ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology
(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 5, May 2014

Forecasting Of the Electricity Demand in Libya Using Time Series Stochastic Method for Long-Term From 2011-2022.

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Abstract: Forecasting electricity consumption is one of the most important operational issues in order to the use facility systems and power sources optimally. Electricity demand forecasting process will ultimately have an important role in the economic and security of the energy operating system. The objectives of this research are to forecast long-term electricity demand for 2011-2022 and to provide mathematical data that can be used as consideration in deciding a particular policy in the field of electricity supply. Thus, this paper studies a load demand based on quantitative forecasting model using a time Series Stochastic Method. SPSS and EViews7 Software analysis were applied. Application of stochastic time series forecasting based on data from 2000- 2010 and Mathematical analysis indicated a continuous growth of demand for oil and electricity there by increasing cost of energy due to rapid population growth in Libya from 2011-2022.

Keywords: Electricity, Demand, Forecasting, Libya, Long term, Stochastic Method.

I. INTRODUCTION

Developing and emerging world economies face the challenge of meeting the needs of billions of people with no electricity and simultaneously transition to clean, low carbon energy sources. A report by [4] and [5] shows that globally at least 1.6 billion of people live without electricity as of 2009. Libya is a crucial country in the Middle East and North Africa and plays a major role in connecting the oil, gas and electricity international grid. [15].

The total population in Libya was last recorded to be 6.2 million people in 2012. The population in Libya has fluctuated from year to year ranged between 1-2 percent. Libya has 3900 MTOE (Million ton of oil equivalent) oil reserves which is why its economy depends primarily upon revenues from the oil sector, which accounts for 80% of GDP and 97% of exports. Libya holds the largest proven oil reserves in Africa and also an important contributor to the global oil supply mainly petroleum but also other natural resources such as natural gas and gypsum.

Oil is the most important source of energy to supply the power generator in Libya. According to the Libyan's Total Primary Energy Supply (TPES) data in 2004, oil has supplied 72.7 % energy gas has supplied 26.5% energy. All in sum, fossil fuel accounted for 99.2 % in Libya. [11]. [14].

The trends of energy demand, imports and exports, coal use increase rapidly globally. The growing power demand is also exemplified by Libya's annually increase of 6 – 8 %, with an estimated demand for 2010 of 5.8 GW and 8 GW for 2020. [5]. Libya as member of Organization of the Petroleum Exporting Countries and participant of 2001 Gas Exporting Countries Forum (GECF) is part of this global network. [6].

Use of electrical energy in Libya is rapidly increasing. This growing energy consumption is a result of the urbanization process in the region, economic growth, population growth and industrialization. In the last ten years in Libya, data shows an increase in electricity consumption every year. By 2050 the government of Libya will face more pressure on the future energy supply, especially in the residential sector with its increasing cooling and heating demand. In the future, by those reason, the Government will be forced to more efficient energy use to overcome the increasing energy cost.

In 2004, 32.3 % of the electricity in Libya was consumed by the residential sector and the power consumption of the industry was 2 %. The power demand from 2003 till 2050 will grow rapidly. The current energy supply in almost all countries cannot be considered as a sustainable source of energy, as the energy costs are exponentially increasing due to the

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environmental issues and limitations of resources. [16]. The demand of the residential sector is expected to grow by 80 % due to rapid population growth. However, electricity supply cannot be stored and is instantaneous, which indicate that supply must be equal to demand at all times. [1].

Forecasting electricity consumption is one of the most important operational issues in order to optimally use facility systems and power sources. With a good electricity demand forecasting, the quantity and quality of electric power generated can fulfill the needs of consumers with the minimum operational cost.

In simplicity, forecasting is a system for quantitatively determining future load demand.[2]. Long range planners consider a period of 20-30 years forecasts to ascertain sufficient generation and transmission as well as distribution plans of actions. Daily forecasts are required to schedule generating units for optimum cost-cutting measure. Weekly or monthly forecasts are required for maintenance scheduling .[2].

