeping stability between variables is important while assessing the
dependency between two or more variables by using regression analysis. However, probability distribution for every time series in order to be stationary must be identical. Nevertheless, stationary of variables is not always desirable. For a long term or cointegration relation and assessment, the variables must be non-stationary in most methods. It is also required that the first difference should be stationary or I(1). It must be noted that if any time series variable is stationary with real values, then it can be considered I(0). If a variable is not I(0), then its first difference is calculated and its stationary is checked. In this case, if the variable is stationary, then it is considered I(1). A variable sometimes changes because of probability distribution. In that case, the variable becomes trend-stationary. One can refer to modern econometric books regarding the stationary of changes and its effect in time series analysis (Hill et al., 2001; Heij et al., 2005; Asteriou and Hall, 2007). We can analyze them by applying three different unit root tests in order to get more reliable stationary test results: Augmented Dickey Fuller, Phillips–Perron (PP) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS). The evaluation of these tests is done through E-Views 9. It must be noted that “unit root problem” or “variable is non-stationary” null hypothesis in unit root tests is checked. In KPSS test, “variable is stationary” hypothesis is taken and considered as stationary null hypothesis. If the variable is non-stationary without trend, and becomes stationary if trend is included, then the checked variable is considered “trend-stationary”.

4.3. Test Cointegration

Cointegration test proves long-term relations and F–statistics is indicated to express it. Menatime, cointegration was identified by ECM model. In these models, GDP is dependent variable while electric energy consumption is an independent variable.

\[
\Delta N_t = \alpha + \delta \Delta N_{t-1} + \theta \Delta M_{t-1} + \sum_{i=1}^{m-1} \phi_i \Delta N_{t-i} + \sum_{i=0}^{m-1} \rho_i \Delta M_{t-i} + \epsilon_i
\]

(1)

Null hypothesis: H0: \( \delta = q_i = 0 \), No cointegration.

Alternative hypothesis: H0: \( \delta \neq q_i \neq 0 \), Cointegration exists.

Table 4: VAR lag order selection criteria

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|-----|------|----|-----|-----|----|----|
| lcedpm | 0 | −18.98 | NA | 0.02 | 1.90 | 2.007 | 1.93 |
| lcedi | 1 | 38.52 | 99.32* | 0.0002* | −2.96* | −2.65* | −2.88* |
| lcgdp | 0 | −19.53 | NA | 0.02 | 1.96 | 2.06 | 1.98 |
| lce | 1 | 29.13 | 84.05* | 0.0004* | −2.10* | −1.81* | −2.03* |
| lcepgdp | 0 | −31.82 | NA | 0.07 | 3.07 | 3.17 | 3.09 |
| lcepec | 1 | 3.97 | 61.83* | 0.004* | 0.18* | 0.48* | 0.25* |
| lcgdp | 0 | −49.32 | NA | 0.36 | 4.67 | 4.77 | 4.69 |
| lcedi | 1 | −6.49 | 73.99* | 0.01* | 1.13* | 1.43* | 1.22* |
| lmgdp | 0 | −28.63 | NA | 0.06 | 2.77 | 2.88 | 2.81 |
| lmcms | 1 | 12.61 | 71.23* | 0.002* | −0.60* | −0.31* | −0.53* |
| lcgdp | 0 | −53.06 | NA | 0.5 | 5.01 | 5.11 | 5.03 |
| lce | 1 | −6.957 | 79.65* | 0.01* | 1.18* | 1.47* | 1.25* |
| lahfgdp | 0 | −31.80 | NA | 0.07 | 3.07 | 3.17 | 3.09 |
| lboni | 1 | 34.76 | 114.96* | 0.0002* | −2.61* | −2.32* | −2.55* |
| lntgdp | 0 | −13.16 | NA | 0.01 | 1.38 | 1.48 | 1.40 |
| lectwii | 1 | 30.63 | 75.62* | 0.0003* | −2.23* | −1.94* | −2.16* |
| lccpsgdp | 0 | −43.31 | NA | 0.22 | 4.11 | 4.22 | 4.10 |
| leccpsi | 1 | 4.43 | 82.467* | 0.003* | 0.15* | 0.44* | 0.21* |
| lpc | 0 | −32.67 | NA | 0.08 | 3.15 | 3.25 | 3.18 |
| lcz | 1 | 41.22 | 127.62* | 0.0001* | −3.20* | −2.90* | −3.13* |

*Indicates lag order selected by the criterion. LR: Sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Haman-quinn information criterion.

Table 5: Results from bound tests

| Dependent variable | AIC lags | F–statistic | Decision | 1 (0) Bound | Significance | 1 (1) Bound |
|-------------------|----------|-------------|----------|-------------|-------------|-------------|
| lcedpm | 5.30 | 1 | 4.04 | 4.94 | 5.77 | 6.84 | 4.78 | 5.73 | 6.68 | 7.84 | Cointegration |
| lcgdp | 9.65 | 1 | 4.04 | 4.94 | 5.77 | 6.84 | 4.78 | 5.73 | 6.68 | 7.84 | Cointegration |
| lcepgdp | 29.39 | 1 | 4.04 | 4.94 | 5.77 | 6.84 | 4.78 | 5.73 | 6.68 | 7.84 | Cointegration |
| lce | 3.02 | 1 | 4.04 | 4.94 | 5.77 | 6.84 | 4.78 | 5.73 | 6.68 | 7.84 | No cointegration |
| lmgdp | 1.37 | 1 | 4.04 | 4.94 | 5.77 | 6.84 | 4.78 | 5.73 | 6.68 | 7.84 | No cointegration |
| lcgdp | 8.37 | 1 | 4.04 | 4.94 | 5.77 | 6.84 | 4.78 | 5.73 | 6.68 | 7.84 | Cointegration |
| lahfgdp | 6.15 | 1 | 4.04 | 4.94 | 5.77 | 6.84 | 4.78 | 5.73 | 6.68 | 7.84 | Cointegration |
| llntgdp | 1.57 | 1 | 4.04 | 4.94 | 5.77 | 6.84 | 4.78 | 5.73 | 6.68 | 7.84 | No cointegration |
| lccpsgdp | 37.17 | 1 | 4.04 | 4.94 | 5.77 | 6.84 | 4.78 | 5.73 | 6.68 | 7.84 | Cointegration |
| lpc | 7.77 | 1 | 4.04 | 4.94 | 5.77 | 6.84 | 4.78 | 5.73 | 6.68 | 7.84 | Cointegration |
\[ I_n = \alpha + \sum_{i=1}^{n} \varphi_i \Delta I_{n-i} + \sum_{i=0}^{m-1} \rho_i \Delta M_{n-i} + \mu_i \]  

The Long Run Model

\[ \Delta I_n = \alpha + \sum_{i=1}^{n} \varphi_i \Delta I_{n-i} + \sum_{i=0}^{m-1} \rho_i \Delta M_{n-i} + \sigma \Delta C_{n-i} + \omega_i \]  

Error Correction (short run) Model

4.4. Diagnostic Test

This article will use Breusch Godfrey LM test (null hypothesis: “no heteroskedasticity problem”) and Ramsey RESET Test and Normality Test (Jarque–Bera) in order to check subsequent correlation problem and use both Breusch–Pagan–Godfrey (null hypothesis: “no serial correlation”) and Ramsey RESET Test for heteroskedasticity problem. During ARCH test, null hypothesis rejection is acceptable for every five cases.

