Uluslararası İleri Doğa Bilimleri ve Mühendislik Araştırmaları Dergisi
Sayı 8, S. 258-267, 7, 2024

Araştırma Makalesi

International Journal of Advanced Natural Sciences and Engineering Researches
Volume 8, pp. 258-267, 7, 2024

Research Article

https://as-proceeding.com/index.php/ijanser
ISSN: 2980-0811

Remarks on linear modelling for assessment of electricity consumption in Albania

Sandër Kovaçi [1]*, Mira Kovaçi [2]

[1]*Department of Mathematical Engineering, Polytechnic University of Tirana, Albania*
[2]*Center of Advanced Training, Tirana, Albania*

(s_kovaci@yahoo.com)

(Received: 25 August 2024, Accepted: 29 August 2024)

(5th International Conference on Engineering and Applied Natural Sciences ICEANS 2024, August 25-26, 2024)

ATIF/REFERENCE: Kovaçi, S. & Kovaçi, M. (2024). Remarks on linear modelling for assessment of electricity consumption in Albania. *International Journal of Advanced Natural Sciences and Engineering Researches*, 8(7), 258-267.

Abstract –The significance of the projected response by a standard model is conditioned from the accuracy of the prediction of the cause variables, the models used and also from the dynamics of the factor variables which affect the response. In this work we have discussed about predictions methods of the consumption of the electricity in Albania. We considered simple linear models which involves heterogeneous variables such as the temperature, and slowly varying variable as the econometric quantities, empirical trend and regression analysis. We concluded that using a single model the prediction and forecasting is questionable, and when considering several methods, we can recognise the range of the expected changes. For enhancing the prediction of the response variable in this case a deeper non-stationarity analysis, and more variables must be considered.

Keywords – Linear Modelling, Electricity Consumption, Distribution, Nonlinear Analysis.

I. INTRODUCTION

Forecasting and modelling in natural and technological systems is a challenging objective because of the heterogeneity features of climate variables and high volatility of quantities related to human activities [1], [2]. The special case of this category, modelling electricity consumption in a country, involves several variables of quite different nature and behaviour. Despite the disputes on the certainty of the models and its prediction, this effort is always meaningful if we consider the importance of the energy management where the electricity consumption figures are very important because it is practically a non- storable good, see [3] and [21] for detailed analysis regarding electricity storage capacities and challenges. This becomes even more important for developing economies such as Albania for example. In this specific case, models are expected to provide a rude assessment because several parameters or elasticities involved in the interdependencies between variables in the simplified linear models are dynamic and change with time. An econometric-like model looks like $EC = \sum_{i=0}^{m} a_i F(i)$, where EC indicates electricity consumption and F are economic and non-economic factors. Several factors that condition energy and electricity consumption in the country fluctuate in time and their behavior would be analyzed by the time series approach and modelling according to [4], [5] but on the other side, the accuracy of employing such techniques for quantitative assessment and prediction is limited. However, econometrists, state agencies and other actors interested in energy management and related issues believe in those modelling approaches and use them for prediction and forecasting purposes. Also, interdisciplinary scientists are interested in such simple models because there is room for improving calculation steps and especially for enhancing better forecasting procedures. So far, econometrists believe that economic growth imposes the increase of electricity consumption, and their relationship is linear, [4], [5]. It is logical also that the electricity demand depends on the temperature, because of corresponding increase in using warming and air conditioner devices etc. The linear relationship might transform into a more complex relationship during a specific period or for a certain country, [3-6], therefore, the analysis of the data and modelling stage are not unique. In employing modelling technique herein, we have considered also that line losses, or illegal use of the electricity could be included as a factor related to electricity consumption. Even though significant reduction of electricity losses has been reported, a remarkable difference exists between the electricity consumption and production in Albania, [6]. The prediction of the consumption of electricity is particularly important for the sustainability of the economic development of a country, because of the variability of the production costs and price dynamics in the global markets. Fortunately, Albania has a solid basis of a near to electricity independence from exterior factors. For understanding the trend of consumption and balance production-demand one might use standard time series approach. There is an agreement among econometrists that the increase of electricity consumption depends linearly on economic growth. It depended also on the temperature [5], mostly because of the domestic appliances use etc., but it must be depended on the temperature magnitudes and other climate indicators, that conditionate the regime of domestic appliance and a chain of activities related to the energy use and electricity consumption. More complex relationships are conditioned by country's economy and technology, period of analysis etc., see [9], [3] etc. Note that an important part of the consumption consists in the losses including line losses, network term and illegal use of the electricity etc., all of them present in our system under investigation, the electricity consumption and production in Albania, [7]. Also, effects of the network term can be considered in theoretical framework but practically the high number of nodes and lines in the electric network make the analysis only theoretical. A very interesting element in the study of electricity consumption or production is related to quality of the prediction and forecasting. Alternative to linear models, prediction can be offered in the framework of the time series analysis, therefore, the improvements on models and discussion of the significance of their prediction are interesting and important. Interdependencies between factors are also part of the discussion and important features can be revealed by simple modelling. In models described in [4], [5] [9] and others which are not listed herein, some characteristics are common. First, some of the cause factors belong to the economic systems and others are climate/weather parameters which are recorded on different time references. In the simplest model we have the GDP measure (Gross Domestic Production) which is evaluated every 3 months, and temperature that is measured every short moment. Second, time series of those quantities are nonlinear and heterogenous. Under such circumstances, measurement, modelling, and forecasting become complicated goals, and in principle, difficult ones. On the other side, such activities are more than a field of research and study and are clearly important and interesting for larger mediums. Bering in mind those arguments we will discuss some few steps on the descriptive analysis for those system that help for fulfilling those objectives.