Many stochastic models are inspired by the financial literature and a desire to adapt some of the well-known and widely applied in practice approaches. [12][13]. Unlike qualitative forecasting methods which do not rely on any rigorous mathematical computations but rather based on opinions, emotions, judgments, intuition, or personal experiences and are subjective in nature, quantitative forecasting methods are based on mathematical models, and are objective in nature. They rely heavily on mathematical computations. [3].

Quantitative forecasting methods can be categorized into two main types: The first one are time series models which look at past patterns of data and attempt to predict the future based upon the underlying patterns contained within those data. The second type is Associative models (often called causal models) which assume that the variable being forecasted is related to other variables in the environment and thus try to project based upon those associations.

In technical time series, there are two time series forecasting namely, deterministic and stochastic time series. Deterministic Time series is a forecasting method with time series data where the data must meet the data stationary. The data used for the analysis of stochastic time series does not require stationary data. [7][8][9][10].

The purpose of this research are to forecast long-term electricity demand for 2011-2022 and to provide mathematical data that can be used as consideration in deciding a particular policy in the field of electricity supply. Thus, this paper studies a load demand based on quantitative forecasting model using a time Series Stochastic Method

II. RESEARCH METHOD

To forecast Long-Term (for 2011-2022) electricity demand in Libya, Time Series Stochastic Method was used based on data from 2000-2010. Time series forecasting method is formulated based on time series data. The following are details of the procedures used.

Firstly, ARIMA model (p, d, q) was identified with the following steps:

A. The first step of ARIMA analysis was to make a time series plot graphs on the Cartesian paper, and analyze whether it had stationary mean and variance or not. If the data is not stationary in the variance, the transformation should be done while if the mean is not stationary. The differencing was done.

B. Plot Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) of the data that has been stationary in mean and variance.

Secondly, to test the feasibility of the obtained ARIMA the following was done

a. Parameter Estimation

Conducting parameter estimation based on the model obtained through SPSS and EViews7 software, and testing the significance of parameters to get a significant parameter model.

b. Diagnostic Checking

Conducting diagnostic checking through SPSS and EViews7 software and an examination of the residuals of the model significantly through:

1) Residual white noise Test
2) Residual normally distributed Test

Thirdly, evaluation of the model obtained if the resulting model is more than one and it should be an evaluated against the model through two criteria

c. Criteria of in a sample based on MSE or SSE.

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d. Criteria of out sample based MAPE value.
Lastly, subsequently load forecasting 2011- 2022 years.

SPSS software was used for forecasting time series. *SPSS* is appropriate to use since it provides a variety of commands that allow the process of data entry, graphing, statistical analysis, and forecasting process.
To verify result of SPSS Software, EViews7 Software analysis was used.EViews7 provides sophisticated data analysis, regression, and forecasting tools on Windows-based computers. With EViews7 you can quickly develop a statistical relation from your data and then use the relation to forecast future values of the data. Areas where EViews7 can be useful include: scientific data analysis and evaluation, financial analysis, macroeconomic forecasting, simulation, sales forecasting, and cost analysis.

III. RESULT AND DISCUSSION

Statistic Descriptive of Electricity Production, Power consumed and cost

The entire electricity production in Libya during the year 2000-2010 amounts 251,594,561 MW/h; with yearly electricity production mean of 22,872,232 MW/h. The total amount of electricity consumed in2000-2010amounted to 233,323,266 MW/h, with yearly average 21,211,206 MW/h. The lowest and highest consumptions were 14,522,025 MW/h and 31,680,704 MW/h, respectively.
The mean yearly production costs during 2000-2010were USD 352,003,663. Price for 1 MW of electricity production amounted to USD 15.39. This indicates an average cost of USD 352,003,663.07 was used for generating 22,872,232 MW/h. The total cost in 2000-2010 amounted to USD 3,872,040,294.

Table 1. Electric energy Generated, consumed and lost (MW/h) during 2000-2010.