Statistical data encompasses 1995-2017. Data have been taken from Statistics Committee of the Republic of Azerbaijan.

5. RESULTS AND DISCUSSIONS

5.1. Unit Root Test

Let’s have a look at stationary of variables before identifying methods for evaluation. All stationary test results of variables for evaluation of both problems were given in the table. Each variable has been checked through three different unit root tests. The table shows that the majority of variables are I(1).

Thus, according to ADF test, in With Intercept only case, ECI, ECMII, ECAHF and PI are stationary. In PP Unit Root Test, in No Intercept case, ECMII and ECII are stationary (I(0)). Out of the variables GDPD and PI are stationary again. The rest of the variables are stationary (I(1)). The rest of the variables are stationary I(1). In With Intercept & Trend case ECI and ECII (0) GDPM, GDPD, EPEGDP and PI (I2) are stationary. The rest of the variables are stationary I(1). In No Intercept & No Trend case, PI (I2) is stationary again. The rest of the variables are stationary I(1) (A.Table 1).

In PP Unit Root Test, in With Intercept only case, ECII, ECAHFI I(0) GDPD and PI (I2) are stationary. The rest of the variables are stationary I(1). In With Intercept & Trend case, ECMII and IECC I(0) GDPM, GDPD, ECCPSI and PI I(2) are stationary.

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Table 7a: Error correction (short run) model coefficients

| Variable                      | Model 7            | Coefficient | Model 8            | Coefficient | Model 9            | Coefficient | Model 10           | Coefficient |
|-------------------------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|
| $\Delta \text{lecahfgdp}_{(t-1)}$ | 0.003              |             | $\Delta \text{lectwtgdp}_{(t-1)}$ | 0.1         | $\Delta \text{leccpsgdp}_{(t-1)}$ | 0.22        | $\Delta \text{lopgpi}_{(t-1)}$ | 0.45        |
| $\Delta \text{lecpsi}_{(t-1)}$  | 0.15               |             | $\Delta \text{ect}_{(t-1)}$ | -0.18       | $\Delta \text{ect}_{(t-1)}$ | -0.04       | $\Delta \text{ect}_{(t-1)}$ | -0.15       |
| $\Delta \text{lcpsgdp}_{(t-1)}$ |                    |             | $\Delta \text{lectwti}_{(t-1)}$ | -0.01       | $\Delta \text{ect}_{(t-1)}$ | -0.06       | $\Delta \text{ect}_{(t-1)}$ | -0.06       |
| $\Delta \text{lectwti}_{(t-1)}$ |                    |             |                    |             | $\Delta \text{ect}_{(t-1)}$ |             |                    |             |
| Constant                      | 0.09*              | 0.13        | 0.12*              | 0.08*       |                    |             |                    |             |

The rest of the variables are stationary I(1). In No Intercept & No Trend case only PI I(2) is stationary. The rest of the variables are stationary I(1) (A. Table 2).

According to Kwiatkowski–Phillips–Schmidt–Shin test statistics most of the variables are I(0).

All these results are available for next assessment and methods. Reliant on the enumerated test results, variable are accepted as I(1) (A. Table 3). It means that all above-mentioned methods are applicable. As mentioned above, during application process of ARDL cointegration method, one of the important issues while establishing a model is to identify optimum lag length. At this time, the most important factor is to eliminate the subsequent correlation problem in selected optimum model and keep the minimum of SBC information criteria value.

5.2. VAR Lag Order Selection Criteria

In order to determine optimal lag for ARDL model, VAR Lag Order Selection Criteria was employed and we got the below-mentioned results (Table 4).

Table 5 illustrates whether cointegration relations between variables exist or not. Thus, there are cointegration relations among electric energy consumption per year (ECI) and GDP in manat (GDPM) and in dollar (GDPD), electric energy consumption of electric energy production entities (EPEITEC) and their GDP (EPEDGDP), electric energy consumption in construction (IECC) and its GDP (CGDP), electric energy consumption in agriculture, hunting and forestry (ECAHFI) and their GDP (AHFGDP), electric energy consumption in industry (ECMII) and its GDP (MIGD), electric energy consumption in mining (ECII) and its GDP (CGDPM), and electric energy consumption in telecommunication, transport and warehouse (ECTWTI) and their GDP (TWTGDP). According to the table, electric energy consumption causes the increase of GDP (Table 6). Having a closer look at the table:

5.3. Error Correction (Short Run) Model

In general, there are valuable from economic standpoint. Except the equations refer to relations among the energy consumption in industry (ECII) and GDP and the energy consumption in transport, warehouse and telecommunication (ECTWTI) and their GDP. The main reason for this is other factors that play key roles in the augmentation of GDP.

Referring to A. Tables 4 and 5, we can mention that coefficients are 5% I(1) and 0.1% I(2) significant.

5.3. Error Correction (Short Run) Model

This table reveals the results of short-term and ECM model. The results are in the following: There is a positive relation between GDP and electric energy consumption in all models. GDPD coefficient is significant at the level of 1% in correlation model between GDPD and total electric energy consumption (ECI). (model 1). Besides,
Table 8: Diagnostic test results (LM version)

| Variable | Ramsey RESET Test (F–Statistic) | Normality Test (Jarque–Bera) JB | Heteroskedasticity Test: ARCH χ² | Heteroskedasticity Test: Breusch–Pagan–Godfrey | Breusch–Godfrey Serial Correlation LM Test |
|----------|---------------------------------|---------------------------------|---------------------------------|-----------------------------------------------|------------------------------------------|
| lgdpm    | F (1,4) 0.31                    | N/A                             | F (1,14) 0.006                  | F (11,5) 0.82                                  | F (2,3) 1.25                             |
|          | 0.61                            | N/A                             | 0.95                            | 0.63                                           | 0.40                                     |
| lgdpd    | F (1,6) 1.33                    | N/A                             | F (1,15) 0.77                   | F (10,7) 4.87                                  | F (2,5) 6.29                             |
|          | 0.29                            | N/A                             | 0.40                            | 0.02                                           | 0.04                                     |
| lepegdp  | F (1, 2) 0.52                   | N/A                             | F (1,14) 0.001                  | F (13,3) 1.10                                  | F (2,1) 1.18                             |
|          | 0.55                            | N/A                             | 0.97                            | 0.53                                           | 0.55                                     |
| ligdp    | F (1, 3) 7.60                   | N/A                             | F (1,14) 0.29                   | F (12,4) 0.14                                  | F (2,2) 0.67                             |
|          | 0.07                            | N/A                             | 0.60                            | 0.99                                           | 0.59                                     |
| limigdp  | F (1, 4) 1.77                   | N/A                             | F (1,14) 0.26                   | F (11,5) 0.71                                  | F (2,3) 2.82                             |
|          | 0.25                            | N/A                             | 0.61                            | 0.69                                           | 0.20                                     |
| lcgdp    | F (1, 2) 0.18                   | N/A                             | F (1,14) 2.57                   | F (13,3) 1.25                                  | F (2,1) 8.92                             |
|          | 0.71                            | N/A                             | 0.13                            | 0.48                                           | 0.2303                                  |
| lahfgdp  | F (1, 6) 0.03                   | N/A                             | F (1,14) 2.71                   | F (9,7) 3.23                                   | F (2,5) 1.18                             |
|          | 0.85                            | N/A                             | 0.12                            | 0.06                                           | 0.38                                     |
| ltvtdp   | F (1, 4) 2.97                   | N/A                             | F (1,14) 0.0006                 | F (11,5) 0.31                                  | F (2,3) 1.81                             |
|          | 0.16                            | N/A                             | 0.9770                          | 0.95                                           | 0.31                                     |
| lcpsgd  | F (1, 2) 8.31                   | N/A                             | F (1,14) 0.40                   | F (13,3) 0.24                                  | F (2,1) 0.42                             |
|          | 0.10                            | N/A                             | 0.53                            | 0.97                                           | 0.71                                     |
| lpi      | F (1, 15) 1.77                  | N/A                             | F (1,18) 1.41                   | F (12,4) 0.77                                  | F (2,14) 1.05                             |
|          | 0.20                            | N/A                             | 0.25                            | 0.69                                           | 0.38                                     |