II. MATERIALS AND METHOD

This work consists of a discussion of the linear models used on forecasting electricity consumption for specific circumstances and mediums, and a tentative proposal for reviewing and improving of a recent calculation of consumption of the electricity provided in [3]. In this regard we have considered a qualitative view on the model based on literature [1], but under severe limitation of the lack of several variables in the original draft, and debatable quality of the records for key variables which are disused in literature [3]. Alternatively, we might use direct prediction based on time series approaches. Initially we started form the simplified and reduced linear model which is based on the general form proposed in [1] and [2], but has been 'forcefully' reduced in the shortened form

$$ElectricityConsumption[MWh] = a + b * GDP + c * AverageTemperature \qquad (1)$$

due to the missing of records for several variables mentioned in [1], [2], etc. Based on the remarks provided in this work, the reduced model aims on the envisaging the projection of the electricity consumption, rather than in a technical calculation, because of small number of variables included in the model imposed by the lack of the data for other factors that potentially affect the electricity use, side effect of power loses in the transmission, the quality of records of the GDP measure , etc. also, in this reference it has been mentioned the problem of the significance of the technology element in the GDP measure, which is related with the consumption of the electricity in the country. Notice that the prediction based on (1) have been commented in original literature [3] as qualitative only, and therefore, in the first step of the discussion, we have proposed initially to make a review and some improvements on this model, and next, to consider alternative proposal. The review would consider the stationary issues of the key variable-the temperature, a revision of the analysis of the criticality for avoiding high non-linear zone in time series and involving an additional variable in the model, based on empirical and descriptive analysis. Next, the outcome would be disused and validated straightforwardly. So, as highlighted in [3], we observe that the correlation of the variables involved in the original equation used therein changes significantly over time. It is emphasized for the monthly series. By performing the calculations based on the model (1), the forecasting of the electricity needs in few succeeding years conclude in a net increase of about 1.4% as of 2026. This outcome considers the increase of the efficiency of energy use as result of the economy growth and technology improvement, reducing of electricity loses and also, increase of the demand due to the improvement of the quality of live, volume of the activities etc. However, by comparing predictions for the years 2023 and 2024, the figures do not match significantly, because of the rapid reduction of the losses, and other effect that we will consider for discussion in the following. Notice that this result has been foreseen also as result of the shortened form (1), the lack of the records for important variables that should be considered in a more realistic model, etc.

A. The Analysis Of The Nonlinearity Of Time Series Involved In The Standard Models

When using a linear model of the type $Y(t) = \sum_{i=1}^{n} a_{i-1} X_i(t)$ where X_i are variables of the time data series types, the calculation of future values for Y needs for prediction of the time series of factor variables X. The first precondition is the quality of the model, and for guaranteeing this element, the first step is to check for the stationary of the series. In several cases and application, this procedure is bypassed with the price of the opportunity of the results but considering additional tools to reduce the insignificance of the neglecting of rigid mathematical rules based on unit root test and nonlinearity analysis. To realise the calculation for the situation when mathematical perquisites are not meet, but an empirical assessment worth more than mathematical rigor, in [4] and [5], has been proposed to consider the stationary of the physical state of the cause variables, and some approximation and ad-hoc rules. Following those ideas, we have analysed the stationarity issues by using the theoretical q-gaussian introduced in [16] a discussed in [17] etc,