Year	Electric energy Generated (MW/h)	Electric energy consumed (MW/h)	Lost Electric energy (MW/h)
2000	15,324,637	14,522,025	802,612
2001	16,014,716	15,208,543	806,173
2002	17,530,669	15,445,816	2,084,853
2003	18,942,597	16,702,230	2,240,367
2004	20,201,794	17,931,957	2,269,837
2005	22,449,852	19,909,502	2,540,350
2006	23,992,442	21,730,193	2,262,249
2007	25,514,082	23,016,749	2,497,333
2008	28,666,141	27,748,242	917,899
2009	30,426,380	29,427,305	999,075
2010	32,531,251	31,680,704	850,547

(Source: general Electricity Company of Libya, 2012)

Technical losses and Forecast of energy loss in the process of distributing electricity to consumers in Libya is in increase. One of the reasons is transmission lines, weather factors the problem after sent power to customer the lost will be in transmission line and the customers are not near from the power the station so far. This is general problem, in the fact is happen from all over the world. The demand need for tools of forecasting of energy loss is increasing.

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Determining electricity demand for 2011-2022 in Libya based on data from 2000-2010

Long-term needs of electricity in the State of Libya based on data from 2011-2022 according forecasting in the figure 1.

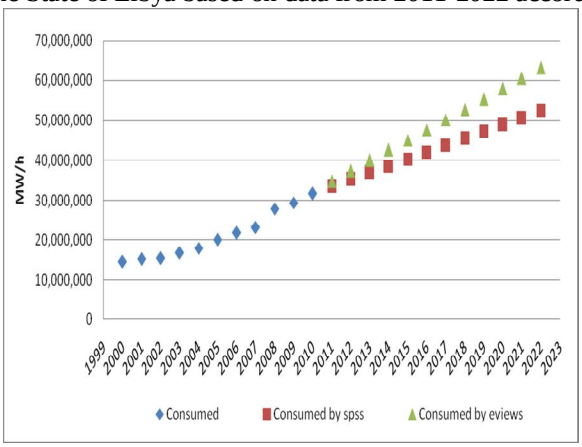

Figure 1. Comparison Consumed with SPSS and EViews 7
Source: data analysis with SPSS and EViews 2014

Electricity consumed by the parameters of existing demand for electricity in the State of Libya. Since the power consumption needs must be met. So would not want to meet the electricity needs in the State of Libya should not be smaller than consumption. If that happens, it will cause shocks to the economy in Libya. besides it also needs to pay attention to the needs of the electric power is lost, as long as it still has not resolved the bias in producing electricity should pay attention to power consumption and loss of electricity, or in other words to meet the demand for electricity in producing electricity it needs to accumulate between electricity consumption and electricity loss.

Table 2: Gap between actual data and forecasted result Analysis Forecasting with ARIMA Model Parameters

Years	Consumption MW/h	Gas M^3	Light M^3	Heavy M^3
	Real data			
2011	12,993,675	3,793,184,,511	4,205,111	1,812,930
2012	20,602,217	4,013,482,065	3,883,932	805,472
	Forecasting			
2011	33,396,572	4,082,506,372	4,390,661	1,162,839
2012	35,112,440	4,371,828,233	4,576,210	774,230

There gap between real data and forecasting data in the year 2011-2012 was because of war tragedy in Libya. Due to internal conflict, the exact electricity consumption for that period of time cannot be forecasted.

Statistic descriptive of Gas Fuel, light fuel oil, Heavy fuel oil in the year 2000-2010

The entire gas fuel in the year 2000-2010 reached 24,758,430,170 M^3, with yearly average2,250,766,379 M^3.Overall light fuel oil production in 2000-2010 reached number 33,638,935 M^3, with yearly average 3,058,085 M^3. Average power heavy fuel oil in the country of Libya reached 1,973,292 M^3. Heavy fuel the whole of the year 2000-2010 reached number 21,706,214 M^3.