Legend: N/A—Not Applicable

(EPEGDPD) coefficient is significant at the level of 5% in the model between energy consumption in electric energy producing entities (EPEITEC) and their GDP (model 3). On the other hand, ect coefficient is negative (−) for all. According to the models, velocity to balance in a long term is 4% (model 1), 6% (model 2), 3% (model 3), 3% (model4), 8% (model 5), 16% (model 6), 3% (model 7), 2% (model 8), 4% (model 9), 9% (model 10) (Tables 7 and 7a). Although ect coefficients are insignificance in these models, their negativity substantiates the existence of cointegration relations proposed by Paseran and others (2001). Having positive relation in these models shows the role of electric energy and its consumption in the increase of GDP for new economic growth.

Some models for ARDL models (model 1-3 and 6) are 5% 1% and 0.1% significant. Regression equations are adequate. It also passes all the diagnostic tests against serial correlation (Durbin Watson test and Breusch-Godfrey test), heteroscedasticity (White Heteroskedasticity Test), and normality of errors (Jarque-Bera test). The Ramsey RESET test also suggests that the model is well specified. All the results of these tests are shown in Table 8 and 8a. The stability of the long-run coefficient is tested by the short-run dynamics. Once the ECM model given by equations (Table 7 and 7a) has been estimated, the cumulative sum of recursive residuals (CUSUM) and the CUSUM of square (CUSUMSQ) tests are applied to assess the parameter stability (Pesaran and Pesaran (1997). A.Figure 2 plot the results for CUSUM and CUSUMSQ tests. The results indicate the absence of any instability of the coefficients because the plot of the CUSUM and CUSUMSQ statistic fall inside the critical bands of the 5% confidence interval of parameter stability However, non-stability in model 2 and model 3 was observed (A.Figure 2).
6. CONCLUSION

Energy and especially electricity is one of the main factors of the development of society. From this perspective, energy and electricity consumption is essential in Azerbaijan too. We have achieved some results from the research that electricity consumption plays an important role in economic growth. Electricity is also important as an economic resource. Although the relationship between electricity consumption and GDP growth is not strong, we can mention the following: there is a positive dependency between total electricity consumption and GDP in manat and dollar, as well as electricity consumption in electricity producing entities such as mining, construction, agriculture, hunting and forestry, commercial and public service and others and GDP in those sectors. Conversely, there is a negative dependency between electricity consumption in industry, transportation, warehouse and telecommunication and GDP. On the contrary, the opposite dependency was observed between electricity consumption of population and people’s income. The positive income was also observed between electricity consumption and GDP according to ECM model results in a short term. Having a positive relationship in models shows that electricity consumption plays an important role in GDP growth.

So, the analysis has revealed that there is a weak relationships between either the electricity consumption and GDP in the Republic or in different sectors of economy. From this perspective, we recommend not to waste electricity consumption.

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### APPENDIX

#### A. Table 1: ADF unit root test

| Model                  | Variable | ADF–Stat  | Levels of critical values | Lag | P-value | Stationarity | Integrir I (0,1,2) |
|------------------------|----------|-----------|---------------------------|-----|---------|--------------|--------------------|
|                        |          |           |                           |     |         |              |                    |
| With intercept only    |          |           |                           |     |         |              |                    |
|                        | lect     | −3.01     | −3.80                     | −3.02 | −2.65  | 2  | 0.0507     | S       | I (0)              |
|                        | lepeitec | −1.35     | −3.77                     | −3.00 | −2.64  | 0  | 0.5881     | N/S     | I (1)              |
|                        | lectii   | −2.83*    | −3.77                     | −3.00 | −2.64  | 0  | 0.0694     | S       | I (0)              |
|                        | lecmii   | −1.71     | −3.77                     | −3.00 | −2.64  | 0  | 0.4112     | N/S     | I (1)              |
|                        | lecc     | −0.92     | −3.77                     | −3.00 | −2.64  | 0  | 0.7596     | N/S     | I (1)              |
|                        | lecahi  | −2.76*    | −3.77                     | −3.00 | −2.64  | 0  | 0.0797     | S       | I (0)              |
|                        | lectwti | −1.12     | −3.77                     | −3.00 | −2.64  | 0  | 0.6849     | N/S     | I (1)              |
|                        | leccpsi  | −2.30     | −3.77                     | −3.00 | −2.64  | 0  | 0.1798     | N/S     | I (1)              |
|                        | lecp    | −0.83     | −3.77                     | −3.01 | −2.65  | 1  | 0.7874     | N/S     | I (1)              |
|                        | lgdpm    | −0.88     | −3.77                     | −3.01 | −2.65  | 1  | 0.7739     | N/S     | I (1)              |
|                        | lgdpd    | −1.26     | −3.77                     | −3.01 | −2.65  | 1  | 0.6243     | N/S     | I (2)              |
|                        | lepepgdp | −0.37    | −3.77                     | −3.00 | −2.64  | 0  | 0.8983     | N/S     | I (1)              |
|                        | lkgdp   | −1.62     | −3.77                     | −3.00 | −2.64  | 0  | 0.4557     | N/S     | I (1)              |
|                        | lmgdgp  | −1.99     | −3.77                     | −3.00 | −2.64  | 0  | 0.2876     | N/S     | I (1)              |
|                        | lcgp    | −2.39     | −3.77                     | −3.00 | −2.64  | 0  | 0.1547     | N/S     | I (1)              |
|                        | lthlgdgp | −0.13    | −3.77                     | −3.00 | −2.64  | 0  | 0.9334     | N/S     | I (1)              |
|                        | lstwgpdp | −0.01    | −3.77                     | −3.00 | −2.64  | 0  | 0.9502     | N/S     | I (1)              |
|                        | lcpxgpdp | −0.81    | −3.77                     | −3.00 | −2.64  | 0  | 0.7961     | N/S     | I (1)              |
|                        | lpi     | −0.83     | −3.77                     | −3.01 | −2.65  | 1  | 0.7874     | N/S     | I (1)              |
| With intercept only    |          |           |                           |     |         |              |                    |
|                        |          |           |                           |     |         |              |                    |
|                        |          |           |                           |     |         |              |                    |
| At level form          |          |           |                           |     |         |              |                    |
|                        |          |           |                           |     |         |              |                    |
| With intercept only    |          |           |                           |     |         |              |                    |
|                        |          |           |                           |     |         |              |                    |
| At first differencing  |          |           |                           |     |         |              |                    |
|                        |          |           |                           |     |         |              |                    |
| With intercept and trend|        |           |                           |     |         |              |                    |
|                        |          |           |                           |     |         |              |                    |
| At level form          |          |           |                           |     |         |              |                    |

