MODELLING AUTOREGRESSIVE INTEGRATED MOVING AVERAGE OF ELECTRICITY GENERATED AND CONSUMED IN KWARA STATE

***Olatunde John* Kuranga.**

Department of Statistics, Kwara State Polytechnic, Ilorin.

Abstract

The study is based on modelling Autoregressive Integrated Moving Average (ARIMA) to the electricity generated by Ibadan Electricity Distribution Company, and also on electricity consumption in three zones of Kwara state (Challenge hub, Baboko and Omu-Aran business unit). It is aimed at constructing time plots, testing the presence of stationary, Autocorrelation and Partial Autocorrelation Function and also forecasting for the future electricity generated, and electricity consumption in three zones of Kwara state. With the help of Akaike Information Criteria (AIC), the best model was selected. The series of electricity generated by IBEDC in Challenge, Baboko and Omu-Aran, shows that there is stationary in the data while the consumptions are non-stationary, the first differencing give a stationary data. Autocorrelation and Partial Autocorrelation Function (ACF and PACF) plot help in the order of Autoregressive Integrated Moving Average (ARIMA) model, used in this study. The forecast shows an increase in both generated and consumption of electricity in Challenge hub, Baboko and Omu-Aran business unit. We also have high rate of electricity generated in December. We recommend Enlightenment campaign on the value of electricity and of the use ARIMA (1, 1, 1) for electricity generated to Challenge and Baboko while ARIMA (2, 1, 1) is recommended for that of Omu-Aran. But for electricity consumption we recommended ARIMA(2,1,2), for Baboko unit and Omu-Aran while challenge hub, ARIMA(1,1,2) is recommended.

Keywords: ARIMA, Stationary data, Electricity Generated, ACF and PACF, Consumption,

1. Introduction

Electricity has become vital in all aspect of society today. In the olden days, Stones, Palm oil and Wool were used to generate light but in this technology era, there are ways in which electricity are generated has been useful to mankind. At home, heating, cooking, baking, lighting, computer, telephone, radio, television depend on electricity. Even the solar powered lamps convert light to electricity. In transportation, cars, buses, train and others use electricity as motive power. In communication, it is used to transmit signals through computers, cell phones, fixed phones and others. Without electricity Communication would have been reduced to letters, lighting of fires or drums. In entertainment, MP3, DVD player, Sstereo and so on depend on electricity either by being connected directly or use of battery cells. In industry, electricity is used in manufacturing factory. In Banking industry, electricity is used to serve for computers, customers' satisfaction, and so on.

Eelectricity had been so helpful to mankind in the whole universe. It is therefore important to fit a model such as Autoregressive Integrated Moving Average (ARIMA) model to electricity generated through the prepaid meter in a country like Nigeria. Thus our study is aimed to fit an Autoregressive integrated moving average model **(ARIMA)** tor the electricity generated through the prepaid of Ibadan Electricity Distribution Company, Kwara zone (Challenge hub, Baboko and Omu-Aran business units). Our objectives are constructing time plots, testing the presence of stationary, Autocorrelation and Partial Autocorrelation Function and forecasting for the future electricity generated Secondary data extracted from the record book of I.B.E.D.C. at Challenge hub, Baboko and Omu-Aran business units in Kwara state was used. With aim of examing the level of consumption of electricity through their prepaid meter and how the company generates electricity for Challenge hub, Baboko and Omu-Aran business units, from 2007 to 2014.

2. Modeling

A process $\{X_t\}$ is an autoregressive process of order p abbreviated AR(p), where

$X_t = \alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \alpha_3 X_{t-3} + ... + \alpha_p X_{t-p} + \varepsilon_t$ ...1

Provided $\{\boldsymbol{\varepsilon_t}\}$ is a purely random proces with mean zero and variance $\boldsymbol{\sigma_\varepsilon^2}$,

$\varepsilon_t = X_t - \alpha_1 X_{t-1} - \alpha_2 X_{t-2} - \alpha_3 X_{t-3} - ... - \alpha_p X_{t-p}$ ...2

, where X_t= time series under investigation, α_i= the autoregressive parameter of order i ≤ p, X_{t-i} = i the time series lagged period, ε_t= the error term of the model. The first – order, when p=1. Is abbreviated AR (1), such that

AR (1): $X_t = \alpha_1 X_{t-1} + \varepsilon_t$

is called the Markov Process. Box Jenkins model is called a moving average model. (Chatfield. 2003): It looks very similar to the AR model,. Moving average parameter 'q' relates what happens in period't' only to the random errors that occurred in the past time period such as ε_{t-1} ε_{t-2} ε_{t-3} rather than X_{t-1} X_{t-2} X_{t-3} as in the autoregressive model (AR). A moving average model with order 'q' is given as

$$X_t = \varepsilon_t - \beta_1 \varepsilon_{t-1} - \beta_2 \varepsilon_{t-2} - \ldots\ldots - \beta_q \varepsilon_{t-q}$$

, where{ε_t } is White Noise Process(WNP) with variance σ^2, X_t = time series under investigation, β_i= the moving average parameter of order i≤ q, $\boldsymbol{\varepsilon_{t-1}}$= the random error in the previous period, $\boldsymbol{\varepsilon_t}$ = the error term of the model. Moving average of order q = 1 is

MA (1) $X_t = \varepsilon_t + \beta_1 \varepsilon_{t-1}$

, where { $\boldsymbol{\varepsilon_t}$} is a WNP with variance σ^2. Moving average of order q = 2 is

MA (2) $\boldsymbol{X_t = \varepsilon_t - \beta_1 \varepsilon_{t-1} - \beta_2 \varepsilon_{t-2}}$

Autoregressive integrated moving average is abbrevated [ARIMA] is in a class of Auto Regressive Moving Average [ARMA] models. (Box, G.E.P. Jenkins, G.M., and Reinsel, G.C. 1994): They are introduced in order to include non- stationarity in mean. Non-stationary time series become stationary with differencing step (corresponding to the 'integrated' part of the model). ARIMA model is generally denoted as ARIMA (p,d,q), where p,d,q, are non- negative integers with p = order of autoregressive model, d = degree of differencing, q = order of moving average model. Thus ARIMA can be defined as

$$X_t^d = \alpha_1 X_{t-1}^d + \alpha_p X_{t-p}^d - \beta_1 \varepsilon_{t-1} - \beta_q \varepsilon_{t-q} \qquad \ldots 3$$

, where X_t^d = the differenced time series. The data collected were examined to see which member of the class of ARIMA processes appears to be most appropriate. The Box-Jenkins methodology for optimal model selection was used. The optimal model parameters criterion of the sample ACF and PACF [Autocorrelation and Partial Autocorrelation Functions] were ploted.

