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Short Term Power Production Forecasting in Smart Grid based on Hybrid Power Plant

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Abstract— Invention of electricity made our daily life easier and now it has became an essential part of our life. In few decays electricity consumption has increased many folds. Companies and scientists are trying to make more electricity efficient devices. Sustainable energy is a good option for pollution free efficient electricity production but it doesn't produce electricity in a constant rate to fulfil the substantial requirement because of its dependence upon never vanishing source which are upon season, weather, geographical condition and many other factors which always varies. In hybrid power plants less stock of fuel causes load-shedding and over stocking of fuel directly effects economic expects of the plant. In this project, we proposed a novel double step, hybrid short-term power production forecasting technique in smart grid; based on hybrid power plant; for power load balancing by advance fuel stocking for diesel generator for short term to produce regular electricity, which doesn't fulfilled by electricity produced by hybrid power plant and battery bank; which is charged by extra electricity production. We have assumed that a hybrid power plant is consists of 1-axis PV (Solar Panel) Modules, battery bank, diesel generator and miscellaneous things. We have used multiple short-term forecasting techniques such as AutoRegressive Integrated Moving Average (ARIMA) and Seasonal ARIMA (SARIMA) as a hybrid short-term forecasting technique in place of blindly depending upon single one. The proposed technique will be useful to prevent load-shedding which the main goal of the project.

Keywords— *short-term forecasting, smart grid, ARIMA, SARIMA, hybrid power plant, solar panel, solar energy.*

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I. Introduction

Electricity is a part of our daily life made our daily life easier and its power load (power consumption) and electricity generation in a balance manner is very important to minimize load shedding for smooth and regular electricity supply. In few decays electricity consumption is increasing in rapid rate. Many companies and scientists are trying to making more electricity efficient devices for balancing power load (power consumption) and electricity generation. Sustainable energy is a good option for pollution free efficient electricity production because it is produced by recyclable source of energy which could be reproduce (bio gas, bio fuel, bio diesel etc.) or an energy which is produced by nature resources (it is available in earth is huge amount and it will be exist in whole life of the earth such as solar light, water fall kinetic energy, tidal, wave, geo-thermal, wave etc.) in a cyclic manner but it doesn't produce electricity in a constant rate due to its dependency on season, weather and many other factors which always varies.

In this research, we are going to study about hybrid solar plant (as shown in Fig. 1) and its dynamic behavior towards the nature such as effect of the sun position towards solar panel, effect of cloudy weather [5] and different seasons etc. Hybrid solar plant couldn't produce electricity in a constant manner, therefore additions power resources (i.e. diesel engine, power storage or other mean of electricity etc.) are required to fulfil shortage of electricity at night, cloudy weather and rainy season for constant and regular power supply.

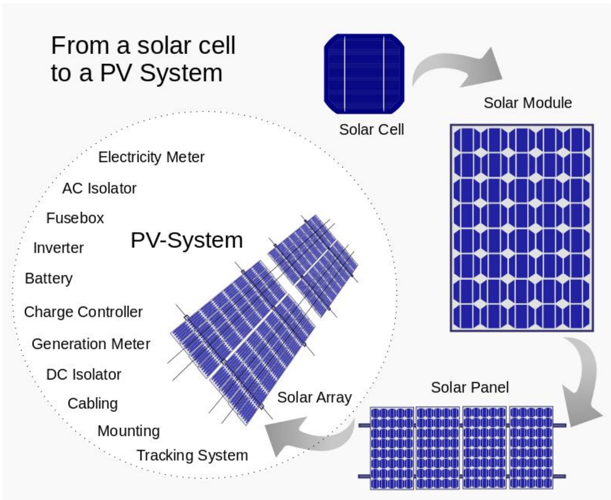

Fig. 1. From a solar cell to a PV system

Advance fuel stocking for diesel generator is required for short term (i.e. we assumed here next seven days) to produce regular electricity, which doesn't fulfilled by electricity produced by smart grid [4], [10] based on hybrid power plant and battery bank; which is charged by extra electricity production. Advance fuel stocking or allocation is generally decided by assistant manager or manager on the basis of forecasting system [6], [7], [8] prediction report. That means forecasting system technology directly effects advance fuel shocking process which very import for efficient working of hybrid power plant on daily routine basis and regular and balanced power generation and supply w. r. to power load / power consumption. In hybrid power plants less stock of fuel causes load-shedding and irregular power generation and over stocking of fuel directly effects economic expects of the plant. In this way accuracy of the forecasting technique (short-term) plays an important role hybrid power plant for regular power supply.