(Contd...)
A. Table 1: (Continued)

| Model | Variable | ADF–Stat | Levels of critical values | Lag | p-value | Stationarity | Integrir I (0,1,2) |
|-------|----------|----------|---------------------------|-----|---------|--------------|-------------------|
|       |          |          | 1% | 5% | 10% | At first differencing | At level form |
| With intercept and trend | dlec | −3.76** | −4.47 | −3.65 | −3.26 | 0 | 0.0397 | S | I (0) |
|       | dlepitec | −4.01** | −4.47 | −3.65 | −3.26 | 0 | 0.0251 | S | I (0) |
|       | dlecii | −3.71** | −4.57 | −3.69 | −3.29 | 3 | 0.0477 | S | I (0) |
|       | dlecmmi | −4.77*** | −4.47 | −3.65 | −3.26 | 0 | 0.0054 | S | I (0) |
|       | dlecct | −5.35*** | −4.47 | −3.65 | −3.26 | 0 | 0.0017 | S | I (0) |
|       | dlecafhf | −4.72*** | −4.47 | −3.65 | −3.26 | 0 | 0.0060 | S | I (0) |
|       | dlecvti | −6.45*** | −4.47 | −3.65 | −3.26 | 0 | 0.0002 | S | I (0) |
|       | dleccpsi | −4.87*** | −4.47 | −3.65 | −3.26 | 0 | 0.0044 | S | I (0) |
|       | dlpi | −3.42* | −4.47 | −3.65 | −3.26 | 0 | 0.0753 | S | I (0) |
|       | dlgdp | −2.77 | −4.47 | −3.65 | −3.26 | 0 | 0.2166 | N/S | I (1) |
|       | dlgdpmd | −5.30*** | −4.49 | −3.65 | −3.26 | 0 | 0.0020 | S | I (0) |
|       | dlgdpd | −2.36 | −4.47 | −3.65 | −3.26 | 2 | 0.3853 | N/S | I (1) |
|       | dlepgdp | −3.85** | −4.53 | −3.67 | −3.29 | 1 | 0.0359 | S | I (0) |
|       | dlepgdp | −3.09 | −4.47 | −3.65 | −3.26 | 0 | 0.1331 | N/S | I (1) |
|       | dlcc | −5.48*** | −4.53 | −3.67 | −3.29 | 1 | 0.016 | S | I (0) |
|       | dlecc | −3.16 | −4.47 | −3.65 | −3.26 | 0 | 0.1185 | N/S | I (1) |
|       | dlmgdp | −5.22*** | −4.49 | −3.65 | −3.26 | 0 | 0.0024 | S | I (0) |
|       | dlmcd | −3.60** | −4.47 | −3.65 | −3.26 | 0 | 0.0543 | S | I (0) |
|       | dlcd | −4.61*** | −4.47 | −3.65 | −3.26 | 0 | 0.0075 | S | I (0) |
|       | dlhfgdp | −3.99** | −4.47 | −3.65 | −3.26 | 0 | 0.0258 | S | I (0) |
|       | dlwtdgdp | −4.65*** | −4.47 | −3.65 | −3.26 | 0 | 0.0068 | S | I (0) |
|       | dlcpsgdp | −3.32* | −4.47 | −3.65 | −3.26 | 0 | 0.0905 | S | I (0) |
|       | dlpi | −2.23 | −4.47 | −3.65 | −3.26 | 0 | 0.4457 | N/S | I (1) |
|       | ddlpi | −4.61*** | −4.53 | −3.67 | −3.29 | 1 | 0.0085 | S | I (0) |

No Intercept & No Trend

| Variable | ADF–Stat | At first differencing | At level form | At First differencing |
|----------|----------|-----------------------|---------------|-----------------------|
| leci     | 0.77     | −2.67 | −1.96 | −1.61 | 0 | 0.8758 | N/S | I (1) |
| lepeitec | 0.71     | −2.67 | −1.96 | −1.61 | 0 | 0.8665 | N/S | I (1) |
| lecii    | −0.06    | −2.67 | −1.96 | −1.61 | 0 | 0.6517 | N/S | I (1) |
| lecmii   | 0.77     | −2.67 | −1.96 | −1.61 | 0 | 0.8697 | N/S | I (1) |
| leecc    | 0.36     | −2.67 | −1.96 | −1.61 | 0 | 0.7814 | N/S | I (1) |
| lecahv   | −1.22    | −2.67 | −1.96 | −1.61 | 0 | 0.1954 | N/S | I (1) |
| lectwii  | −1.61    | −2.67 | −1.96 | −1.61 | 1 | 0.1004 | N/S | I (1) |
| leccpsi  | 0.12     | −2.67 | −1.96 | −1.61 | 0 | 0.7115 | N/S | I (1) |
| lepci    | 0.65     | −2.67 | −1.96 | −1.61 | 0 | 0.8499 | N/S | I (1) |
| lgdp     | 1.77     | −2.67 | −1.96 | −1.61 | 1 | 0.9775 | N/S | I (1) |
| lgdpm    | 0.77     | −2.67 | −1.96 | −1.61 | 1 | 0.8765 | N/S | I (1) |
| lepgdp   | 1.19     | −2.67 | −1.96 | −1.61 | 0 | 0.9350 | N/S | I (1) |
| ldgdp    | 1.47     | −2.67 | −1.96 | −1.61 | 1 | 0.9597 | N/S | I (1) |
| lmgdp    | 1.45     | −2.67 | −1.96 | −1.61 | 1 | 0.9578 | N/S | I (1) |
| lcmgdp   | 2.62     | −2.67 | −1.96 | −1.61 | 0 | 0.9965 | N/S | I (1) |
| lthfgdp  | 4.41     | −2.67 | −1.96 | −1.61 | 0 | 1.0000 | N/S | I (1) |
| ltwtdgdp | 3.69     | −2.67 | −1.96 | −1.61 | 0 | 0.9997 | N/S | I (1) |
| lcpsgdp  | 4.69     | −2.67 | −1.96 | −1.61 | 0 | 1.0000 | N/S | I (1) |
| lpsi     | 1.80     | −2.67 | −1.96 | −1.61 | 1 | 0.9789 | N/S | I (2) |

(Contd...)
A. Table 1: (Continued)

| Model                  | Variable | ADF–Stat | Levels of critical values | Lag | p-value | Stationarity | Integrir I (0,1,2) |
|------------------------|----------|----------|---------------------------|-----|---------|--------------|-------------------|
| No Intercept & No Trend| dlwtdgdp | -2.69*** | -2.67 -1.96 -1.61         | 0   | 0.0099  | S            | I (0)             |
|                        | dlcpsgdp | -2.15**  | -2.67 -1.96 -1.61         | 0   | 0.0330  | S            | I (0)             |
|                        | dlpi     | -1.15    | -2.67 -1.96 -1.61         | 0   | 0.2192  | N/S          | I (1)             |
|                        | ddipi    | -4.67*** | -2.69 -1.95 -1.60         | 0   | 0.0001  | S            | I (0)             |

ADF denotes the Augmented Dickey–Fuller single root system respectively. The maximum lag order is 3. The optimum lag order is selected based on the Shwarz criterion automatically; ***, ** and * indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels respectively. The critical values are taken from MacKinnon (Mackinnon, 1996).