These plots help in determining the order of AR and MA terms. A minimizion of a quantity called Akaike's information criterion (AIC) and Bayesian information criterion (BIC) which penalize models with large numbers of parameters were used for model selection,

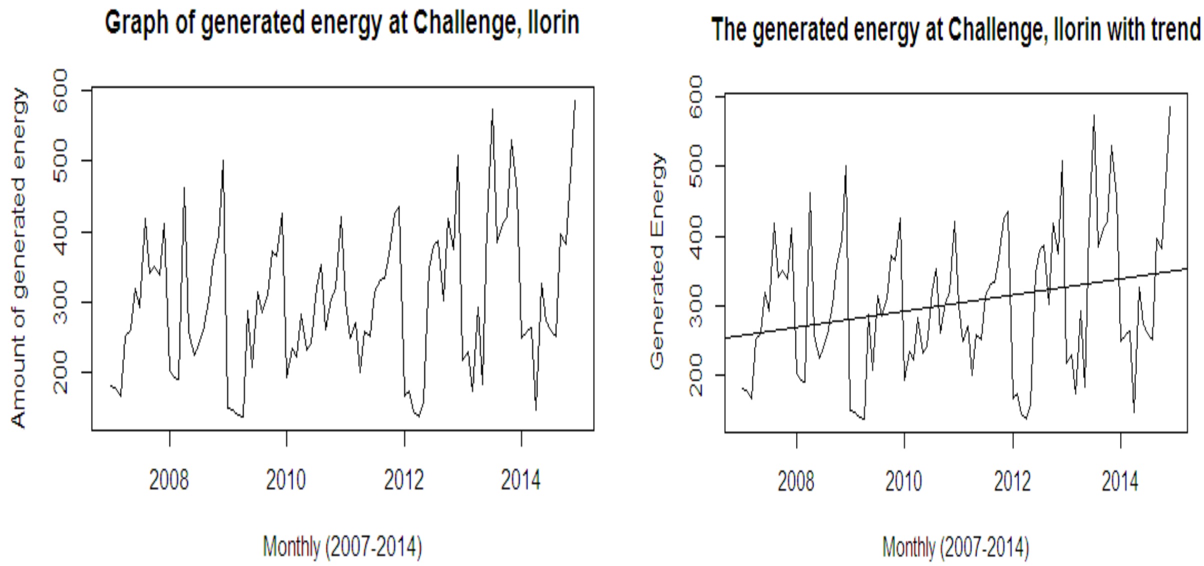
AIC(p) = nIn($\bar{\sigma}_e^2/N$) + 2p; BIC (p) = nIn ($\bar{\sigma}_e^2/N$) +p + In(N)

, where N is the number of observations to which the model is fitted, p is the number of parameters in the model, $\bar{\sigma}_e^2$ is the sum of sample squared residuals. The optimal model order is chosen by the number of model parameter which minimizes either AIC or BIC.

3. Numerical Results

Eletricity Generated: The original data collected from challenge Eletrification business hub is shown in table 1 of appendix 1. From the table, we absevеd an increase from Jan 2007 (79.4) and in Jan 2008 to 201.43 it keeps on increasing frome one Jan to anothe for the years under investigation. High value were obseved in all the Decembers when compare with January.

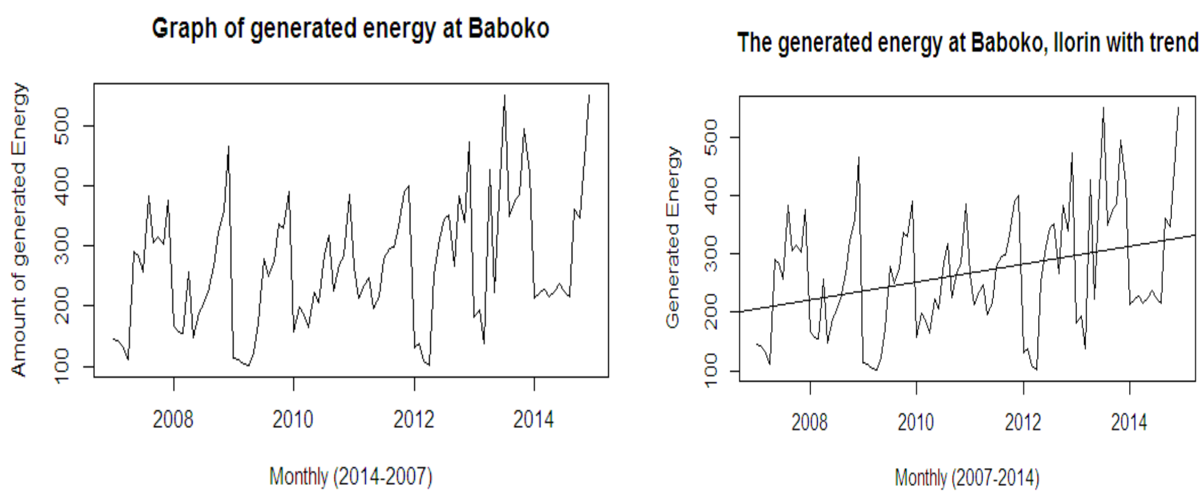
Fg.1: Graph of Original data and Graph of orignal data with trend for electricity generated IBEDC to Challenge business hub 2007 to 2014



There are stationarity in the series of generated energy over the year and general rise in trend over the years.

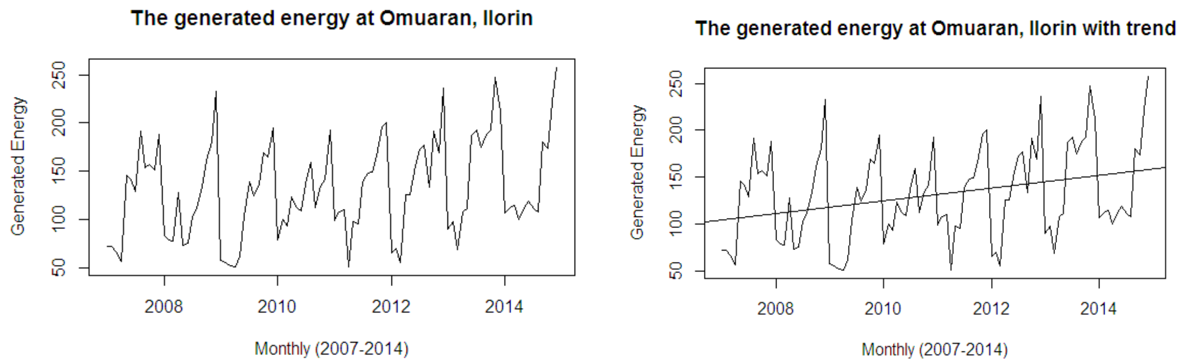
The original data was collected from Baboko electricity business unit is shown in table 2 of the Appendix1. Looking at the table, we obseved a steady increas.

Fig 2: Graph of Origina data and graph of original data with Trend of electricity Generated byIBEDC to Baboko, Ilorin business unit 2007 to 2014



There is stationarity in series; and a steady upward rise in trend of electricity generated. The original data was collected from Omu-Aran electricity business unit as shown in table 3.of the Appendix1. Looking at the table, we obseved a stedy increas in Eletricity generated.