In our research and literature survey we observed that all research scholars are focusing on a specific forecasting method for short-term forecasting [9] but according to George Edward Pelham Box (British statistician) - "Essentially, all models are wrong, but some are useful" i.e. a model is not always best for different kind of data and for different kind (i.e. short-term, medium-term and long term) of forecasting. And we also found that in mostly research papers performance and accuracy of the proposed short-forecasting techniques are evaluated by mean error w. r. t. gathered historical data and forecasted data but don't focusing on predicted output data which the main objective of any forecasting.

Aim of this research to develop/propose a high accuracy and high performance short term forecasting technique for power production forecasting in smart grid based on hybrid power plant without blindly depending upon single short-term forecasting technique to achieve the goal of load-shedding prevention by regular and smooth electricity generation.

For the achievement of the aim, our object is to develop a hybrid short-term forecasting technique which should consist of multiple short-term forecasting techniques. Here we are going to use AutoRegressive Integrated Moving Average (ARIMA) and Seasonal ARIMA (SARIMA) standard and popular short-term forecasting techniques with double checking technique for predicted output data accuracy evaluation. Here, we have assumed that a smart grid based on hybrid power plant is consists of 1-axis PV (Solar Panel) Modules, battery bank, diesel generator and miscellaneous things.

In this paper, in we will discuss hybrid power systems in section II, literature survey of different of research papers, in section III we will focus on limitations of the papers and their solution, further in section IV we will discuss about different methodologies and formulas which are used in the proposed system and old standard systems. In section V problem formulation and proposed system/technique is discussed. After that in section VI experimental result & discussion has been discussed then conclusion and future scope is discussed in section VII. After that literature references are mentioned.

II. Hybrid Power Systems

Hybrid power systems/plants (as shown in Fig. 2) use a fossil fuel i.e. diesel or gas as well as renewable energy source as a supplement such as hydro, solar, tidal, wind, wave. Some of them combine renewable sources and battery storage in order to achieve minimum consumption of expensive diesel or oil. However, there is a worldwide trend for natural gas to replace diesel and, with the substantial decline in the cost of batteries, to employ batteries to store surplus power for later use.

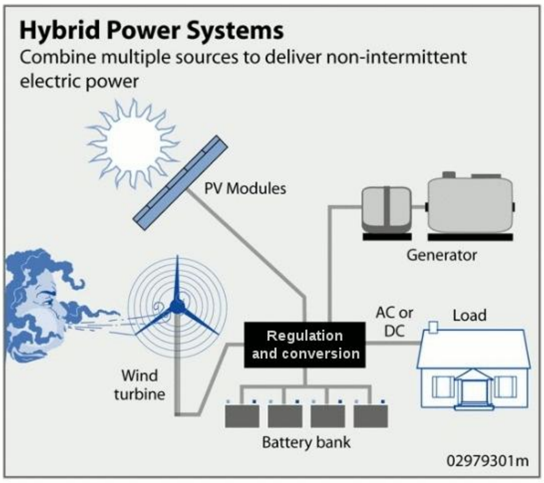

Fig. 2. Hybrid Power Systems

Hybridizing CHP with PV can enable additional PV deployment above what is possible with a conventional centralized electric generation system. In addition, large PV+CHP systems are possible for institutional buildings, which again provide back up for intermittent PV and reduce CHP runtime.

a) PVT system (hybrid PV/T): also known as photovoltaic thermal hybrid solar collectors convert solar radiation into thermal and electrical energy. Such a system combines a solar (PV) module with a solar thermal collector in a complementary way.

b) CPVT system: A concentrated photovoltaic thermal hybrid (CPVT) system is similar to a PVT system. It uses concentrated photo-voltaic (CPV) instead of conventional PV technology, and combines it with a solar thermal collector.

c) CPV/CSP system: A novel solar CPV/CSP hybrid system has been proposed recently, combining concentrator photovoltaic with the non-PV technology of concentrated solar power (CSP), or also known as concentrated solar thermal.

d) PV diesel system: It combines a photovoltaic system with a diesel generator. Combinations with other renewable are possible and include wind turbines.

III. Literature Review

In literature survey we found many research scholars are working on sustainable energy/renewable energy and short term power production forecasting in smart grid based on hybrid power plant.

[1] Mohini et al. In this paper artificial neural network (ANN) and generalized neural network are used for Renewable Energy Forecasting and compared the performance of the proposed model with ARIMA model which is used for solar power forecasting.

[2] Ömer et al. In this paper Seasonal Autoregressive Integrated Moving Average (SARIMA) and Artificial Neural Network (ANN) are discussed and presented their comparative performances.