A. Table 2: PP unit root test

| Model                  | Variable | PP–test | Levels of critical values | Bandwidth | P-value | Stationarity | Integrir I (0,1,2) |
|------------------------|----------|---------|---------------------------|-----------|---------|--------------|-------------------|
| With Intercept only    | leci     | -1.60   | -3.77 -3.01 -2.64         | 2         | 0.4646  | N/S          | I (1)             |
|                        | lepetec  | -1.31   | -3.77 -3.01 -2.64         | 0         | 0.5881  | N/S          | I (1)             |
|                        | lecii    | -2.84*  | -3.77 -3.01 -2.64         | 1         | 0.0689  | S            | I (0)             |
|                        | lecmii   | -1.71   | -3.77 -3.01 -2.64         | 0         | 0.4112  | N/S          | I (1)             |
|                        | lecc     | -0.92   | -3.77 -3.01 -2.64         | 1         | 0.7622  | N/S          | I (1)             |
|                        | lecafh   | -2.69*  | -3.77 -3.01 -2.64         | 1         | 0.0900  | S            | I (0)             |
|                        | lectwtt  | -0.83   | -3.77 -3.01 -2.64         | 1         | 0.7896  | N/S          | I (1)             |
|                        | leccpsi  | -1.41   | -3.77 -3.01 -2.64         | 2         | 0.5596  | N/S          | I (1)             |
|                        | leccpi   | -2.33   | -3.77 -3.01 -2.64         | 2         | 0.1705  | N/S          | I (1)             |
|                        | lgdpdm   | -1.18   | -3.77 -3.01 -2.64         | 2         | 0.6598  | N/S          | I (1)             |
|                        | lgdpm    | -1.56   | -3.77 -3.01 -2.64         | 2         | 0.4836  | N/S          | I (1)             |
|                        | lepegdgp | -0.37   | -3.77 -3.01 -2.64         | 0         | 0.8983  | N/S          | I (1)             |
|                        | lgdgp    | -1.62   | -3.77 -3.01 -2.64         | 0         | 0.4557  | N/S          | I (1)             |
|                        | lmigdp   | -1.89   | -3.77 -3.01 -2.64         | 1         | 0.3265  | N/S          | I (1)             |
|                        | lgcdp    | -2.21   | -3.77 -3.01 -2.64         | 1         | 0.2095  | N/S          | I (1)             |
|                        | Lahfgdp  | -0.17   | -3.77 -3.01 -2.64         | 1         | 0.9290  | N/S          | I (1)             |
|                        | ltwtdgdp | -0.02   | -3.77 -3.01 -2.64         | 1         | 0.9465  | N/S          | I (1)             |
|                        | lctpsgd  | -0.81   | -3.77 -3.01 -2.64         | 0         | 0.7961  | N/S          | I (1)             |
|                        | lpi      | -0.11   | -3.77 -3.01 -2.64         | 2         | 0.9356  | N/S          | I (2)             |

With Intercept only At First differencing

| Model                  | Variable | PP–test | Levels of critical values | Bandwidth | P-value | Stationarity | Integrir I (0,1,2) |
|------------------------|----------|---------|---------------------------|-----------|---------|--------------|-------------------|
|                        | dlec     | -3.92***| -3.78 -3.01 -2.65         | 2         | 0.0073  | S            | I (0)             |
|                        | dlepetic | -4.12***| -3.78 -3.01 -2.65         | 1         | 0.0048  | S            | I (0)             |
|                        | dlecii   | -6.71***| -3.78 -3.01 -2.65         | 1         | 0.0000  | S            | I (0)             |
|                        | dlecnn   | -4.99***| -3.78 -3.01 -2.65         | 3         | 0.0007  | S            | I (0)             |
|                        | dlcc     | -5.01***| -3.78 -3.01 -2.65         | 2         | 0.0007  | S            | I (0)             |
|                        | dlecabf  | -3.65** | -3.78 -3.01 -2.65         | 1         | 0.0136  | S            | I (0)             |
|                        | dlectwtt | -6.61***| -3.78 -3.01 -2.65         | 0         | 0.0000  | S            | I (0)             |
|                        | dleccpsi | -5.78***| -3.78 -3.01 -2.65         | 7         | 0.0001  | S            | I (0)             |
|                        | dlecpi   | -3.29***| -3.78 -3.01 -2.65         | 2         | 0.0293  | S            | I (0)             |
|                        | dlgdpm   | -2.78*  | -3.78 -3.01 -2.65         | 2         | 0.0771  | S            | I (0)             |
|                        | dldgd   | -2.30   | -3.78 -3.01 -2.65         | 1         | 0.1798  | N/S          | I (1)             |
|                        | dldlgd   | -4.17***| -3.80 -3.02 -2.65         | 8         | 0.0047  | S            | I (0)             |
|                        | dlepegd  | -3.18** | -3.78 -3.01 -2.65         | 2         | 0.0358  | S            | I (0)             |
|                        | dldgp    | -3.09** | -3.78 -3.01 -2.65         | 1         | 0.0422  | S            | I (0)             |
|                        | dlimdgp  | -3.41** | -3.78 -3.01 -2.65         | 1         | 0.0223  | S            | I (0)             |
|                        | dlcdgp   | -5.02***| -3.78 -3.01 -2.65         | 0         | 0.0007  | S            | I (0)             |
|                        | diiahgdpm| -4.02***| -3.78 -3.01 -2.65         | 0         | 0.0059  | S            | I (0)             |
|                        | dltwbgdp | -4.77***| -3.78 -3.01 -2.65         | 1         | 0.0011  | S            | I (0)             |
|                        | dlcpsgdp | -3.31** | -3.78 -3.01 -2.65         | 3         | 0.0273  | S            | I (0)             |
|                        | dlpi     | -2.36   | -3.78 -3.01 -2.65         | 2         | 0.1623  | N/S          | I (1)             |
|                        | dlipi    | -5.42***| -3.80 -3.02 -2.65         | 11        | 0.0003  | S            | I (0)             |

With Intercept & Trend At Level Form

| Model                  | Variable | PP–test | Levels of critical values | Bandwidth | P-value | Stationarity | Integrir I (0,1,2) |
|------------------------|----------|---------|---------------------------|-----------|---------|--------------|-------------------|
|                        | leci     | -2.15   | -4.44 -3.63 -3.25         | 2         | 0.4927  | N/S          | I (1)             |
|                        | lepetec  | -2.29   | -4.44 -3.63 -3.25         | 0         | 0.4217  | N/S          | I (1)             |