$$G_q(x) = \sqrt{\frac{\beta(q-1)}{\pi}} \frac{\Gamma(\frac{1}{1-q})}{\Gamma(\frac{3-q}{2-2q})} \left(1 - (1-q)\beta\left(x - \mu_q\right)^2\right)^{\frac{1}{1-q}} \qquad (1')$$

and not the simplified form proposed in [3], by arguing that in our proposed form (1'), by including an additional variable, the risk of a high error is increased. Also, in [4] is argued that the smoothed form of the q-gaussian is less sensitive to the empty bins than (1'). Note that the q-gaussian has been considered in physical and mathematical literature as very intriguing describing the distributions for nonequilibrium states analysis, and offer a benefit compared to the alternative stationarity analysis because the q-parameter obtained after the fit, represents a direct stationarity measure. So, that for $1 < q < \frac{5}{3}$ the distribution is stationary, for $\frac{5}{3} < q < 2$ it is nonstationary, and the variance is infinite, whereas for $2 < q < 3$ the variance is undefined. For $q > 3$ the equation (1') is no more a distribution object. For fitting the form (1') which is more delicate, we have used the algorithm PSO (particle Swarm Optimization) by MATLAB. So, the basic idea described in [4] and consisting in the preliminary qualifying (or disqualifying) of series for modelling approach is realised by using the theoretical q-Gaussian as an instrument for measuring un-stationarity weight.

B. Involving More Variables In The Model

Based on general approaches [1], [2], etc., and comments of [3] regarding involvement of more variables, we make several attempts by extending model (1) towards them used in literature [1] or [2] etc. The candidate variables are those related to the technological indicator, the level of prices, unemployment rate etc, the share of energy used as electricity, the consumption of oils, total energy demand etc. So, the employment rate, (ER), the prices level (CPI) would talk more about consumption; also, the prices of the oil (PO) which acts as substitute goods should be considered considering other cause factors as employment level. Also, the average temperature might not indicate correctly the share of electricity absorbed by householding and domestic appliances, so the magnitude of daily temperatures $\Delta T = Tmax - Tmin$ can express more. Therefore, the model can be assumed as follow,

$$EC = C^{te} + a*GDP + b*CPI + c*PO + d*ER + e*T + f*\Delta T \qquad (2)$$

By using the data provided by official sources, all coefficients would be evaluated. To assess electricity demand, we need the forecasted values for variables included in the model. It contains two remarkable amendments, but again, the basic question regarding temperatures persists: the need for improved forecasting of temperatures and for their magnitudes. Regarding this last, we have considered initially the nature of the distribution of the magnitudes based on the argument that mostly the householding use would depend strongly on the variation of the temperature which can impose different regimes of the use for domestic appliances. Basically, this element merits a depended analysis, but we believe that this procedure could compensate in some extend the lack of several important cause variables related to the electricity consumption. So, if the population is concentrated in few big cities and so does the industry, the consumption of the electricity can be assumed as uniform among many elementary units of electricity use and the inclusion of any additional parameter in linear model make sense. However, because economic parameters used in the two liner forms above can be projected based on official predictions, the use of the model for forecasting would result in non-neglectable inaccuracy. All those limitations would be confronted with a follow-up checking procedure. We have used initially the model (2) using official data for the variables included in it, but its significance and reproduction of the target variable EC was not reliable enough. So, we have discussed particularly the quality of the modelling by the equation,

$$EC = Cte + a * GDP + e * T + f * \Delta T + residuals \qquad (3)$$

which is intended to consider some remarks of additional effect of the increase of household consumption of the electricity but not limited to. After comparing the data reproduced, we have estimated qualitatively the significance of the liner models and discussed the alternative solutions. In this step we have commented also the significance of the fit and the reproductivity ability as criterion for considering each of the shortened models.

C. Autoregressive Model Alternative

Finally, we considered the time series alternative for predicting directly future values of the variable of interests. Several techniques are applicable, but we may refer to those directly related with electricity consumption and demand analysis like in [6], [7], [9], [10] etc. also, direct use of standard neural network calculation, regression models like ARIMA or machine learning algorithm etc., which hidden the effect of cause factors but emphasise direct correlation between terms of the series.

Note that all data are gathered from official or open sources and the work does not intend to correct other calculation nor to provide a receipt for application but is focused on alternative solution and discussion for the use of simple linear models in the situation and system where some data might be missing, some variables are not recorded and other one might be noisy or not accurate.