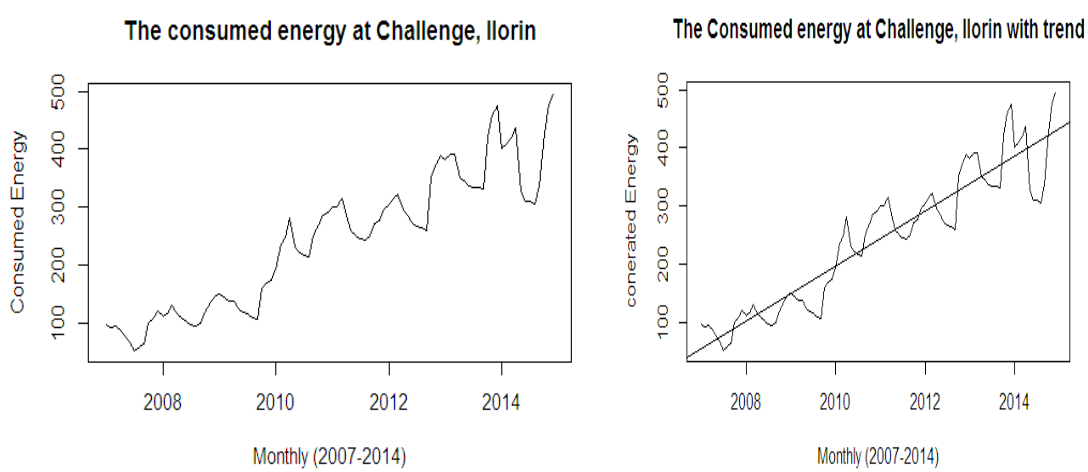
Fig 3: Graph of Origina data and graph of original data with Trend of electricity generated byIBEDC to Omu-Aran business unit (2007 to 2014)



We obseved stationarity in the series, and a steady upward rise in trend of generated energy over the year.

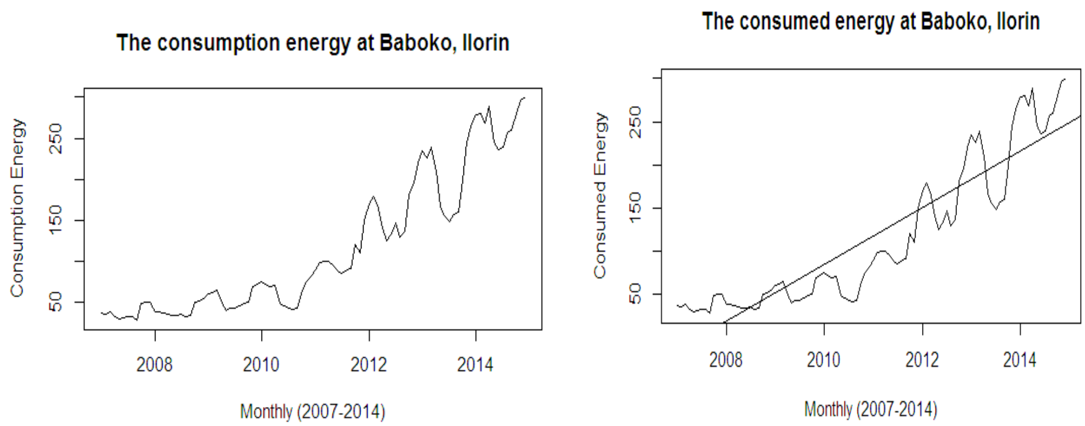
Electricity Consumed: The original data collected on electricity consumed from Challenge electricity business hub is shown in table 4; from the table we observed a general increas in electricity consumed.

Fig.4: Graph of original data and graph of original data with trend for electricity Consumed in Challenge, Ilorin business hub.



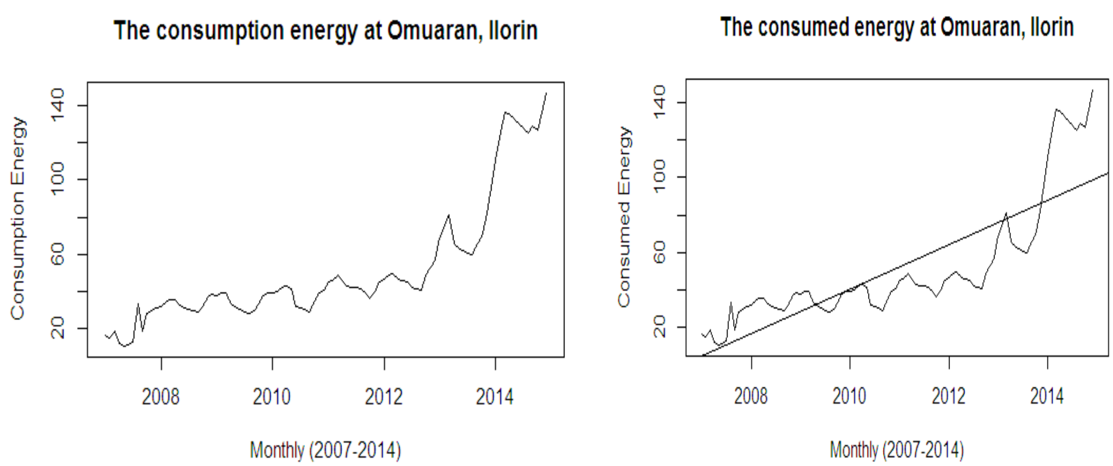
There is non stationarity in the series of consumed energy over the year and the upward trend of consumed energy over the month. The original data collected from Baboko electricity business unit is shown in table4. Looking at the table we obseved an increase.

Fig 5: Graph of Original data and Graph of Original data with trend for electricity consumed in Baboko business unit.



There is non-stationarity in the data series of consumed energy and upward trend of consumed energy observed over the month. The original data collected from Omu-Aran electricity business unit is shown in table 6. Looking at the table, we obseved that there is not a remakable increase till 2013 from where it rose from 68.96 to 110.56 in Jan 2014.

Fig 6: Graph of Original date and Graph of Original data with trend for electricity consumed in Omu-Aran business unit.



There is upward rising in 2014 and non-stationarity in the series of consumed energy over the month. There is upward trend of consumed energy over the month. Augmented Dickey-Fuller Test was selected for stationarity test as follows.

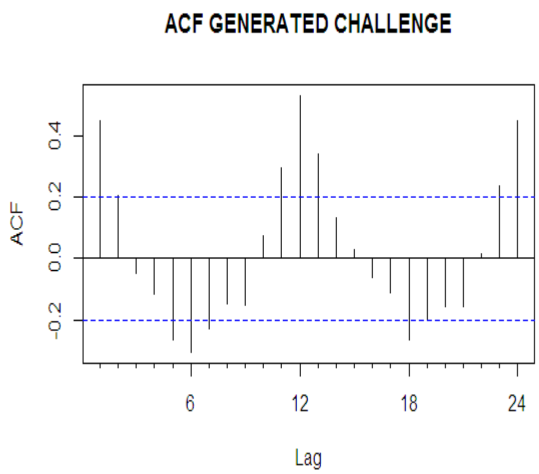
Generated Challenge Stationarity Test:

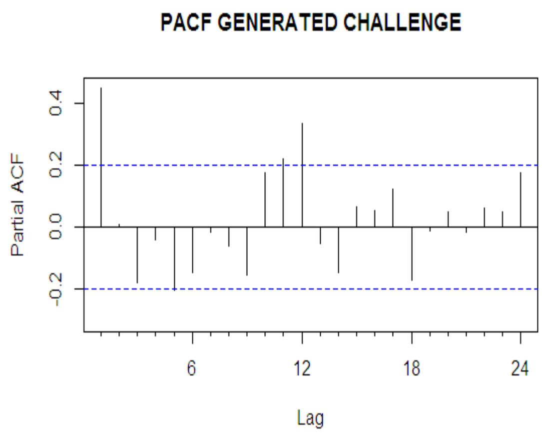
H_0 =No stationarity in the series; H_1 = There is Stationarity in the series

Test Statistic: Dickey-Fuller= -5.3519, p-value=0.01

Decision: Reject $\boldsymbol{H_0}$if $p - value < 0.05$, otherwise we do not.