(Contd...)
### Table 2: (Continued)

| Model                  | Variable  | PP-test statistic | Levels of critical values | Bandwidth | p-value | Stationarity | Integrir I (0,1,2) |
|------------------------|-----------|-------------------|---------------------------|-----------|---------|--------------|---------------------|
| **With Intercept & Trend** | lcgdp     | −3.57*            | −4.44 −3.63 −3.25        | 6         | 0.0565  | S            | I(0)                |
|                        | lgdp      | −2.63             | −4.44 −3.63 −3.25        | 0         | 0.2695  | N/S          | I(1)                |
|                        | liecc     | −2.06             | −4.44 −3.63 −3.25        | 1         | 0.5402  | N/S          | I(1)                |
|                        | lecahfi   | −1.77             | −4.44 −3.63 −3.25        | 6         | 0.6807  | N/S          | I(1)                |
|                        | lectwiti  | −2.99             | −4.44 −3.63 −3.25        | 2         | 0.1579  | N/S          | I(1)                |
|                        | leccpsi   | −2.81             | −4.44 −3.63 −3.25        | 2         | 0.2077  | N/S          | I(1)                |
|                        | lecri     | −2.40             | −4.44 −3.63 −3.25        | 2         | 0.3680  | N/S          | I(1)                |
|                        | lgcpsgdp  | −0.99             | −4.44 −3.63 −3.25        | 2         | 0.9253  | N/S          | I(1)                |
|                        | lgdpsgdp  | −0.41             | −4.44 −3.63 −3.25        | 2         | 0.9803  | N/S          | I(1)                |
|                        | lepegdpsgdp | −2.12       | −4.44 −3.63 −3.25        | 1         | 0.5081  | N/S          | I(1)                |
|                        | lgdp      | −0.83             | −4.44 −3.63 −3.25        | 1         | 0.9458  | N/S          | I(1)                |
|                        | lmigdp    | −0.95             | −4.44 −3.63 −3.25        | 1         | 0.9309  | N/S          | I(1)                |
|                        | lgdp      | −3.31             | −4.44 −3.63 −3.25        | 2         | 0.0913  | S            | I(0)                |
|                        | lahfgdp   | −1.71             | −4.44 −3.63 −3.25        | 0         | 0.7014  | N/S          | I(1)                |
|                        | ltwgdp    | −2.40             | −4.44 −3.63 −3.25        | 2         | 0.3680  | N/S          | I(1)                |
|                        | lcpd      | −1.77             | −4.44 −3.63 −3.25        | 1         | 0.6712  | N/S          | I(1)                |
|                        | mpi       | −1.75             | −4.44 −3.63 −3.25        | 2         | 0.6914  | N/S          | I(2)                |
| **With Intercept & Trend** | dlpi       | −3.45**           | −4.47 −3.65 −3.26        | 2         | 0.0705  | S            | I(0)                |
|                        | dlcgdp    | −2.82             | −4.47 −3.65 −3.26        | 1         | 0.2072  | N/S          | I(1)                |
|                        | dlcgdpkm  | −6.29**           | −4.49 −3.65 −3.26        | 7         | 0.0003  | S            | I(0)                |
|                        | dlcgdp    | −2.37             | −4.47 −3.65 −3.26        | 2         | 0.3823  | N/S          | I(1)                |
|                        | dlcgdp    | −3.84**           | −4.49 −3.65 −3.26        | 9         | 0.0356  | S            | I(1)                |
|                        | dlepgdp   | −3.01             | −4.47 −3.65 −3.26        | 2         | 0.1543  | S            | I(1)                |
|                        | ddlepgdp  | −8.98***          | −4.49 −3.65 −3.26        | 19        | 0.0000  | S            | I(0)                |
|                        | dlcgdp    | −3.08             | −4.47 −3.65 −3.26        | 3         | 0.1370  | N/S          | I(1)                |
|                        | dlnigdp   | −7.92**           | −4.47 −3.65 −3.26        | 10        | 0.0000  | S            | I(0)                |
|                        | dlmigdp   | −3.45*            | −4.47 −3.65 −3.26        | 3         | 0.0706  | S            | I(0)                |
|                        | dlcgdp    | −4.61**           | −4.47 −3.65 −3.26        | 0         | 0.0075  | S            | I(0)                |
|                        | dlahfgdp  | −3.99**           | −4.47 −3.65 −3.26        | 0         | 0.0258  | S            | I(0)                |
|                        | dlwlgdpgp | −4.63***          | −4.47 −3.65 −3.26        | 1         | 0.0071  | S            | I(0)                |
|                        | dlcpsgdp  | −3.25             | −4.47 −3.65 −3.26        | 2         | 0.1017  | N/S          | I(1)                |
|                        | dlcpsgdp  | −6.46**           | −4.49 −3.65 −3.26        | 17        | 0.0000  | S            | I(0)                |
|                        | ddpi      | −2.22             | −4.47 −3.65 −3.26        | 2         | 0.4540  | N/S          | I(1)                |
|                        | ddpi      | −7.34             | −4.49 −3.65 −3.26        | 16        | 0.0000  | S            | I(0)                |

| **No Intercept & No Trend** | lcei       | 0.69               | −2.67 −1.96 −1.61        | 2         | 0.8575  | N/S          | I(1)                |
|                           | lepeitec   | 0.71               | −2.67 −1.96 −1.61        | 1         | 0.8624  | N/S          | I(1)                |
|                           | leci       | 0.11               | −2.67 −1.96 −1.61        | 13        | 0.7087  | N/S          | I(1)                |
|                           | lecmii     | 1.22               | −2.67 −1.96 −1.61        | 4         | 0.9381  | N/S          | I(1)                |
|                           | liecc      | 0.39               | −2.67 −1.96 −1.61        | 1         | 0.7903  | N/S          | I(1)                |
|                           | lecahfi    | −1.06              | −2.67 −1.96 −1.61        | 2         | 0.2505  | N/S          | I(1)                |
|                           | lectwiti   | −1.18              | −2.67 −1.96 −1.61        | 1         | 0.2069  | N/S          | I(1)                |
|                           | leccpsi    | 0.25               | −2.67 −1.96 −1.61        | 7         | 0.7484  | N/S          | I(1)                |
|                           | lecri      | 0.49               | −2.67 −1.96 −1.61        | 2         | 0.8138  | N/S          | I(1)                |
|                           | lgdp       | 3.63               | −2.67 −1.96 −1.61        | 2         | 0.9997  | N/S          | I(1)                |
|                           | lgdpsgdp   | 1.77               | −2.67 −1.96 −1.61        | 2         | 0.9774  | N/S          | I(1)                |
|                           | lecgdpsgdp | 1.18               | −2.67 −1.96 −1.61        | 0         | 0.9355  | N/S          | I(1)                |
|                           | lgdp       | 2.38               | −2.67 −1.96 −1.61        | 2         | 0.9938  | N/S          | I(1)                |
|                           | ltwlgdpsgdp | 2.31           | −2.67 −1.96 −1.61        | 1         | 0.9928  | N/S          | I(1)                |
|                           | lgdp       | 2.29               | −2.67 −1.96 −1.61        | 1         | 0.9926  | N/S          | I(1)                |
|                           | lahfgdpsgdp | 4.17           | −2.67 −1.96 −1.61        | 1         | 0.9999  | N/S          | I(1)                |