III. RESULTS

Based on the steps described above we have discussed the calculating feature and usefulness of simple models for the consumption of the electricity in Albania. Firstly, the models based on general form (3) is fitted to the data covering the period [2000,2020], where we believe that our response variable and at least one of the cause variables is recorded correctly, next, we used official data for economic variable and our own forecasted ones for prediction. Initially, the significance of the regression of the linear model is considered as indicative, and next, by comparing current data for consumption of the electricity during 2021, 2022 we validated or disqualified the model, and discussed alternatives. Before going onto results of this discussion, let have a brief for the electricity consumption pattern in the country.

A. General Characteristics Of The Electricity Consumption In Albania And Linear Approach

Albania has domestic production comparable to the country needs. So, for 2021 the consumption has been at 8.14 TWh, whereas production 7.8 TWh, for 2022 the consumption 7.92 TWh and the production 7.02 TWh, and for 2023 the consumption 7.88 TWh and the production 8.80 TWh etc., [7], [6], [14]. The consumption 2.92 MWh per capita that is in the same range with Balkan countries, Turkey at 2.818 MWh, Serbia 4.2, Macedonia 3.020 MWh, etc. Before 2004, about 93% of the electricity was provided from hydroelectric sources (HPP), and the other part from fuels. After 2004 year 100 % of it comes from the green sources where HPP provides almost all electricity used in the country. From this characteristic, the production depends on the water reserves and the balances of prices in the regional electricity market, hence the time series exhibit complicated dynamics. By naked eye view, the consumption of electricity exhibits the same trend as the GDP for the country, whereas yearly changes exhibit intense dynamics, Figure 1

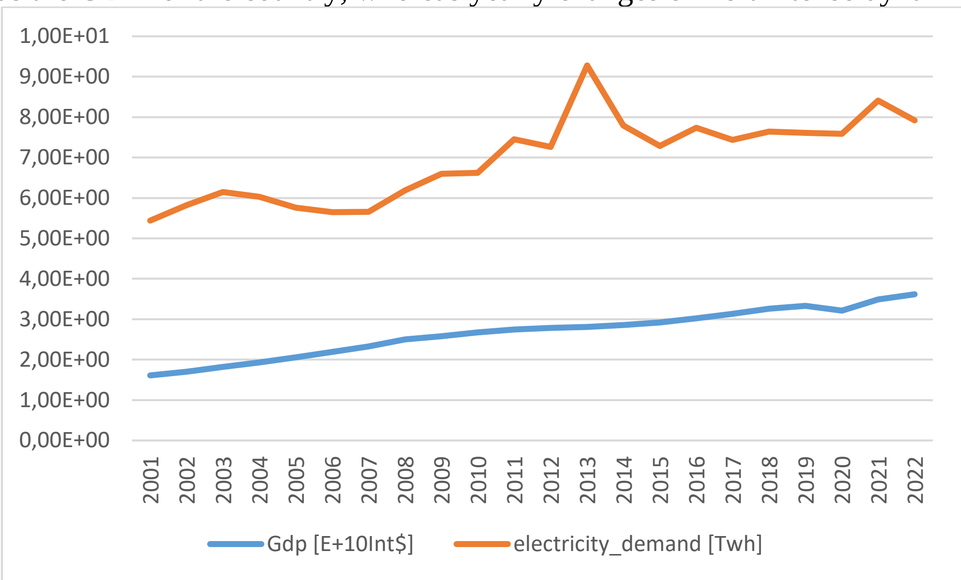

Figure 1. Illustrative representation-the trend of GDP and electricity consumption

The data have been taken from reference [10], and [7] and from official sites [14]. As seen from the figure 1, the trend of the electricity consumption and normalized GDP are linearizable in the sense that, neglecting further analysis and detailed arguments, we can assume a linear correlation between them. Regarding modelling and forecasting, another factor is important, the electricity lost during transmission. It is also very difficult to predict current or future losses, that must be used after having established a model. Just for clarifying the complexity of this parameter, electricity losses contain two terms, technical and nontechnical losses and from 2012-2013, it has a decreasing trend from 28% toward 22% in 2021 see, [7] for details or [14].