Conclusion: Since p-value < 0.05, we do not accept tH_0. There is stationarity in the series.





The two plots reveal that there is autocorrelation at lag(1).

Proposed Models

Fit ARIMA(2,1,2)	AIC=1139.95	BIC=1150.67
Fit ARIMA(1,1,1)	**AIC=1138.52**	**BIC=1146.18*****
Fit ARIMA(2,1,1)	AIC=1140.46	BIC=1152.72
Fit ARIMA(1,1,2)	AIC=1140.48	BIC=1150.7
Fit ARIMA(1,0,0)	AIC=1146.63	BIC=1154.32
Fit ARIMA(1,0,1)	AIC=1148.60	BIC=1158.86
Fit ARIMA(0,1,1)	AIC=1149.54	BIC=1154.65
Fit ARIMA(1,1,0)	AIC=1150.67	BIC=1155.78
Fit ARIMA(0,0,1)	AIC=1153.14	BIC=1160.83

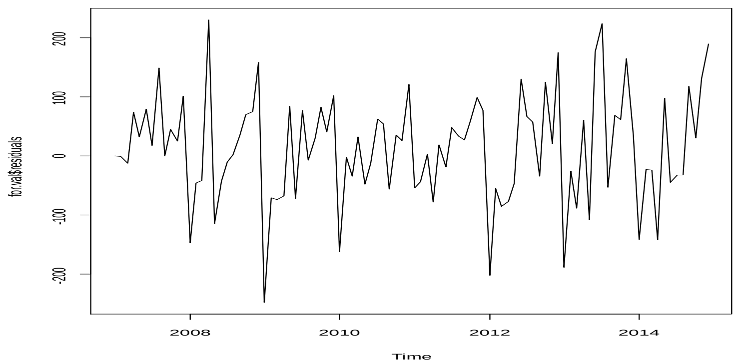
Fit ARIMA(0,1,0)	AIC=1156.24	BIC=1158.79
Fit ARIMA(0,0,0)	AIC=1168.49	BIC=1173.62

Selected Model: The smallest **AIC = 1138.52 and BIC = 1146.18** with ARIMA (1, 1, 1). Thus ARIMA (1, 1, 1) is selected as the best model.

ARIMA (1, 1, 1): $\Delta^{1}X_{t}$= 0.488X_{t-1}+0.9696e_{t-1}

Forecast Value for Electricity Generated for Challenge.

Point	Forecast	Lo 95	Hi 95
Jan 2015	456.0024	271.8395	640.1654
Feb 2015	392.1427	184.6927	599.5927
Mar 2015	360.9762	147.0550	574.8974
Apr 2015	345.7655	129.5966	561.9343
May 2015	338.3419	121.1771	555.5067
Jun 2015	334.7189	116.9848	552.4530
Jul 2015	332.9507	114.8124	551.0889
Aug 2015	332.0877	113.6158	550.5596
Sep 2015	331.6665	112.8931	550.4400
Oct 2015	331.4610	112.4013	550.5207
Nov 2015	331.3607	112.0222	550.6992
Dec 2015	331.3117	111.6982	550.9252



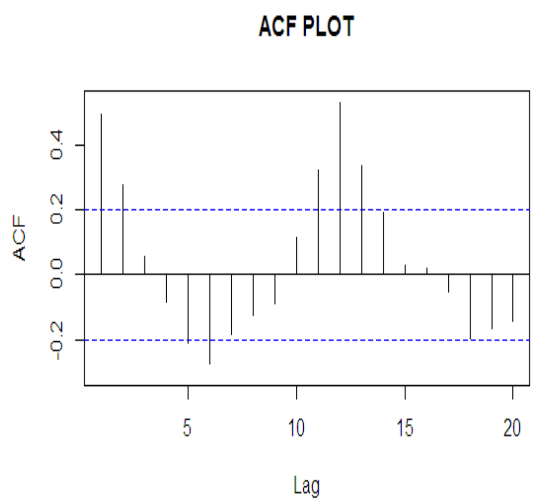
Generated Baboko Stationarity

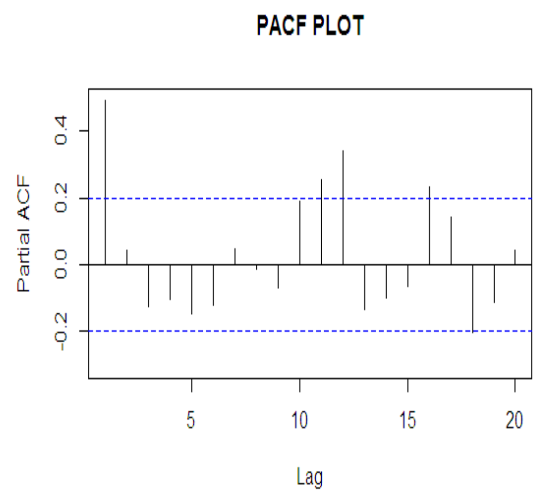
H_0 =No stationarity in the series; H_1 =There is stationarity in the series

Test Statistic: Dickey-Fuller= -5.2974, p-value=0.01

Decision: Reject$\boldsymbol{H_0}$if $p - value < 0.05$, otherwise does not

Conclusion: Since p-value < 0.05, weH_0. There is stationarity in the series.





The ACF plot reveals the order of auto-regressive part of the model AR (1) while PACF plot reveals the order of moving average part of the model MA (1) for Baboko energy generated data

Proposed Models

Fit ARIMA(1,1,1)	**AIC=1132.41**	**BIC=1140.07*** **
Fit ARIMA(2,1,1)	AIC=1134.15	BIC=1144.37
Fit ARIMA(1,1,2)	AIC=1134.25	BIC=1144.46
Fit ARIMA(0,1,1)	AIC=1141.45	BIC=1146.56
Fit ARIMA(1,1,0)	AIC=1142.37	BIC=1147.48
Fit ARIMA(1,0,0)	AIC=1141.53	BIC=1149.22
Fit ARIMA(1,0,1)	AIC=1143.31	BIC=1153.56
Fit ARIMA(0,1,0)	AIC=1148.30	BIC=1150.85

Fit ARIMA(0,0,1)	AIC=1150.42	BIC=1158.11
Fit ARIMA(0,0,0)	AIC=1169.00	BIC=1174.13

Selected Model

The smallest **AIC = 1132.41 and BIC = 1140.07** with ARIMA (1, 1, 1). Thus ARIMA (1, 1, 1) is selected as the best model

ARIMA(1,1,1) model : $\Delta^{1}\boldsymbol{X_t}$= 0.5108$X_{t-1}$- 0.9583$e_{t-1}$

Forecast Value For Electricity Generated For Baboko**.**

Point	Forecast	Lo 95	Hi 95
Jan 2015	436.1672	257.51919	614.8153
Feb 2015	377.0809	172.97987	581.1818
Mar 2015	346.9018	134.75579	559.0478
Apr 2015	331.4874	116.13721	546.8376
May 2015	323.6144	106.65722	540.5715
Jun 2015	319.5931	101.63019	537.5560
Jul 2015	317.5392	98.82315	536.2552
Aug 2015	316.4901	97.13632	535.8440
Sep 2015	315.9543	96.01849	535.8901
Oct 2015	315.6806	95.19090	536.1704
Nov 2015	315.5409	94.51188	536.5698
Dec 2015	315.4695	93.90928	537.0296