(Contd...)
A. Table 2: (Continued)

| Model | Variable | PP–test statistic | Levels of critical values | Bandwidth | p-value | Stationarity | Integrir I (0,1,2) |
|-------|----------|-------------------|---------------------------|-----------|---------|-------------|------------------|
|       |          |                   | 1% | 5% | 10% | At level form |                   |                   |
| No Intercept & No Trend | lwtgdp | 3.48 | −2.67 | −1.96 | −1.61 | 1 | 0.9995 | N/S | I (1) |
|       | lcppsd | 4.66 | −2.67 | −1.96 | −1.61 | 0 | 1.0000 | N/S | I (1) |
|       | lpi    | 4.55 | −2.67 | −1.96 | −1.61 | 2 | 1.0000 | N/S | I (2) |

|       | At First differencing |                   |                   |           |         |             |                   |
| No Intercept & No Trend | dleci  | −3.89*** | −2.67 | −1.96 | −1.61 | 2 | 0.0005 | S | I (0) |
|       | dlepeitec | −4.11*** | −2.67 | −1.96 | −1.61 | 1 | 0.0003 | S | I (0) |
|       | dleciii | −6.88*** | −2.67 | −1.96 | −1.61 | 2 | 0.0000 | S | I (0) |
|       | dlecni | −4.86*** | −2.67 | −1.96 | −1.61 | 2 | 0.0000 | S | I (0) |
|       | dlecpc | −5.12*** | −2.67 | −1.96 | −1.61 | 2 | 0.0000 | S | I (0) |
|       | dleccahfi | −3.68*** | −2.67 | −1.96 | −1.61 | 1 | 0.0008 | S | I (0) |
|       | dlectwi | −6.18*** | −2.67 | −1.96 | −1.61 | 1 | 0.0000 | S | I (0) |
|       | dlecpsi | −5.42*** | −2.67 | −1.96 | −1.61 | 6 | 0.0000 | S | I (0) |
|       | dlecp | −3.40*** | −2.67 | −1.96 | −1.61 | 2 | 0.0017 | S | I (0) |
|       | dlgdpdm | −1.77* | −2.67 | −1.96 | −1.61 | 2 | 0.0793 | S | I (0) |
|       | dlgdp | −2.00** | −2.67 | −1.96 | −1.61 | 2 | 0.0456 | S | I (0) |
|       | dlpepgdp | −2.99*** | −2.67 | −1.96 | −1.61 | 3 | 0.0048 | S | I (0) |
|       | dltgdp | −2.33** | −2.67 | −1.96 | −1.61 | 2 | 0.0223 | S | I (0) |
|       | dltmgdp | −2.71*** | −2.67 | −1.96 | −1.61 | 1 | 0.0093 | S | I (0) |
|       | dltcgdp | −4.38*** | −2.67 | −1.96 | −1.61 | 1 | 0.0001 | S | I (0) |
|       | dltlhsd | −2.71*** | −2.67 | −1.96 | −1.61 | 1 | 0.0093 | S | I (0) |
|       | dltwagdp | −2.77*** | −2.67 | −1.96 | −1.61 | 2 | 0.0083 | S | I (0) |
|       | dltcpsgdp | −2.05** | −2.67 | −1.96 | −1.61 | 3 | 0.0408 | S | I (0) |
|       | dltpi | −1.08 | −2.67 | −1.96 | −1.61 | 6 | 0.2451 | N/S | I (1) |
|       | dltlpi | −5.65*** | −2.69 | −1.96 | −1.61 | 11 | 0.0000 | S | I (0) |

PP Phillips–Perron is single root system. The optimum lag order in PP test is selected based on the Newey–West criterion automatically; ***, ** and *indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels respectively. The critical values are taken from MacKinnon (Mackinnon, 1996). Assessment period: 1995-2017. S: Stationarity, N/S: No Stationarity

A. Table 3: KPSS unit root test

| Model | Variable | Kwiatkowski–Phillips–Schmidt–Shin test statistic | Levels of Critical Values | Bandwidth | Stationarity | Integrir I (0,1,2) |
|-------|----------|-----------------------------------------------|---------------------------|-----------|-------------|------------------|
|       |          |                                               | 1% | 5% | 10% | At level form |                   |                   |
| With Intercept only | leci | 0.38* | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |
|       | lepiete | 0.49** | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |
|       | lepi | 0.32 | 0.71 | 0.47 | 0.35 | 2 | N/S | I (0) |
|       | leccii | 0.53** | 0.71 | 0.47 | 0.35 | 2 | S | I (0) |
|       | liec | 0.47** | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |
|       | lecahfi | 0.26 | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |
|       | lectwt | 0.57** | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |
|       | leccpsi | 0.45* | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |
|       | lecp | 0.12 | 0.71 | 0.47 | 0.35 | 3 | N/S | I (0) |
|       | lgdpdm | 0.65** | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |
|       | lgdpd | 0.61** | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |
|       | lepegdp | 0.57** | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |
|       | ligdp | 0.63** | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |
|       | lmgdp | 0.63** | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |
|       | lcgdp | 0.69** | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |
|       | lalhfgdp | 0.66** | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |
|       | ltwagdp | 0.66** | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |
|       | lcpsgdp | 0.67** | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |
|       | lpi | 0.66** | 0.71 | 0.47 | 0.35 | 3 | S | I (0) |

|       | At First differencing |                   |                   |           |         |             |                   |
| With Intercept only | dleci | 0.06 | 0.71 | 0.47 | 0.35 | 2 | N/S | I (0) |
|       | dlepeitec | 0.05 | 0.71 | 0.47 | 0.35 | 1 | N/S | I (0) |
|       | dleciit | 0.35* | 0.71 | 0.47 | 0.35 | 13 | S | I (0) |
|       | dlecmii | 0.15 | 0.71 | 0.47 | 0.35 | 3 | N/S | I (0) |
|       | dliec | 0.15 | 0.71 | 0.47 | 0.35 | 1 | N/S | I (0) |