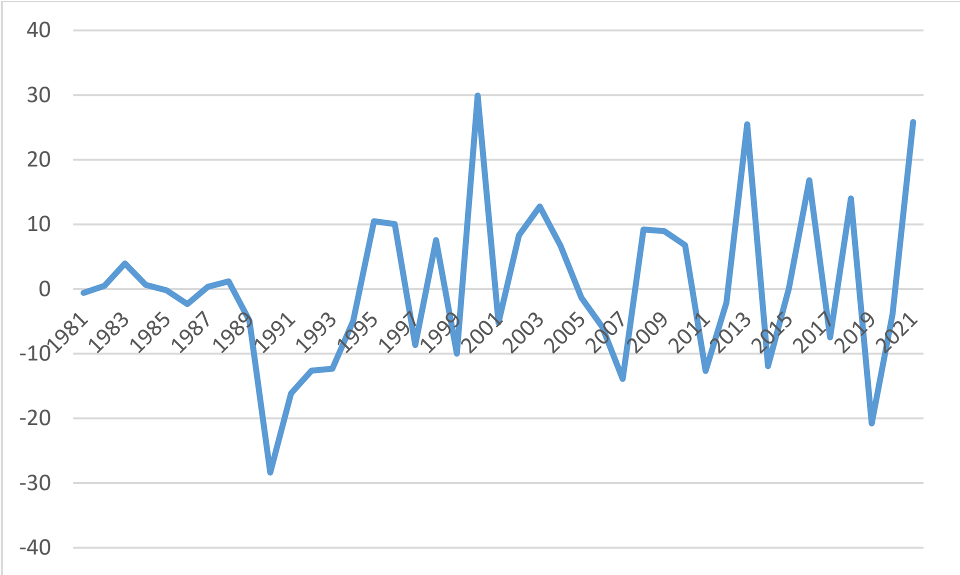

Figure 2. The rate (%) of yearly change in the consumption of electricity.

We observed that the trend of electricity consumption is increasing but the rate has changed over the years. This behaviour is not plausible for the linear modelling. The end user consumption has increased during the periods 2000-2011 and 2012-2021. Regarding correlation of the Electricity Consumption and CPI or ER we do not observe a clear pattern, whereas the series of the share use of the oil as substitute of the electricity is not known so far. In the simplest but practical reference, we might use an econometric model that stipulates a linear relationship between electricity consumption, economic variables, and environmental variables. The logic behind this assumption is simple: economic growth needs for more energy and mostly electricity, the increase of the prices could slow down the consumption by householdings, the magnitudes in temperatures would ask for more electricity for heating or cooling etc. for those simple models direct or logarithmic forms are used. Also, the correlation of temperature with electricity consumption for monthly reference is presented in [3] and we are not repeating it, but we highlight that a correlation and monotone behaviour has been recognised in [3]. Regarding the correlation of the electricity consumption with magnitudes of temperature we observed a high volatility by time, but considering the empiric nature of including this variable, we have skipped any analysis letting it in the final term of the re-producing of the data. Considering that as of 2020, 60% of the energy needs for the country comes from fuels, [10], [7], modelling and forecasting techniques become important for scientific and economic purposes. On the other side, the accuracy of models must be checked continuously because of the high volatility of variables which is reflected in the changes of the electricity consumption shown in figure 2.

B. *A Discussion For Linear Model Approach For Electricity Consumption In Albania*

Econometrics projection uses the reference on the ration ‘consumption to GDP measure’ based on annual reference that corresponds to a better assessment for both quantities, consumption of the electricity and GDP measures. Therefore, we may start the analysis based on this definition and commenting about it. Considering the annual data and trying the mono-variable linear model we obtained, the yearly increase is predicted around 3.2%. It is similar in figures with prediction by using a ANN which forecasted 8.1355 Twh for 2028, but nonlinearly, and is comparable with official projection, but higher in absolute figures. According to state agencies, electricity consumption is expected to increase by an average of 2.9%/year between 2022 and 2030 (to 9.3 TWh) and by 2.5%/year between 2030 and 2040 to 11.9 TWh. To improve the model, we have employed the liner model by excluding the temperature, $EC = a + b * GDP + c * CPI + d * Unemplymet$, trying to catch the dependence of the electricity consumption from economic variables, and also, we used tinner assessment of the variables, the 4-month time series. So, by using the full form and following normal scenarios for the projection of the GDP growth ~3.42%-3.47% yearly up to 2028, price index CPI ~2.7%-1.8% linearly, and keeping employment rate nearly unchanged, we obtained that the need for electricity would increase at around 3.2% yearly but the goodness of the fit is not statistically appropriate. Also, we must underline that simplified linear model calculates electricity demand, but not electricity consumption. Before discussing alternative prediction, we have considered inclusion of the temperature parameter based on general models [1], [2].