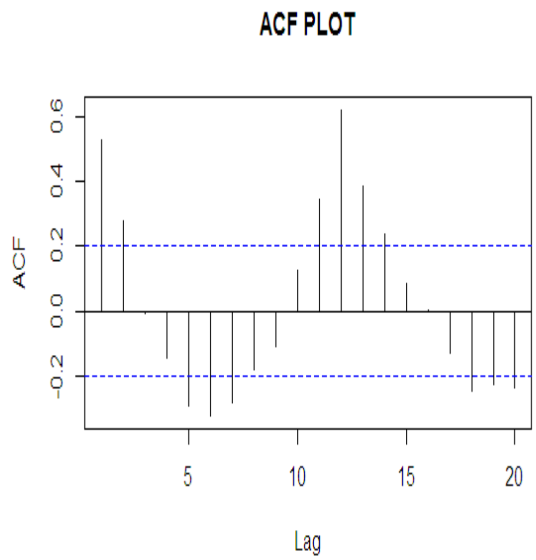
Generated Omu-Aran Stationarity Test

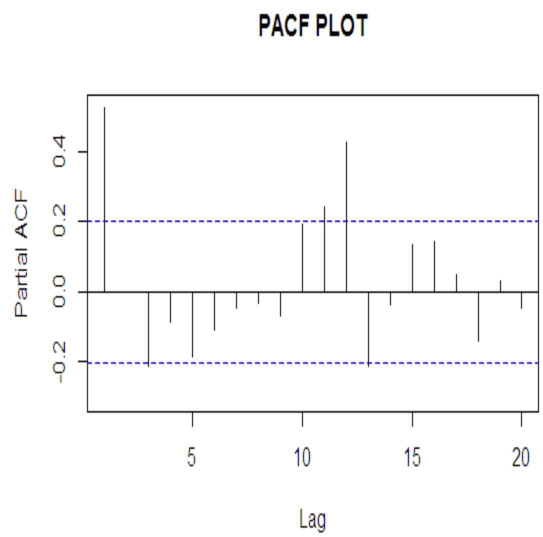
H_0 =No stationarity in the series; H_1 =There is stationarity in the series

Test Statistic: Dickey-Fuller = -5.7172, Lag order = 4, p-value = 0.01

Decision: Reject$\boldsymbol{H_0}$if $p - value < 0.05$, otherwise do not

Conclusion: Since p-value < 0.05, we rejectH_0. There is stationarity in the series.





The ACF plot reveals that there is autocorrelation at lag (1) and at the same lag (1) on PACF plot

Proposed Models

Fit ARIMA(2,1,1)	**AIC=988.03**	**BIC=998.25*** **
Fit ARIMA(1,0,0)	AIC=993.22	BIC=1000.91
Fit ARIMA(1,1,2)	AIC=996.75	BIC=1006.96
Fit ARIMA(1,0,1)	AIC=995.20	BIC=1005.46
Fit ARIMA(0,1,1)	AIC=996.31	BIC=1001.42
Fit ARIMA(1,1,0)	AIC=996.34	BIC=1001.45
Fit ARIMA(0,1,0)	AIC=999.86	BIC=1002.41
Fit ARIMA(0,0,1)	AIC=1004.11	BIC=1011.81
Fit ARIMA(0,0,0)	AIC=1025.35	BIC=1030.48

Selected Model: The smallest **AIC = 988.03 and BIC = 998.25** with ARIMA (2, 1, 1). Thu s ARIMA (2, 1, 1) is selected as the best model

$\Delta^1 X_t$= 0.5487X_{t-1}-0.0183X_{t-2}-0.9658e_{t-1}

Forecast valeu for electricty generated for Omu-Aran

Point	Forecast	Lo 95	Hi 95
Jan 2015	245.674	157.2937	334.0541

`Feb 2015	245.674	135.2182	356.1297
Mar 2015	245.674	116.8722	374.4756
Apr 2015	245.674	100.8317	390.5162
May 2015	245.674	86.3984	404.9495
Jun 2015	245.674	73.1686	418.1793
Jul 2015	245.674	60.8835	430.4644
Aug 2015	245.674	49.3657	441.9822
Sep 2015	245.674	38.4872	452.8607
Oct 2015	245.674	28.1521	463.1958
Nov 2015	245.674	18.2863	473.0616
Dec 2015	245.674	8.8310	482.5169

The forecast valu is constant at 245.674

Consumption

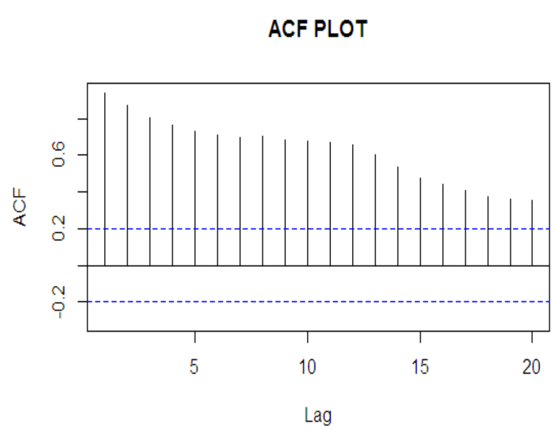
Challenge Augmented Dickey-Fuller Test

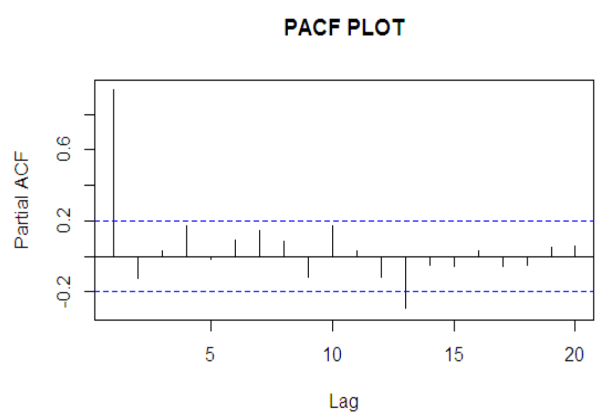
H_0 =No stationarity in the series; H_1 = There is stationarity in the series

Test Statistic: Dickey-Fuller = -5.8021, Lag order = 4, p-value = 0.01

Decision: Reject$\boldsymbol{H_0}$if $p - value < 0.05$, otherwise do not

Conclusion: Since p-value < 0.05, we reject H_0.There is stationarity in the series.





The ACF plot reveals the order of auto-regressive part of the model s AR (1) while PACF plot reveals the order of moving average part of the model MA (2) for Challenge energy consumption

Proposed Model

Fit ARIMA(1,0,1)	AIC=912.52	BIC=922.78
Fit ARIMA(1,0,0)	AIC=916.34	BIC=924.04
Fit ARIMA(0,1,1)	AIC=896.38	BIC=901.49
Fit ARIMA(0,1,0)	AIC=899.79	BIC=902.34
Fit ARIMA(0,0,1)	AIC=1092.14	BIC=1099.83
Fit ARIMA(0,0,0)	AIC=1189.88	BIC=1195.01
Fit ARIMA(2,1,2)	AIC=895.19	BIC=907.96
Fit ARIMA(1,1,2)	**AIC=895.11**	**BIC=905.33***
Fit ARIMA(1,1,1)	AIC=897.59	BIC=905.26
Fit ARIMA(1,1,0)	AIC=895.60	BIC=900.7

Selected Model: The smallest **AIC = 895.11 and BIC = 905.33** with ARIMA (1, 1, 2). Thus ARI MA (1,1,2) is selected as the best model.