(Contd...)
| Model                  | Variable | Kwiatkowski–Phillips–Schmidt–Shin test statistic | Levels of Critical Values | Bandwidth | Stationarity | Integrir I (0,1,2) |
|-----------------------|----------|-------------------------------------------------|---------------------------|-----------|--------------|-------------------|
|                       |          | At First differencing                           | 1% | 5% | 10% |                   |                   |
| With Intercept only   | dlecahfi | 0.57                                            | 0.71 | 0.47 | 0.35 | 2 | N/S |
|                       | dlectwii | 0.11                                            | 0.71 | 0.47 | 0.35 | 1 | N/S |
|                       | dleccpsi | 0.23                                            | 0.71 | 0.47 | 0.35 | 7 | N/S |
|                       | dlecpi  | 0.31                                            | 0.71 | 0.47 | 0.35 | 2 | N/S |
|                       | dgdpdm  | 0.20                                            | 0.71 | 0.47 | 0.35 | 2 | N/S |
|                       | dgdpd  | 0.29                                            | 0.71 | 0.47 | 0.35 | 2 | N/S |
|                       | dlepegdp | 0.19                                            | 0.71 | 0.47 | 0.35 | 0 | N/S |
|                       | dligd | 0.26                                            | 0.71 | 0.47 | 0.35 | 1 | N/S |
|                       | dimigdp | 0.41                                            | 0.71 | 0.47 | 0.35 | 0 | N/S |
|                       | dlecpgdp | 0.22                                            | 0.71 | 0.47 | 0.35 | 1 | N/S |
|                       | dlecpi | 0.08                                            | 0.71 | 0.47 | 0.35 | 2 | N/S |
|                       | lgdpm  | 0.12                                            | 0.71 | 0.47 | 0.35 | 3 | N/S |
|                       | lgdpd  | 0.12                                            | 0.71 | 0.47 | 0.35 | 3 | N/S |
|                       | dleccpsi | 0.12                                            | 0.71 | 0.47 | 0.35 | 3 | N/S |
|                       | lgdp  | 0.12                                            | 0.71 | 0.47 | 0.35 | 3 | N/S |
|                       | ligd | 0.12                                            | 0.71 | 0.47 | 0.35 | 3 | N/S |
|                       | lcgd | 0.09                                            | 0.71 | 0.47 | 0.35 | 2 | N/S |
|                       | lahfgdp | 0.09                                            | 0.71 | 0.47 | 0.35 | 3 | N/S |
|                       | ltwgdp | 0.09                                            | 0.71 | 0.47 | 0.35 | 3 | N/S |
|                       | dleccpsigdp | 0.09   | 0.71 | 0.47 | 0.35 | 2 | N/S |
|                       | dlpi  | 0.09                                            | 0.71 | 0.47 | 0.35 | 2 | N/S |
| With Intercept & Trend | leci  | 0.08                                            | 0.21 | 0.15 | 0.12 | 2 | N/S |
|                       | lepeitec | 0.07                                            | 0.21 | 0.15 | 0.12 | 2 | N/S |
|                       | leci | 0.13                                            | 0.21 | 0.15 | 0.12 | 0 | N/S |
|                       | lecmii | 0.09                                            | 0.21 | 0.15 | 0.12 | 1 | N/S |
|                       | liecc | 0.47                                            | 0.21 | 0.15 | 0.12 | 3 | N/S |
|                       | lecahfi | 0.18                                            | 0.21 | 0.15 | 0.12 | 3 | N/S |
|                       | lectwii | 0.08                                            | 0.21 | 0.15 | 0.12 | 3 | N/S |
|                       | leccpsi | 0.15                                            | 0.21 | 0.15 | 0.12 | 2 | N/S |
|                       | dlecpi | 0.12                                            | 0.21 | 0.15 | 0.12 | 3 | N/S |
|                       | lgdpm  | 0.12                                            | 0.21 | 0.15 | 0.12 | 3 | N/S |
|                       | lgdpd  | 0.12                                            | 0.21 | 0.15 | 0.12 | 3 | N/S |
|                       | dleccpsi | 0.12                                            | 0.21 | 0.15 | 0.12 | 3 | N/S |
|                       | lgdp  | 0.12                                            | 0.21 | 0.15 | 0.12 | 3 | N/S |
|                       | dleccpsigdp | 0.12   | 0.21 | 0.15 | 0.12 | 3 | N/S |
|                       | dlpi  | 0.09                                            | 0.21 | 0.15 | 0.12 | 3 | N/S |

A. Table 3: (Continued)

KPSS denotes Kwiatkowski–Phillips–Schmidt–Shin (Kwiatkowski et al., 1992) single root system. The optimum lag order in KPSS test is selected based on the Newey–West criterion automatically; ***, ** and * indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels respectively. The critical values are taken from Kwiatkowski–Phillips–Schmidt–Shin. Assessment period: 1995-2017. S: Stationary, N/S: No Stationarity.
### A. Table 4: Coefficients ARDL model

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|----------|---------|---------|---------|---------|---------|---------|
| $\Delta \lg dpm$ | 0.44 | | | | | |
| $\lg dpm$ | | | | | | |
| $\Delta \l eci$ | 0.06 | | | | | |
| $\l eci$ | | | | | | |
| $\Delta \lg dpd$ | | 0.61* | | | | |
| $\lg dpd$ | | | | | | |
| $\Delta \l epegdpd$ | | | 1.80 | | | |
| $\l epegdpd$ | | | | | | |
| $\Delta \lg dpgdp$ | | | | | | |
| $\lg dpgdp$ | | | | | | |
| $\Delta \l memi$ | | | | | | |
| $\l emi$ | | | | | | |
| $\Delta \lg dpgdp$ | | | | | | |
| $\lg dpgdp$ | | | | | | |
| $\Delta \l cmi$ | | | | | | |
| $\l cmi$ | | | | | | |
| $\Delta \lg dpgdp$ | | | | | | |
| $\lg dpgdp$ | | | | | | |
| $\Delta \l cmi$ | | | | | | |
| $\l cmi$ | | | | | | |
| $\Delta \lg dpgdp$ | | | | | | |
| $\lg dpgdp$ | | | | | | |
| $\Delta \l cmi$ | | | | | | |
| $\l cmi$ | | | | | | |
| Constant | | | | | | |

### A. Table 5: Coefficients ARDL model

| Variable | Model 7 | Model 8 | Model 9 | Model 10 |
|----------|---------|---------|---------|----------|
| $\Delta \lahfgdp$ | | | | |
| $\l ahfgdp$ | | | | |
| $\Delta \lecpsi$ | | | | |
| $\l epsi$ | | | | |
| $\Delta \ltwtgdp$ | | | | |
| $\l twtgdp$ | | | | |
| $\Delta \l eccpsi$ | | | | |
| $\l eccpsi$ | | | | |
| $\Delta \l pi$ | | | | |
| $\l pi$ | | | | |
| Constant | | | | |
A. Figure 1: Dynamic
A. Figure 2: Plot of cumulative sum of recursive residuals
## A. Abbreviations

| Abbreviation | Description                                      | Unit            |
|--------------|--------------------------------------------------|-----------------|
| ECI          | Electric energy consumption, total               | million kVt.h   |
| EPEITEC      | Internal consumption of electric energy producing entities | million kVt.h   |
| ECII         | Electric energy consumption in industry          | million kVt.h   |
| ECMII        | Electric energy consumption in mining            | million kVt.h   |
| IECC         | Electric energy consumption in construction      | million kVt.h   |
| ECAHFI       | Electric energy consumption in agriculture, hunting and forestry | million kVt.h   |
| ECTWTI       | Electric energy consumption in transport, warehouse and telecommunication | million kVt.h   |
| ECCPSI       | Electric energy consumption in other, commercial and public service | million kVt.h   |
| ECPI         | Electric energy consumption by people and in household | million kVt.h   |
| GDPM         | GDP in manat                                     | mln. manat      |
| GDPD         | GDP in dollar                                    | mln. dollar     |
| EPETECGDPM   | GDP in electric energy producing entities        | mln. manat      |
| ECGDP        | GDP in industry                                  | mln. manat      |
| ECMIGDP      | GDP in mining industry                           | mln. manat      |
| ECCGDp       | GDP in construction                              | mln. manat      |
| ECAHFGDP     | GDP in agriculture, hunting and forestry         | mln. manat      |
| ECTWTGDP     | GDP in transport, warehouse and telecommunication | mln. manat      |
| ECCPSGDMP    | GDP in other, commercial and public service      | mln. manat      |
| PI           | People’s income                                  | mln. manat      |