C. *A Temperature-Based Approach*

We initially used the full form given in (2) but the statistic of the fit is quite redundant. So, we started from the reduced form (1) used in [3] where at around 14% increase for electricity is projected for 2026 compared to 2022. To improve the effect of the temperature we proposed to include an extra term which tries to catch specifics of the temperature dependence regarding shifting of using specific device or appliances in domestic use etc. The model has the form

$$ElectricityConsumption = Cte + \alpha * GDP + \beta Taverge + \gamma \Delta Taverage + \varepsilon \qquad (3')$$

Here, the records of the GDP are reported quarterly by the official sources, whereas temperatures are in daily basis, so firstly we need a unique time-interval references. Obviously, the daily GDP data are quite an exaggerated approach, whereas quarterly temperature average would lose a lot of information, so we descried to use the monthly references. For this step, the series of average temperatures are tailored by producing monthly averages, whereas the monthly GDP records are produced by an inverse idea of the averaging. Here we used a linear approach, and next we added a zero mean white noise to the series. In the same way, the projection of the GDP for the period [2024-2028] are used for producing monthly GDP and using them for predicting EC by using (3'). For predicting the temperatures data, we attempted ANN similar as [3], the VARIMAX and a seasonal ARIMA like in [21] despite different nature of the data series and checked for re-productivity of the data and regression significance. We have considered an empirical set rule for fixing subseries based on those elements: a:) the distribution of the values on each subseries could be the same level of nonstationary and preferably none of them has non-defined variance ($q>2$), so we seek for a kind of homogenisation in this regard; b:) the optimal histograms (we used standard Freedman - Draconic rule because series were non-stationary) must have as less as possible empty bins. We believe that those ad-hoc condition would guarantee for a more compatibility of product using four subseries with those obtained by using the full data set. This claim is based on the idea the physical series are continuous, and the grouping of the data in 4 subseries could inflict additional uncertainty. So, the q-parameter is found [1.73 1.89 1.82 1.95] for series [November-March, February-May, June-August, September-October] respectively. The distribution is highly unstable, but their non-stationarity looks at the same category and none of the series has a non-defined variance. Based on the similarity of the distribution we qualify this feature as improved approach for the reference of the temperature time series and decide to follow calculation based on those separate groups and follow the calculation based on model (3). Initially we observed that the goodness of the fitting was not significantly good, so the model is debatable, but it reproduces the immediate data with higher accuracy than the reduced version (1), whereas this last perform better for reproducing farthest data. By this procedure we have realised four series for temperature and their magnitudes and followed the averaging process for monthly reference. So, we obtained that increase of the demand for electricity in 2028 would be 17.4 % compared to the year of reference 2024 by using formula (3) which is higher than the 14% predicted by (1), and higher than official projections.

D. Data Oriented Assessment

Finally, we have considered a calculation based on regressive models, neural networks and ARIMA algorithms. The idea is to obtain other patterns for electricity consumption, and based on them, regardless of their empirical and semi-mechanical nature, we would be able to identify the region of the electricity needs for view incoming years. For this calculation we have referred to the quarterly data for the electricity consumption. For this section we have used that data from INSTAT (Albanian Institute of Statistics) database that showed them for the period [2012-2024].

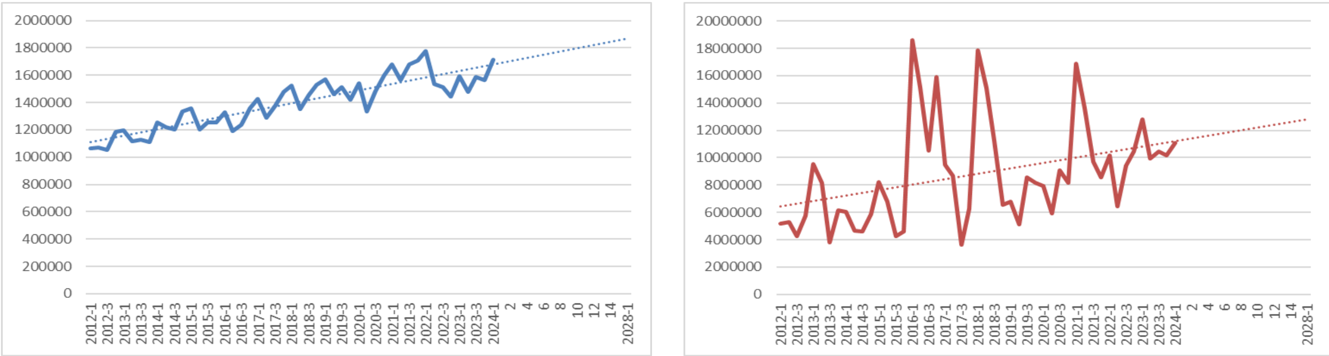

Figure 3. The trend of electricity consumption by consumers and total electricity consumption. Units are MWh