[3] C. Creayla et al. In this paper, artificial intelligence (AI) techniques used to capture the nonlinear PV fluctuation in a better way and the wavelet transform (WT) is used to have a significant impact on ill-behaved PV power time-series data.

In the literature review we observed that all research scholars are focusing on a specific forecasting method for short-term forecasting but the reality is "Essentially, all models are wrong, but some are useful" said by George Edward Pelham Box (British statistician) i.e. a model is not always best for different kind of data and for different kind (i.e. short-term, medium-term and long term) of forecasting. In all the above research papers performance and accuracy of the proposed short-term forecasting techniques are evaluated by percentage error i.e. Average of Errors (E) w. r. t. gathered historical data and forecasted data but don't focusing on predicted output data which the main objective of any forecasting.

So, in this paper we are going to use multiple short-term forecasting techniques such as AutoRegressive Integrated Moving Average (ARIMA) and Seasonal ARIMA (SARIMA) as a hybrid short-term forecasting technique with double checking technique for predicted output data accuracy evaluation.

IV. Methodologies

A. *Calculate the hourly solar energy output of a photovoltaic system*

The global formula to estimate the electricity generated in output of a photovoltaic system [11] is:

$$E = A * r * H * PR \qquad (1)$$

Where,

E = Energy (in kWh)

A = Total solar panel Area (in m2)

r = solar panel yield or efficiency (in %)

H = Hourly average solar radiation on tilted panels (shedding not included)

PR = Performance ratio, coefficient for losses (range between 0.5 and 0.9, default value = 0.75)

r is the yield of the solar panel given by the ratio : electrical power (in kWp) of one solar panel divided by the area of one panel.

B. *ARIMA Model*

Let specify an ARIMA(2,1,2) model,
i.e.

$$(1 - \phi_1 L - \phi_2 L^2)(1 - L)y_t = (1 + \theta_1 L + \theta_2 L^2)\varepsilon_t$$

The result is a model with two non-seasonal AR coefficients (***p*** = 2), two non-seasonal MA coefficients (***q*** = 2), and one degree of differencing (***D*** = 1). The property P is equal to ***P + D***= 3. NaN values indicate estimable parameters.

C. *Seasonal ARIMA (SARIMA) Model*

Let specify a multiplicative seasonal ARIMA ***(SARIMA)*** model with no constant term,
i.e.

$$(1 - \phi_1 L)(1 - \Phi_{12} L^{12})(1 - L)^1(1 - L^{12})y_t = (1 + \theta_1 L)(1 + \Theta_{12} L^{12})\varepsilon_t,$$

where, the innovation distribution is Gaussian with constant variance. Here, ***(1-L)^1*** is the first degree nonseasonal differencing operator and ***(1-L^12)*** is the first degree seasonal differencing operator with periodicity 12.

The name-value pair argument ARLags specifies the lag corresponding to the nonseasonal AR coefficient, ϕ_1. SARLags specifies the lag corresponding to the seasonal AR coefficient, here at lag 12. The nonseasonal and seasonal MA coefficients are specified similarly. D specifies the degree of nonseasonal integration. Seasonality specifies the periodicity of the time series, for example Seasonality = 12 indicates monthly data. Since Seasonality is greater than 0, the degree of seasonal integration D_s is one.

Whenever you include seasonal AR or MA polynomials (signaled by specifying SAR or SMA) in the model specification, arima incorporates them multiplicatively. arima sets the property P equal to $\boldsymbol{p + D + p_s + s}$ (here, 1 + 1 + 12 + 12 = 26). Similarly, arima sets the property ***Q*** equal to $\boldsymbol{q + q_s}$ (here, 1 + 12 = 13).

D. *Average of Errors (E):*

Average of Errors (E)

i.e. $$\bar{E} = \frac{\sum_{i=1}^{N} E_i}{N} \qquad (2)$$

V. PROPOSED SYSTEM

In this research we have studied about hybrid solar plant and observed its dynamic behavior towards the nature such as effect of the sun position towards solar panel, effect of cloudy weather and different seasons etc. So, it don't produce electricity in constant manner therefore additions power resources (i.e. diesel engine, power storage or other mean of electricity etc.) are required to fulfil shortage of electricity at night, cloudy weather and rainy season for constant and regular power supply to prevent load-shedding.

The uniqueness of the work is it doesn't favour any model in advance and its' double accuracy checking system in two steps.

We have assumed that a smart grid based hybrid power plant is consists of 1-axis PV (Solar Panel) Modules, battery bank, diesel generator and miscellaneous things.