$\Delta^1 \boldsymbol{X_t}$= -0.6346$X_{t-1}-0.9427e_{t-1}-0.3649e_{t-2}$

Forecast Value for Electricity Consumption in Challenge.

Point	Forecast	Lo 95	Hi 95
Jan 2015	493.9810	442.67910	545.2830
Feb 2015	495.3615	410.88884	579.8341
Mar 2015	494.4855	380.99145	607.9795
Apr 2015	495.0414	361.54683	628.5359
May 2015	494.6886	342.16082	647.2164
Jun 2015	494.9125	326.43112	663.3938
Jul 2015	494.7704	311.16529	678.3755
Aug 2015	494.8605	297.61445	692.1066
Sep 2015	494.8033	284.60504	705.0016

Oct 2015	494.8396	272.55955	717.1197
Nov 2015	494.8166	261.00761	728.6256
Dec 2015	494.8312	250.07862	739.5838

The Forecast Value 494.8 is Relatively Stable.

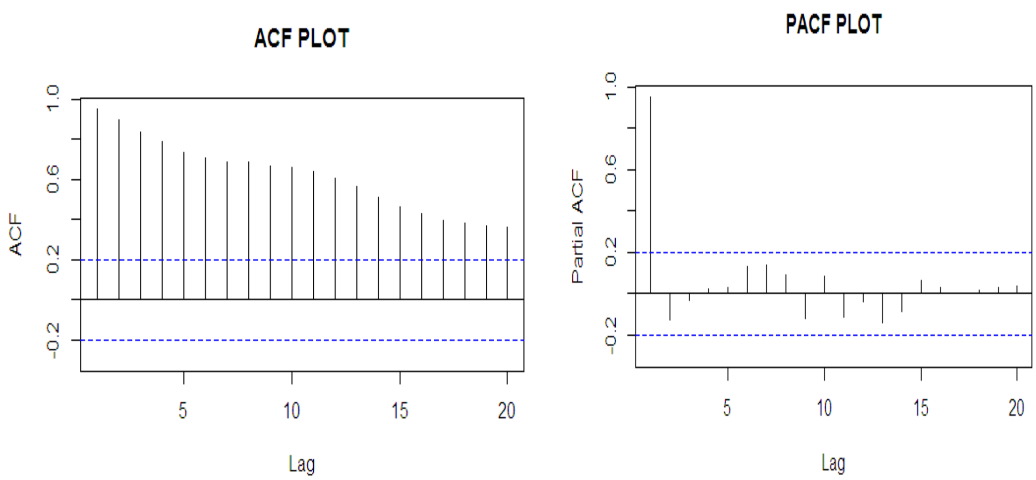
Baboko Stationarity Test: Augmented Dickey-Fuller Test

H_0 =No stationarity in the series: H_1 = There is stationarity in the series

Test Statistic: Dickey-Fuller = -2.7775, Lag order = 4, p-value = 0.2568

Decision: Reject$\boldsymbol{H_0}$if $p - value < 0.05$, otherwise do not

Conclusion: Since p-value < 0.05, we shall rejectH_0. There is no stationarity in the series, we therefore difference the series.



The ACF plot reveals the order of auto-regressive part of the model. This is AR (2) while PACF suggested the order of moving average part of the model MA (2) for Baboko energy consumption data

Proposed Model

Fit ARIMA(0,0,0)	AIC=1125.15	BIC=1130.28
Fit ARIMA(0,0,1)	AIC=1018.67	BIC=1026.36
Fit ARIMA(0,1,0)	AIC=788.37	BIC=790.92
Fit ARIMA(0,1,1)	AIC=782.19	BIC=787.29

Fit ARIMA(1,0,0)	AIC=804.45	BIC=812.14
Fit ARIMA(1,0,1)	AIC=798.00	BIC=808.25
Fit ARIMA(1,1,0)	AIC=779.82	BIC=784.92
Fit ARIMA(1,1,1)	AIC=781.33	BIC=788.99
Fit ARIMA(1,1,2)	AIC=782.43	BIC=792.64
Fit ARIMA(2,1,1)	AIC=782.82	BIC=793.04
Fit ARIMA(2,1,2)	**AIC=755.51**	**BIC=768.28*** **

Selected Model

The smallest **AIC = 755.51 and BIC = 768.28** with ARIMA (2, 1, 2). Thus ARIMA (2, 1, 2) is selected as the best model.

$\Delta^1 X_t = 1.6383X - 0.9548X_{t-2} - 1.5456e_{t-1} - 1.0000e_{t-2}$

Forecast Value for Electricty Consumption at Baboko

Point	Forecast	Lo 95	Hi 95
Jan 2015	296.1755	272.26028	320.0907
Feb 2015	283.2307	247.53398	318.9274
Mar 2015	265.2450	217.74712	312.7429
Apr 2015	248.1381	188.06197	308.2143
May 2015	237.2842	164.49186	310.0764
Jun 2015	235.8352	151.30233	320.3681
Jul 2015	243.8246	149.46799	338.1813
Aug 2015	258.2972	156.42650	360.1679
Sep 2015	274.3797	167.09945	381.6600
Oct 2015	286.9099	175.72694	398.0928
Nov 2015	292.0828	177.79040	406.3752
Dec 2015	288.5942	171.32406	405.8644

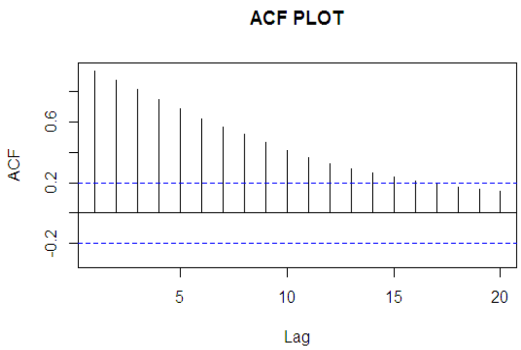
Omu-Aran Stationarity Test: Augmented Dickey-Fuller Test

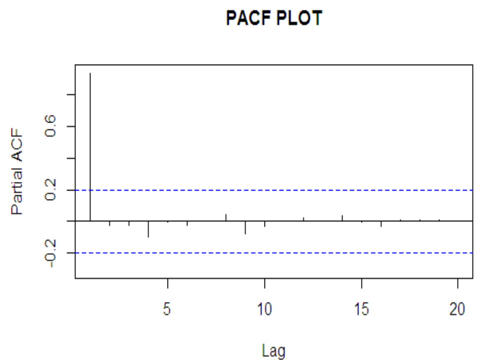
H_0 =No stationarity in the series; H_1 =There is stationarity in the series

Test Statistic: Dickey-Fuller = -0.41211, Lag order = 4, p-value = 0.984

Decision: Reject$\boldsymbol{H_0}$if $p - value < 0.05$, otherwise do not

Conclusion: Since p-value < 0.05, we do not rejectH_0. There is no stationarity





The ACF plot reveals the order of auto-regressive part of the model **AR(2)** while PACF plot reveals the order of moving average part of the model **MA(2)** for Omu-Aran energy consumption data.