ISSN: 2319-8753

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Comparison of SPSS and EViews7 based forecasting for the year 2011-2022

A. Comparison of gases by using the SPSS forecasting results and EViews 7.

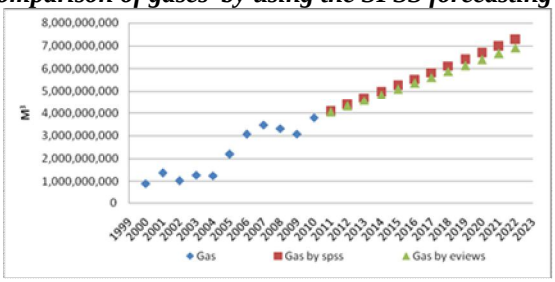

Figure 2. 2011-2022 fuel demand forecasting for comparison of Gas Fuel with SPSS and EViews7

The figure above shows that forecasting using SPSS software has higher expectations than on forecasting using EViews 7. This is seen from year to year has predictions starting in the 2011-2022 overall forecasting results put the results by using SPSS higher than the EViews7 as in 2022 reached 6,907,699,469 M3 forecasting using EViews7 greater than using the SPSS reached 916,679,895 M3.

B. Comparison of Light Fuel Oil by using the SPSS forecasting results and EViews 7.

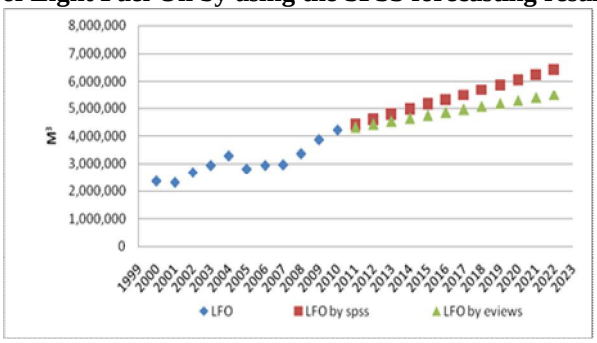

Figure 3. 2011-2022 fuel demand forecasting for comparison of Light Fuel Oil with SPSS and EViews7

The above figure shows that Light Fuel Oil demand forecasting using SPSS software has higher expectations than on forecasting using EViews7. This is seen from year to year has predictions starting in the 2011-2022 overall forecasting results put the results using SPSS higher than in 2022 EViews7. Forecasting using SPSS reached 6,431,707M^3 while using EViews7 which reached 5,501,603 M^3.

C. Comparison of Heavy fuel oil by using the SPSS forecasting results and EViews 7.

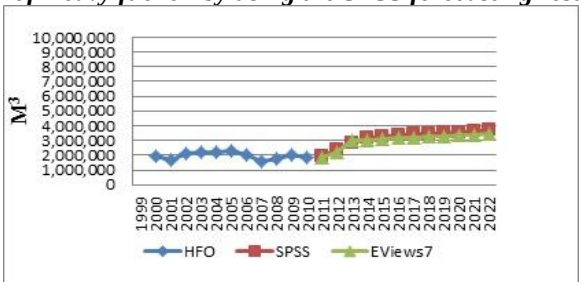

Figure 4. 2011-2022 fuel demand forecasting for comparison of Heavy Fuel Oil with SPSS and EViews7

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology
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Forecasting heavy fuel oil demand based using SPSS software has higher expectations than on forecasting using EViews 7. This is seen from year to year has predictions starting in the 2011-2022 overall forecasting results put the results using SPSS higher than in 2022 Eviews 7 like forecasting using SPSS 3,513,819 M^3 greater reach than using EViews7 which reached 3,309,907 M^3.

Population forecast

Comparison of population based on the results of forecasting using SPSS and EViews7 as in the figure 4.11

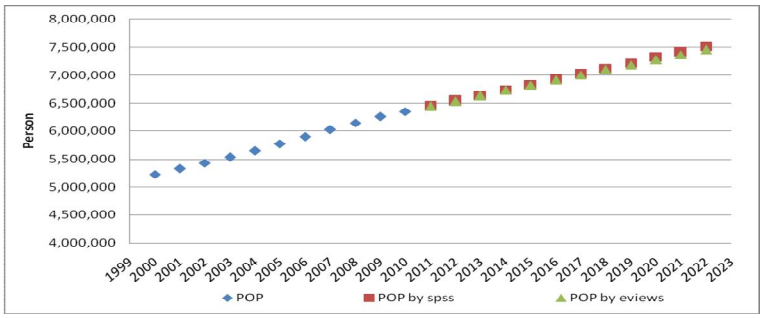

Figure 5. Comparison of populations with SPSS and EViews 7:Source: data analysis with SPSS and EViews 7 2014