We have used multiple short-term forecasting techniques; theses are AutoRegressive Integrated Moving Average (ARIMA) and Seasonal ARIMA (SARIMA). We have used formula (mention in equation (1)) for solar panel energy measurement which is produced by solar irradiation and multiple the extra required electricity in MW and fuel (in liter) per MW for fuel consumption calculation.

A. DATA GATHERING

We have gathered historical power load data in hourly basis of Patna from "Central Load Dispatch, Bihar State Power Holding Company Limited (or BSPHCL), also known as Bihar State Electricity Board (BSEB), Patna, Bihar" and historical weather data in hourly basis of Patna from "National Renewable Energy Laboratory (NREL) website https://maps.nrel.gov/gst-india/" of 01-Jan-2012 to 31-Dec-2014.

B. PRE-PROCESSING

We applied pre-processing in the collected historical data (X) for retrieving relevant data in right format for short-term forecasting. Break down historical data is into two parts for the propose technique into last seven days (X12) data and remaining data from starting (X11).

Here, X=X11+X12 (no. of hours or period difference).

C. MODEL FITTING

Step 1: we have applied AutoRegressive Integrated Moving Average (ARIMA) and Seasonal ARIMA (SARIMA) model one by one on pre-processed historical data (X11) of hourly solar radiation and power load for short-term (seven days X11) forecasting and estimated accuracy of the model by calculating percentage error i.e. AVERAGE OF ERRORS (E) w. r. t. the predicted data of seven days (F11) and last seven days data (X12) from historical data which has been taken before.

D. BEST MODEL SELECTION AND FORECASTING

Select the model which has minimum error and use the forecasting model to prediction the next seven days (X12).

E. ESTIMATE EXTRA POWER REQUIRED

We used predicted DNI hourly data as H in equation 1 for calculating hourly energy produced by solar panels. And assume predicted power load hourly data as hourly power consumption.

The difference in forecasted (predicted) total power load and forecasted (predicted) total power production (incl. power from battery bank) in next seven days is equal to the additional electricity power required, which is proportional to required fuel for diesel engine in next seven days (F22).

F. ESTIMATE EXTRA FUEL FOR DIESEL ENGINE

To estimate extra fuel for diesel engine in next seven days (F22), multiple the extra required electricity in MW and fuel (in liter) per MW for fuel consumption calculation and minus the available fuel.

Block diagram of the proposed technique is shown in Fig. 3.

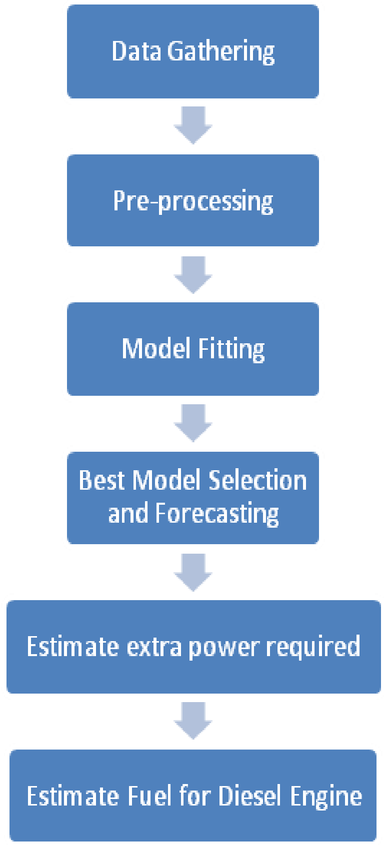

Fig. 3. Block diagram of the proposed technique

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VI. Experimental Result And Discussion

A. *EXPERIMENTAL SETUP*

For the performance and accuracy evaluation of the proposed technique we have gathered historical power load data in hourly basis of Patna from "Central Load Dispatch, Bihar State Power Holding Company Limited (or BSPHCL), also known as Bihar State Electricity Board (BSEB), Patna, Bihar" and historical weather data in hourly basis of Patna from "National Renewable Energy Laboratory (NREL) website https://maps.nrel.gov/gst-india/" of 01-Jan-2012 to 31-Dec-2014 (as shown in Table II and Table III). After that the pre-processing procedure has been applied in the collected historical data (X) for retrieving relevant data in right format for short-term forecasting. Here, it is assumed that a smart grid based hybrid power plant consists of 1-axis PV (Solar Panel) Modules, battery bank, diesel generator and miscellaneous things. Multiple short-term forecasting techniques have been used in the proposed technique such as AutoRegressive Integrated Moving Average (ARIMA) and Seasonal ARIMA (SARIMA) techniques. We have used formula (mention in equation 1) for solar panel energy measurement which is produced by solar irradiation and we have multiplied the extra required electricity in MW and fuel (in liter) per MW for fuel consumption computation.