Proposed Model

Fit ARIMA(4,1,1)	AIC=589.07	BIC=604.39
Fit ARIMA(2,1,2)	**AIC=574.86**	**BIC=587.63***
Fit ARIMA(2,1,1)	AIC=590.19	BIC=600.41
Fit ARIMA(1,1,2)	AIC=588.44	BIC=598.66
Fit ARIMA(1,1,1)	AIC=591.78	BIC=599.45
Fit ARIMA(1,1,0)	AIC=593.05	BIC=598.15
Fit ARIMA(0,1,1)	AIC=596.06	BIC=601.17
Fit ARIMA(0,1,0)	AIC=599.32	BIC=601.87
Fit ARIMA(0,0,1)	AIC=841.31	BIC=849.01
Fit ARIMA(0,0,0)	AIC=949.01	BIC=954.13

Selected Model

The smallest **AIC=574.86 and BIC=587.63** with ARIMA (2, 1, 2). Thus ARIMA (2, 1, and 2) is selected as the best model.

$\Delta^1 \boldsymbol{X_t}$= 1.7185$X_{t-1}$- 0.9789$X_{t-2}$ - 1.6093e_{t-1} - 0.9515e_{t-2}

Forecast Value for Electricty Consumption at Omu-Aran**.**

Point	Forecast	Lo 95	Hi 95
Jan 2015	155.7824	146.50512	165.0597
Feb 2015	163.9759	150.11669	177.8351
Mar 2015	169.2246	151.03128	187.4180
Apr 2015	170.2243	147.65806	192.7905
May 2015	166.8044	139.93826	193.6706
Jun 2015	159.9489	129.10075	190.7970
Jul 2015	151.5152	117.23348	185.7968
Aug 2015	143.7325	106.68986	180.7751
Sep 2015	138.6134	99.46997	177.7568
Oct 2015	137.4344	96.72608	178.1428
Nov 2015	140.4193	98.50052	182.3380
Dec 2015	146.7028	103.73921	189.6663

COMMENT: Forecast Value reveals a decreas in consumption.

4. Summary of Results

The Original data collected on electricity generated, (Tables 1,2,3) reveals that there is high rate of electricity generated in December when compared with other months for all the three zones and for all the 8 years counsidered. There is general rise in trend over the years for the three zones. Generally electricity generated is zig zag in nature. Plots 1,2,3 reveals that there is stationary in the three series of electricity generated. Augmented Dickey-Fuller Test was used to carry out the stationary test of each series for electricity generated in all the three zones. In the case of eletricity consumed plots 4, 5, 6 reveal the non stationarity in the series of eletricity consumed over the years in the entire three zones. We also observe a steap upward trend of consumed energy for all the three zones over the month. Augmented Dickey-Fuller Test was also used to carry out the stationary test of each series. The best Autoregressive Integrated Moving Average (ARIMA) model selected for electricity generated for **Challenge** is ARIMA **(1,1,1)** with the smallest **AIC = 1138.52 and BIC = 1146.18.** The forecast value reveal a general decress from 456.0024 to 331.3117. The Baboko electricity generated with **ARIMA(1,1,1)** is the best model with the smallest **AIC = 1132.41 and BIC = 1140.07.** The forecast value reveals a general decrease from 436.1672 to 315.4695. Omu-Aran electricity generated has the smallest **AIC = 988.03 and BIC = 998.25** with ARIMA (2,1,1). Thus ARIMA (2, 1, 1) selected is the best model. The Forecast value is generaly stable as 245.674. In the same way for electricity consumed in the three zones; the same Augmented Dickey-Fuller test was used to carry out the stationary test.

The original data collected on electricity consumed reveals a general increase in electricity consu med. The data is non stationarity. plot 7 reveals an upward trend of consumed energy. Non-statio narity in the data series was revealed at Baboko business unit. Upward trend in eletricity consum ed was revealed in the unit. The same Non-stationarity and upward trend in eletricity consumed was revealed at Omu-Aran business unit as well. The best Autoregressive Integrated Moving Ave rage (ARIM) model selected for electricity consumption at challenge hub is ARIMA(1,1,2) moda l. It has the smallest AIC = 895.11 and BIC = 905.33. The forecast Value is Relatively Stable at 4 94.8312. The best ARIMA model selected for electricity consumption at Baboko unit is ARIMA(2,1,2), model. It has the smallest AIC = 755.51 and BIC = 768.28 . The forecast Value is not stab le intialy at 296 1755 millions of kwh troping to 283.2307, and droping further till September wh en it pick up to 274.3797, and finaly at 288.5942 millions of kwh. Finaly the best ARIMA selecte d for electricty consumption in omu-aran is ARIMA (2,1,2).Model. It has the smallest AIC=574. 86 and BIC=587.63. Forecast Value reveals a decrease in Consumption. From 163.9759 to 140.4 193 millions of kwh.

5. Conclusion

There is high rate of electricity generated in December when compared with other months.Generally
electricity generated is zig zag in nature. We have rise in trend for electricity generated and electricity consumed in the three zones. There is stationary in the three series of electricity generated. Augmented Dickey-Fuller Test was used to carry out the stationary test of each series for electricity generated in all the three zones. Non stationarity in the series of eletricity consumed and a stip upward trend of consumed energy in all the three zones.

ARIMA model for electricity generated to **Challenge** is ARIMA **(1,1,1).** The forecast value shows a general decrease. ARIMA model at **Baboko** electricity generated is **ARIMA(1,1,1).** The forecast value revealed a general decrease from 436.1672 to 315.4695 . ARIMA model of **Omu-Aran** electricity generated is **ARIMA (2,1,1).** The Forecast value is generaly stable at 245.674. The best Autoregressive Integrated Moving Average (ARIM) model for electricity consumption at **challenge hub** is ARIMA(1,1,2) model. The forecast value is relatively stable at 494.8312. The best ARIMA model for electricity consumption at **Baboko unit** is ARIMA(2,1,2) model. The forecast value is not stable. The best ARIMA for electricty consumption at **Omu-Aran** is ARIMA (2,1,2) model. Forecast value reveals a decrease in consumption from 163.9759 to 140.4193 millions of kwh. It is recommended that

-Ibadan Electricity Distribution Company (IBEDC) should generate more electricity for consumers, expecaily at Challenge and Baboko zones to meet up with the increase in demad.

-Enlightenment campaign on the need for electricity is needed at Omu-Aran

-Establishment of industry and factory are required to enhance need for electricity at Omu-Aran zone.

-We strongly recommended ARIMA (1,1,1) for electricity generated at Challenge and Baboko. while ARIMA (2,1,1) is recommended for that of Omu-Aran. For electricity consumption, we recommended ARIMA(2,1,2), for Baboko unit and Omu-Aran while ARIMA(1,1,2) is recommended for challenge hub.