Initially we observe that the trend of electricity consumption keeps increasing but the rate of increasing is higher on consumer consumption. Also, we observe that both types of consumption vary among periods. We followed our discussion by attempting data-oriented forecasting based on neural network models. ARIMA models are also interesting, but we argued that a better approach must be based on the training of the relationships that is covered better by standard or more detailed neural network algorithms. Here by using ANN algorithm in Matlab we have identified a non-smoother pattern of the electricity consumption with a light magnitude but keeping the increase of the trend, Figure 4. The model predicts a lighter rate of the increase of electricity consumption at a range of 1.8% yearly which is lower than other forecasting mentioned above. We conclude that the distribution of the semester and quarterly data varies considerably that imposes a light movement ahead of the expected values. Particularly, the trend of the consumption increases is lower than those appearing in the empirical regressions presented above. However, a net increase of about 5.8% obtained so far, can be viewed as the lower limit of the change of consumption of the electricity for the country.

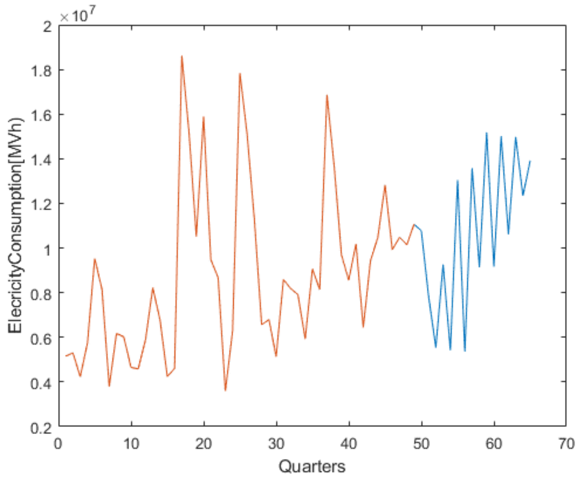

Figure 4. A neural network approach for electricity consumption

In figure 4 we showed the ANN simulation pattern where the fit of the 0.1% of the data has the best goodness, skipping details of the fit, because herein we are interested on the range and a qualitative estimation for predicting by models. Considering also the volatility of the electricity consumption and the value of the increase obtained herein, we recognize this finding as the lower boundary of the forecasting, which completes the full pattern of electricity consumption projection.

IV. DISCUSSION

The econometric models are by nature simple and mostly linear, and therefore their accuracy is not so good for a deep analysis, but nevertheless, they remain a useful tool when one considers the importance of predicting and forecasting important quantities like electricity consumption for example. Their predictive power depends on the nature of variables, their accuracy of records etc. A more complex situation appears when uncertainty of econometrics variables is paired with the volatility of physical ones as is the temperature. Moreover, lacking records for some cause factors will hamper the quality of the prediction for responses and make the forecasting horizon close to the current date. For dealing with such circumstances that are characteristic for our current system and similar ones, altering methods and tools is interesting and useful. For example, herein, we tried step by step linear modelling starting from the simplest one, adding variables based on general models, and trying to improve forecasting for cause variables. In this case, the predictive power of the models become disputable, but can be improved by employing nonlinear analysis for variables with significant seasonality feature. Also, for this purpose, we propose to add other variable which seems to be logical, but not used routinely in such econometric modelling, the magnitude of daily temperatures. So, the stationarity of temperature time data series is considered as the primary argument for forecasting them, and therefore, the full series is partitioned initially in daughter's series with reasonable low un-stationary, based on them, one proceeds with forecasting by using routine neural network algorithm. In all cases, the inclusion of the temperature as case variables is interesting, but must be accompanied with careful analysis, because of its time and geographical variability. Alternatively, proper regressive models can be used for comparison. Based on them, we may recognise the range of the prediction for electricity consumption in the country rather a direct prediction which is always a technical and econometric challenge. Another drawback regarding forecasting and prediction is related to two hidden variables, the electricity losses associated to the transmissions and informal economy.

V. CONCLUSION

In this work we have used some empirical steps to improve modelling of electricity consumption in Albania regarding a better assessment of the range of the future demand. Starting from rude dependency on economic factors and by including variables based on the general modelling borrowed from the literature, and by including additional term which represent the magnitude of the temperature, which provide more information on the consumption of the energy, we obtained an upper level of the electricity demand for few incoming years at a range of 14% -17% as of 2028 compared to 2022. In general, it is evidenced a correlation between GDP and average temperature that indicate the major consumption volatility comes from the domestic householding use of the electricity. From data-oriented analysis perspective, the range of the increase for the time horizon of 2028 is around 6% comparing to 2022. Based on those observations and findings, we conclude that for a better assessment of the range and projection of the electricity consumption, and to deal with sparce data and also lack of several variable records, advanced techniques are needed. Form economic perspective and recognising the capability of the country for using solar energy which actually covers less than 1% of the country's needs, we might suggest that the additional amount of electricity needs could be covered by intensifying production of the solar and wind energy, maintaining the production of the electricity by green sources at the actual level of 100% clean energy.