The proposed technique performance and accuracy have been compared with other short-term forecasting techniques i.e. AutoRegressive Integrated Moving Average (ARIMA) and Seasonal ARIMA (SARIMA) which are proposed in [1] and [2]. For the performance and accuracy evaluation of the proposed technique data of the last seven days (assumed as unknown data) (X12) have been taken from historical data; and compared the data with final predicted data (F11) which have come after the forecasting using proposed technique and [1] and [2] using percentage error i.e. AVERAGE OF ERRORS (E) from equation. 2.

Here, X=X11+X12 (no. of hours or period difference). Where, X12= F11

B. *EXPERIMENTAL EVALUATION*

In the literature review we observed that all research scholars are focusing on a specific forecasting method for short-term forecasting but the reality is "Essentially, all models are wrong, but some are useful" said by George Edward Pelham Box (British statistician) i.e. a model is not always best for different kind of data and for different kind (i.e. short-term, medium-term and long term) of forecasting. In all the above mentioned literature review (in Chapter 2) research papers performance and accuracy of the proposed short-forecasting techniques are evaluated by mean error w. r. t. gathered historical data and forecasted data but don't focusing on predicted output data which the main objective of any forecasting. So, in this paper we are going to use multiple short-term forecasting techniques such as AutoRegressive Integrated Moving Average (ARIMA) and Seasonal ARIMA (SARIMA) as a hybrid short-term forecasting technique with double checking technique for predicted output data accuracy evaluation.

For the purpose of comparing performance evolution and accuracy of the proposed technique and [1], [2] we have applied AutoRegressive Integrated Moving Average (ARIMA) and Seasonal ARIMA (SARIMA) model one by one on pre-processed historical data (X12) of hourly solar radiation (as shown in Fig. 4 to Fig. 12) and power load for short-term (seven days F11=F12) forecasting, and estimated accuracy of the model by calculating percentage error i.e. AVERAGE OF ERRORS (E) between predicted data (F11) of seven days and last seven days data (X12) from historical data which has been taken before and the output is noted down.

step 1: we have applied AutoRegressive Integrated Moving Average (ARIMA) and Seasonal ARIMA (SARIMA) model one by one on pre-processed historical data (X12) of hourly solar radiation and power load for short-term (seven days X12) forecasting, and estimated accuracy of the model by calculating percentage error i.e. AVERAGE OF ERRORS (E) w. r. t. the predicted data of seven days and last seven days data (F11) from historical data which has been taken before. (step 2) Select the model which has minimum error and use the forecasting model to prediction the next seven days (F22) and estimated accuracy of the model by calculating percentage error i.e. Average of Errors (E) w. r. t the predicted data of seven days and last seven days data (X2) from historical data which has been taken before and the output is noted down.

TABLE I. AVERAGE OF ERRORS (E) RESULTS

Techniques	Parameters	AVERAGE OF ERRORS (E)
ARIMA	Power Load	9.306182e+04
	Direct Normal Irradiance (DNI)	1.745701e+04
SARIMA	Power Load	9.307182e+04
	Direct Normal Irradiance (DNI)	1.746701e+04
Proposed technique	Power Load	9.306182e+04
	Direct Normal Irradiance (DNI)	1.745701e+04

Table I results showing that the proposed system is giving better accuracy and performance in comparison to [1] and [2].

We used predicted DNI hourly data as H in equation 1 for calculating hourly energy produced by solar panels. And we assumed that the predicted power load hourly data as hourly power consumption.

The difference between forecasted (predicted) total power load and forecasted (predicted) total power production (incl. power from battery bank) in next seven days is equal to the additional electricity power required (as shown in Fig. 12), which is proportional to required fuel for diesel engine in next seven days.

To estimate extra fuel for diesel engine in next seven days (X2) we have multiplied the extra required electricity in MW and fuel (in liter) per MW for fuel consumption calculation and minus the available fuel.

C. UNIQUENESS OF THE WORK

The uniqueness of the work is that it doesn't favour any model in advance and its' double accuracy checking system (i.e. step 1 and step 2).