Production cost in the process of distributing electricity to Libya

Production costs for producing electricity to be distributed to consumers is shown in the figure 5

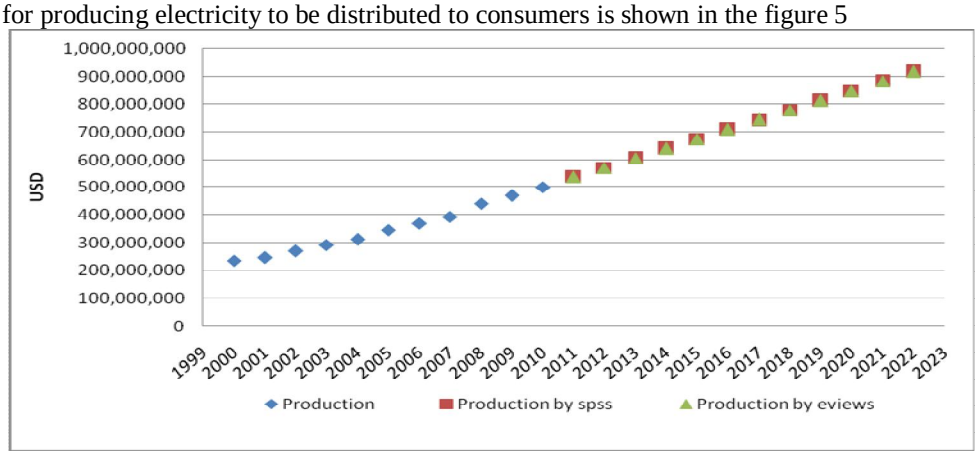

Figure 5: Comparison of production costs with SPSS and EViews 7. Source: data analysis with SPSS and EViews 7 2014

Table 3: Gap between actual data and forecasted result Analysis Forecasting with Exponential Smoothing Model Parameters

Years	Production Cost	Generated	Population
	Real data		
2011	405,504,753	26,348,587	6,103,221
2012	533,397,023	34,658,676	6,154,623
2013	543,774,561	35,332,980	6,237,393
	Forecasting		
2011	537,150,947	34,902,596	6,448,248.21

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology
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Years	Production Cost	Generated	Population
2012	571,653,578	37,144,482	6,542,064.89
2013	606,156,210	39,386,368	6,636,576.65

There gap between real data and forecasting data in the year 2011-2012 was because of war tragedy in Libya. Due to internal conflict, the exact electricity consumption for that period of time cannot be forecasted.

IV. CONCLUSION AND RECOMENDATION

Application of stochastic time series forecasting based on data from 2000- 2010 and Mathematical analysis indicated a continuous growth of demand for oil and electricity there by increasing cost of energy due to rapid population growth in Libya from 2011-202. This shows that alternative policy options for market reforms can be based on reliable long-term forecasts from in-sample parameter estimates of long-run relationships that are useful for decision-making.

The government should use its power source carefully. Government also needs to fix the electricity network infrastructure so that electricity needs can be met in Libya for the welfare of society. Because the government of Libya will face 2050 more pressure on the future energy supply, especially in the residential sector with its increasing cooling and heating demand. In the future, by those reason, the Governments will be forced to more efficient energy use to overcome the increasing energy cost, make strategies towards a more efficient allocation of resources while taking account of the budgetary Go to the use of renewable energy.

Specifically, the forecasts under different scenarios for subsidy removal that reflect the pace of reform can help the government in devising appropriate Strategies towards a more efficient allocation of resources, The adoption of a certain scenario to remove problems in electricity market depend on the development of a social protection system most of all efficient functioning of a social safety net requires that the target consumer groups be determined on well-defined criteria.This will help in designing programs that aim at improving both resource allocation and income distribution. Libyan community should reduce unnecessary power usage. People can use energy efficient technologies to improve national energy security. Energy saving at every household is also beneficial to reduce the cost of electricity bills.

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