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APPENDIX

Table 1 Monthly Electricity Generated to Prepaid Meter in Millions Kwh

TIME	2007	2008	2009	2010	2011	2012	2013	2014
Jan	179.6	201.43	149.65	193.33	299.54	164.5	215.55	247.36
Feb	178.53	192.5	145.7	234.74	249.2	172.87	229.74	259.01
Mar	165.85	189.25	138.17	222.21	269.57	144.59	173.34	263.31
Apr	249.89	461.23	137.43	281.33	198.84	136.16	291.29	146.88

Source: From the record book of I.B.E.D.C. Challenge business unit.

May	259.35	257.72	286.64	231.14	258.68	159.56	181.98	325.72
Jun	318.03	224.61	206.76	241.07	251.06	346.99	409.99	273.31
Jul	292.64	239.35	314.16	320.56	312.75	379.43	574.86	258.12
Aug	418.63	257.72	285	352.53	329.96	387.74	384.43	249.89
Sept	341.56	300.83	307.91	259.63	333.97	301.99	411.68	395.52
Oct	349.92	358.03	372.91	304.35	367.4	418.03	420.17	382.53
Nov	337.09	395.03	365.39	318.15	426.01	374.46	529.84	478.38
Dec	411.49	500.03	425.6	420.47	436.3	508.4	457.45	586.85

Table 2 Monthly Electricity Generated to Prepaid Meter in Millions Kwh

TIME	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Jan	144.6	166.43	114.65	158.33	264.54	129.5	180.55	212.36
Feb	143.53	157.5	110.7	199.74	214.2	137.87	194.74	224.01
Mar	130.85	154.25	103.17	187.21	234.57	109.59	138.34	228.31
Apr	111.88	256.29	101.16	163.84	246.33	102.43	426.23	214.89
May	290.72	146.96	124.54	223.68	196.14	251.64	222.72	224.35
Jun	283.03	189.61	171.76	206.07	216.06	311.99	374.99	238.31
Jul	257.64	204.35	279.16	285.56	277.75	344.43	549.86	223.12
Aug	383.63	222.72	250	317.53	294.96	352.74	349.43	214.89
Sep	306.56	265.83	272.91	224.63	298.97	266.99	376.68	360.52
Oct	314.92	323.03	337.91	269.35	332.42	383.03	385.17	347.52
Nov	302.02	360.03	330.39	283.15	391.01	339.46	494.84	443.38
Dec	376.49	465.03	390.6	385.47	401.3	473.4	422.45	551.85

Source: From the record book of I.B.E.D.C. Baboko business unit.

Table 3 Monthly Electricity Generated to Prepaid Meter in Millions Kwh

TIME	2007	2008	2009	2010	2011	2012	2013	2014
Jan	72.34	83.22	57.33	79.17	98.69	64.75	90.28	106.18
Feb	71.79	78.75	55.35	99.87	107.71	69.94	97.37	112.16
Mar	65.48	77.13	51.59	93.61	110.29	54.8	69.17	114.16
Apr	55.96	128.1	50.58	123.17	51.22	125.12	107.45	99.92
May	145.38	73.48	62.27	111.84	98.07	125.82	111.36	112.18
Jun	141.54	74.81	103.04	108.83	95.88	155.92	187.5	119.16
Jul	128.8	102.18	139.58	142.78	138.88	172.22	192.93	111.56
Aug	191.28	111.36	125	158.77	147.48	177.37	174.72	107.45
Sep	153.2	132.92	136.46	112.42	149.49	133.5	188.34	180.26
Oct	157.47	161.52	168.96	134.68	166.2	191.52	192.59	173.77
Nov	151	180.02	165.2	141.58	195.51	168.73	247.42	221.69
Dec	188.24	232.52	195.3	192.74	200.63	236.7	211.23	257.93

Source: From the record book of I.B.E.D.C. Omu-Aran business unit

Table 4: Monthly Eletricity Consumed by Prepaid Meter in Millions Kwh

TIME	2007	2008	2009	2010	2011	2012	2013	2014
Jan	97.56	110.45	149.65	193.33	299.54	305.56	380.9	400.12
Feb	92.34	115.78	145.7	234.74	300.15	315.45	390.45	410.98
Mar	95.45	130.32	138.17	248.12	315.24	320.96	392.14	420.95
Apr	87.98	115.25	137.43	281.33	285.16	295.45	350.45	435.68
May	75.65	108	125.29	231.14	258.68	286.68	345.45	325.72
Jun	65.47	101.51	118.26	220.15	251.06	272.34	335.65	310.14
Jul	50.95	95.68	115.34	215.45	245.78	265.78	334.1	309.12
Aug	58.96	93.56	109.56	213.14	242.19	263.45	333.33	305.16
Sep	62.45	99.45	105.34	248.96	249.13	260.1	331.12	335.45
Oct	99.9	119.45	158.98	269.14	272.45	350.45	420.17	426.12
Nov	108.45	135.28	168.76	285.45	275.45	374.46	457.45	478.38
Dec	120.45	145.32	172.34	290.92	295.65	389.45	475.78	495.15

Source: From the record book of I.B.D.C. Challenge business hub

Table 5: Monthly Electricity Consumed by Prepaid Meter in Millions Kwh

TIME	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Jan	36.5	39.12	60.24	75.23	90.5	170.25	234.45	278
Feb	35.2	38.34	62.12	70.35	98.2	178.45	225.7	280.45
Mar	38.9	37.45	65.23	69.84	100.24	168.95	239.67	268.87
Apr	32.12	35.43	48.32	71.1	99.9	140.34	210.34	289.34
May	30.45	34.34	39.56	48.23	95.46	125.44	167.45	245.45
Jun	31.45	34.81	42.75	45.65	88.88	134.35	155.45	235.68
Jul	32.58	35	43.46	43.23	85.34	146.25	148.8	238.75
Aug	33.15	33.34	45.55	42.1	90.45	129.98	157.45	256.34
Sep	28.12	34.89	48.9	43.44	91.91	136.34	160.45	260.1
Oct	48.12	49.9	50.34	65.56	120.56	180.9	199.45	280.45
Nov	49.78	52.35	69.55	75.9	110.45	195	245.45	295.67
Dec	50.93	55.34	72.45	82.58	150.34	220.34	268.89	299.55

Source: From the record book of I.B.E.D.C Baboko business unit.

Table 6: Monthly Electricity Consumed by Prepaid Meter in Millions Kwh

TIME	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Jan	16.5	32.12	37.56	39.1	45.15	46.87	68.96	110.56
Feb	15.25	34.15	38.98	40.12	46.12	48.45	75.34	125.59
Mar	18.9	35.34	39.46	42.18	48.95	49.58	80.74	136.46
Apr	12.25	35.43	33.25	43.26	45.65	46.87	65.38	135.45
May	10.45	32.35	31.67	41.55	43.12	45.65	63.46	132.48
Jun	11.45	31.12	30.1	32.15	42.25	44.76	62.17	130.56
Jul	12.58	30.56	29.1	31.12	42.1	42.38	60.45	127.45
Aug	33.15	29.36	28.45	30.14	41.07	41.07	59.89	125.55
Sep	18.91	28.9	29.55	29.25	39.45	40.34	65.45	128.93
Oct	28.12	32.12	33.45	34.68	36.56	48.98	69.45	126.54

Nov	29.45	36.75	37.88	38.94	39.89	53.16	78.9	136.32
Dec	30.93	38.34	38.98	40.45	45.23	56.87	95.48	146.76

Source: From the record book of I.B.E.C. Omu-Aran business unit.