D. EXPERIMENTAL RESULTS

TABLE II. HOURLY WEATHER DATA 2012-2014

	1 Year	2 Month	3 Day	4 Hour	5 DHI	6 DNI	7 GHI	8 SolarZenithAngle
1	2012	1	1	0	0	0	0	171.0307
2	2012	1	1	1	0	0	0	157.6354
3	2012	1	1	2	0	0	0	144.1284
4	2012	1	1	3	0	0	0	130.7088
5	2012	1	1	4	0	0	0	117.4642
6	2012	1	1	5	0	0	0	104.4406
7	2012	1	1	6	0	0	0	91.8931
8	2012	1	1	7	59	0	59	79.9776
9	2012	1	1	8	94	0	94	69.0415
10	2012	1	1	9	135	0	135	59.6382
11	2012	1	1	10	131	0	131	52.6078
12	2012	1	1	11	176	0	176	48.9907
13	2012	1	1	12	123	0	123	49.5437
14	2012	1	1	13	109	0	109	54.1386
15	2012	1	1	14	98	0	98	61.8783
16	2012	1	1	15	47	0	47	71.7463
17	2012	1	1	16	12	0	12	82.9785
18	2012	1	1	17	0	0	0	95.0855
19	2012	1	1	18	0	0	0	107.7587
20	2012	1	1	19	0	0	0	120.8068
21	2012	1	1	20	0	0	0	134.1020

TABLE III. HOURLY POWER LOAD DATA 2012-2014 IN MW

	1 Year	2 Month	3 Day	4 Hour	5 PowerLoad
1	2012	1	1	0	2.0423e+03
2	2012	1	1	1	1.9300e+03
3	2012	1	1	2	1.8501e+03
4	2012	1	1	3	1.7511e+03
5	2012	1	1	4	1.7448e+03
6	2012	1	1	5	1.7669e+03
7	2012	1	1	6	1.7805e+03
8	2012	1	1	7	1.8549e+03
9	2012	1	1	8	1.9494e+03
10	2012	1	1	9	2.0680e+03
11	2012	1	1	10	2.1864e+03

We have applied pre-processing to gather relevant data in right format for short-term forecasting using 'Matlab'.

=======Power Load=========

=======ARIMA=========

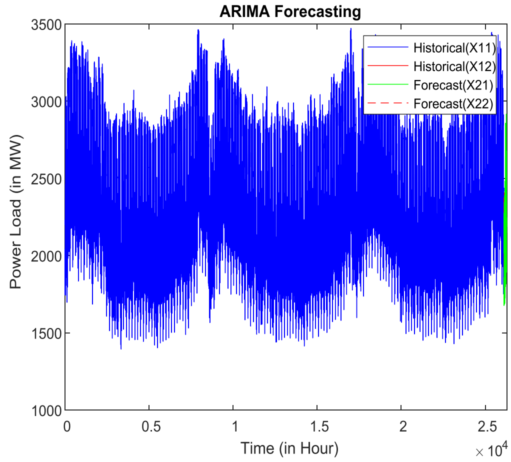

Fig. 4. Result of ARIMA Forecasting for Power Load

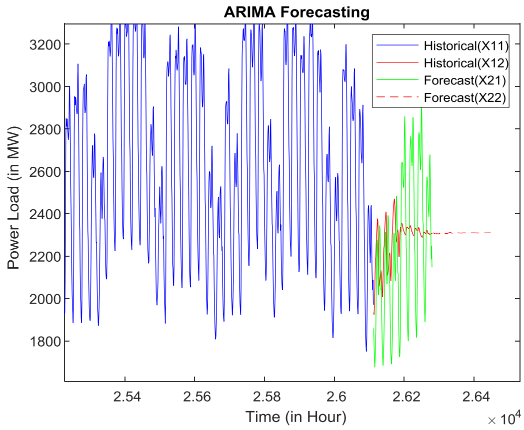

Fig. 5. Result of ARIMA Forecasting for Power Load (Zoomed)

ARIMA(80,1,80) Model (Gaussian Distribution):

	Value	StandardError	TStatistic	PValue
Constant	0.0086524	0.68618	0.012609	0.98994
AR{80}	-0.12021	0.022362	-5.3755	7.6368e-08
MA{80}	-0.22857	0.021045	-10.861	1.7719e-27
Variance	14646	106.48	137.54	0