REFERENCES

[1] Richard F. Hirsh and Jonathan G. Koomey. Electricity Consumption and Economic Growth: A New Relationship with Significant Consequences? Richard F. Hirsh and Jonathan G. Koomey. November 2015, Vol. 28, Issue 9 1040-6190/# 2015 Elsevier Inc. All rights reserved., http://dx.doi.org/10.1016/j.tej.2015.10.002 7

[2] Tieyan Zhang, Yun Teng, Zhe Chen, and Jiakun Fang. Monthly Electricity Consumption Forecasting Method Based on X12 and STL Decomposition Model in an Integrated Energy System Tianhe Sun, Mathematical Problem in Engineering. Volume 2019 Article ID 9012543 https://doi.org/10.1155/2019/9012543

[3] Elmira Kushta, Dode Prenga, Astrit Denaj, Valbona Tahiraj, Elmira Kushta, An Empirical Approach in The Study of Heterogenous Na-Tech Systems. International Academic Conference. Education and Social Sciences Business and Economics Corvinus University, Budapest, Hungary, 12 May 2023

[4] Dode Prenga, Margarita Ifti; Complexity methods used in the study of some real systems with weak characteristic properties. *AIP Conf. Proc.* 25 March 2016; 1722 (1): 080006. https://doi.org/10.1063/1.4944171

[5] Linh Phuong Catherine Do, Kuan-Heng Lin, Peter Molnár, Electricity consumption modelling: A case of Germany, Economic Modelling, Volume 55, 2016, Pages 92-101,

[7] Ozair Ali. Revitalizing the Albanian Electricity Sector. Report, Centre for International Development Harvard University

[8] https://www.irena.org/

[9] Bunn, D. W. (1982). Short-Term Forecasting: A Review of Procedures in the Electricity Supply Industry. Journal of the Operational Research Society, 33(6), 533–545. https://doi.org/10.1057/jors.1982.116.

[10] Hannah Ritchie and Pablo Rosado (2020) - "Electricity Mix" Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/electricity-mix' [Online Resource]

[11] Worldometer: www.Worldometers.info.

[12] Instat: http://www.instat.gov.al

[13] https://www.kesh.al/en/

[14] P Geraskin, D Fantazzini. Everything you always wanted to know about log-periodic power laws for bubble modelling but were afraid to ask. The European Journal of Finance 19 (5), 366-391

[15] C. Tsallis. Economics and Finance: q-Statistical Stylized Features Galore. Entropy. 2017; 19(9):457.

[16] S. Umarov, C. Tsallis, and S. Steinberg, "On a q-Central Limit Theorem Consistent with Nonextensive Statistical Mechanics," Milan J. Math, vol. Online First, 2008.

[17] Sornette, D. (1998). Discrete-scale invariance and complex dimensions. Physics Reports, 297(5), 239–270. doi:10.1016/s0370-1573(97)00076-8

[18] Sandër Kovaçi, Dode Prenga, Margarita Ifti, *"Analysis of distributions and dynamics for water side inflows in the Drin River basin, Albania"*. INTERNATIONAL JOURNAL OF ENGINEERING & TECHNICAL RESEARCH, VOL.3, 2015 ISSN**:** 2321-0869 (O) 2454-4698 (P)

[19] Prenga, D., Peqini, K., & Osmani, R. (2021, November). The analysis of the dynamics of the electorate system by using q-distribution-a case study. In Journal of Physics: Conference Series (Vol. 2090, No. 1, p. 012073). IOP Publishing.

[20] Kushta, E., Vuka, E., Prenga, D., & Dika, I. (2024). Investigating Statistical Features of the FX Bid Ask Series in a Small Economy with a Sizeable Informal Economy. *Journal of Human, Earth, and Future*, *5*(1), 19-33.

[21] Mira Kovaçi, Sandër Kovaçi, **"**Analysis of The Impact of Different Technologies for Diversification of Electricity Production from Renewable Sources in Albania**",** in Proceedings of INTERNATIONAL SCIENTIFIC CONFERENCE, ISCOIM, Durrës, Albania, 2018.