AVERAGE OF ERRORS (E) = 9.306182e+04

=======SARIMA=========

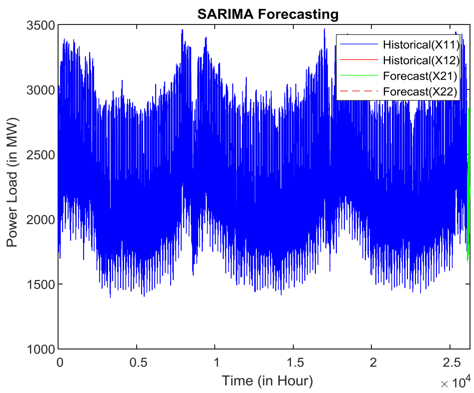

Fig. 6. Result of SARIMA Forecasting for Power Load

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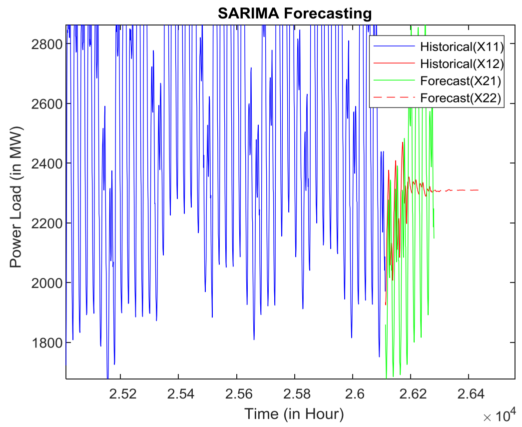

Fig. 7. Result of SARIMA Forecasting for Power Load (Zoomed)

ARIMA(80,1,80) Model (Gaussian Distribution):

	Value	StandardError	TStatistic	PValue
Constant	0.0086524	0.68618	0.012609	0.98994
AR{80}	-0.12021	0.022362	-5.3755	7.6368e-08
MA{80}	-0.22857	0.021045	-10.861	1.7719e-27
Variance	14646	106.48	137.54	0

AVERAGE OF ERRORS (E) = 9.307182e+04

BestModel = ARIMA

========DNI==========

========ARIMA==========

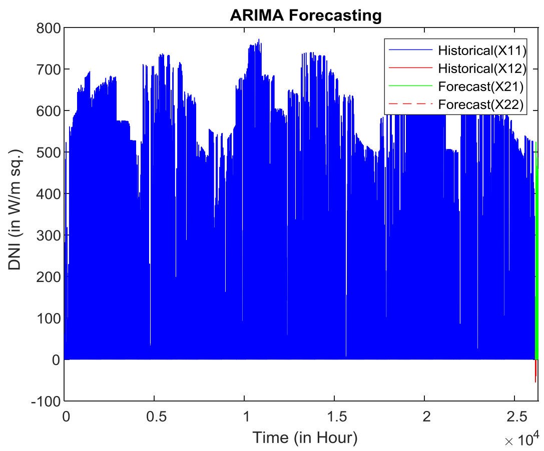

Fig. 8. Result of ARIMA Forecasting for DNI

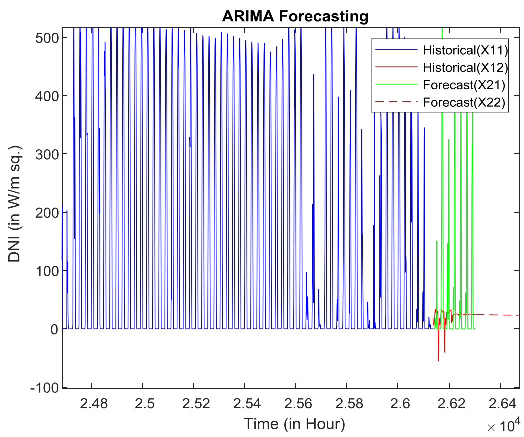

Fig. 9. Result of ARIMA Forecasting for DNI (Zoomed)

ARIMA(80,1,80) Model (Gaussian Distribution):

	Value	StandardError	TStatistic	PValue
Constant	-0.0089545	0.53401	-0.016768	0.98662
AR{80}	0.030545	0.029135	1.0484	0.29446
MA{80}	-0.24349	0.027661	-8.8025	1.3384e-18
Variance	11236	50.794	221.21	0

AVERAGE OF ERRORS (E) = 1.745701e+04

========SARIMA==========

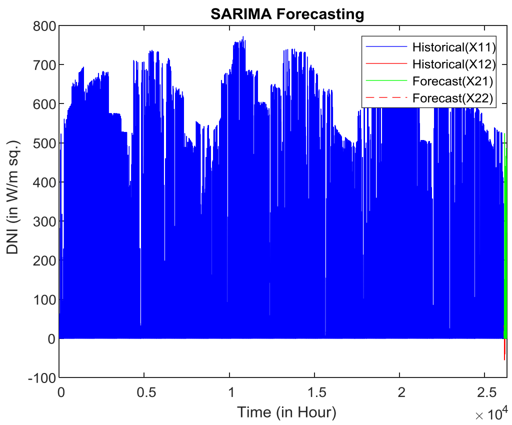

Fig. 10. Result of SARIMA Forecasting for DNI

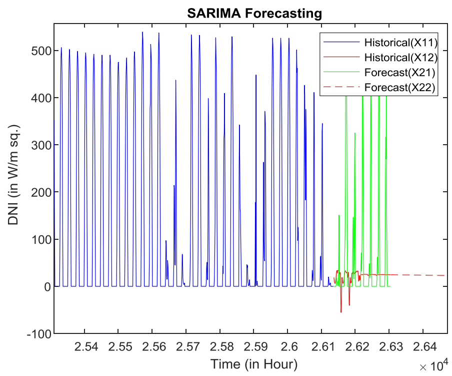

Fig. 11. Result of SARIMA Forecasting for DNI (Zoomed)

ARIMA(80,1,80) Model (Gaussian Distribution):

	Value	StandardError	TStatistic	PValue
Constant	-0.0089545	0.53401	-0.016768	0.98662
AR{80}	0.030545	0.029135	1.0484	0.29446
MA{80}	-0.24349	0.027661	-8.8025	1.3384e-18
Variance	11236	50.794	221.21	0

AVERAGE OF ERRORS (E) = 1.746701e+04

BestModel = ARIMA

Fuel Estimation

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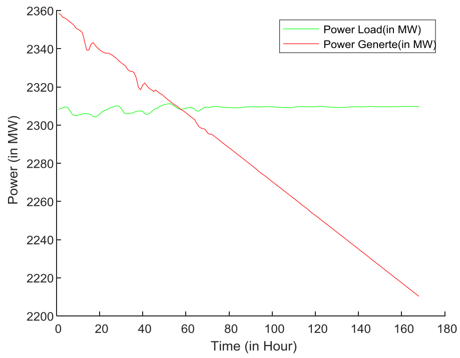

Fig. 12. Comparing predicted Power Load w. r. t. Power generated by solar panels

Let Assumed,

Fuel for 1 MW=100.000000 Liter

Area of solar panel = 1.420000e+08 m sq.

Result

Power Required = 4.184674e+03 MW

Fuel Required = 4.184674e+05 Liter

VII. Conclusion and Upcoming Work

Electricity is very important for our daily life activities. In this paper we have studied about solar systems, its types, utilisations and their pros and cons. Here we have gain knowledge of hybrid power grid, it architecture and working system. In this study we found that sustainable energy is a good option for pollution free efficient electricity production but it doesn't produce electricity in a constant rate because its depends on renewable energy which depends upon season, weather and many other factors which always varies. In hybrid power plants less stock of fuel causes load-shedding and irregular power generation and over stocking of fuel directly effects economic expects of the plant. In literature review we have studied about different kinds of short-term forecasting techniques which are used in electrical field some of them are AutoRegressive Integrated Moving Average (ARIMA) and Seasonal ARIMA (SARIMA) as a hybrid short-term forecasting technique. In the literature survey we observed that all research scholars are focusing on a specific forecasting method for short-term forecasting but the reality is "Essentially, all models are wrong, but some are useful" said by George Box (scientist) i.e. a model is not always best for different kind of data and for different kind (i.e. short-term, medium-term and long term) of forecasting, its varies. So, as a solution we proposed a novel double step, hybrid short-term power production forecasting technique in smart grid; based on hybrid power plant; for power load balancing by advance fuel stocking for diesel generator for short term to produce regular electricity, which is not fulfilled by electricity produced by hybrid power plant and battery bank; which is charged by extra electricity production. Here, it is assumed that a hybrid power plant consists of 1-axis PV (Solar Panel) Modules, battery bank, diesel generator and miscellaneous things.

We have used multiple short-term forecasting techniques such as AutoRegressive Integrated Moving Average (ARIMA) and Seasonal ARIMA (SARIMA) in place of blindly depending upon single one. We first pre-processed the historical data then break the historical data into two parts (i.e. X11 and X12 where the length of X12 is equal to the length of F11 which the forecasted result) thereafter we have applied ARIMA and SARIMA model on X11 one by one then measured the AVERAGE OF ERRORS (E) with respect to X11 and F11. After that we have selected model which have minimum AVERAGE OF ERRORS (E) and used its predicted result (i.e. F12) in estimation of the required fuel by getting difference between predicted power load and predicted power generated by solar panels. In performance evaluation we found the proposed technique giving better accuracy in short-term forecasting. The proposed technique will be useful to prevent load-shedding.

We will extend this research work by adding other existing and new forecasting techniques in the proposed system.

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