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Modeling Battery Monitoring System (Bms) On Photovoltaic Based Moving Average And Autoregressive Integrated Moving Average Model (Arima)

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Abstract- Battery Management System (BMS) is a tool used to monitor and manage battery conditions. In battery modeling to engineer batteries, it is necessary to identify the parameters. Accurate modeling and identification of parameters are required to create a reliable BMS system. In this study, battery modeling was carried out using a moving average and ARIMA model because it was able to predict the shape of the data to resemble its original form and was significant. Meanwhile, the identification of parameters is carried out using test data that has been carried out on a dataset of power consumption for 1 year. The results obtained by the ARIMA model which has the best accuracy for predicting BMS, namely the MSE test: 0.076 with a relatively small error deviation value.

Keywords- ARIMA, Moving Average, BMS, Photovoltaic, Modeling

I. INTRODUCTION

The use of batteries in photovoltaics presents several disadvantages, such as increased cost and reduced efficiency [1], and there are few studies cited in which batteries are considered [2]. Financial analysis conducted on several irrigation systems shows that the use of batteries in PV for energy storage is more cost-effective than connected to the grid [3]. Batteries with five years estimated life in cost analysis were carried out on various types of irrigation networks to ensure PV operation in unfavorable weather conditions, although short life results in a longer payback period than the no-storage solution [4]. A comparative cost analysis of energy storage in batteries was carried out in PV used in urban areas, and it was found that battery use is the most efficient alternative with the shortest payback period [5].
The development of BMS on PV was developed to monitor the condition of the battery. In 1998, BMS used a lead-acid battery (Accu) type battery [6]. In 2012, the standard for developing BMS for li-ion or lithium battery types was to ensure energy systems with parameters such as voltage, current, and battery temperature [7]. This scientific publication discusses modeling battery monitoring systems (BMS) on moving average-based photovoltaic and autoregressive integrated moving average model (ARIMA). The modeling parameters used in this BMS are data on the use of power consumption against the projected time value for the maximum and minimum total usage so that an optimal modeling system is obtained for the battery charging system.

II. METHODS

In this research, the method used is moving average and ARIMA with a modeling battery monitoring system (BMS). The BMS method is a technology system that maximizes battery life, to ensure the battery remains within ideal working parameters which include.

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1. Battery Modeling

The object of this research is the modeled battery. In this study, the data required is the size of the geometry, material, and currently given to the battery which is used for battery modeling. The limitations of the model used in this modeling are the battery with 1 cell and the completion of the model using the ComsolMultiphysics program. Determining the limit of this model aims to simplify the modeling by including the assumptions that have been set. geometric spaces used in the battery model are 1 dimensional and 2 dimensional. The size of the Geometry used corresponds to the actual battery. The geometry sizes used are shown in Table 1.

Table 1. Battery geometry size

Geometry	1 dimension	2 dimension	
	Thickness	Thickness	Width
Katoda	0,7 mm	0,2 cm	10 cm
Reservoir	1,76 mm	0,3 cm	10 cm
Separator	0.06 mm	0,05 cm	10 cm
Anode	0,75 mm	0,2 cm	10 cm

The equation used to model this battery is the charge diffusion equation as follows [12]:

$$\frac{\partial c_l}{\partial t} + \nabla.(-D_l \nabla c_l) + u.\nabla c_l = R_{1,src} \quad 1$$

$$\nabla.i_1 = Q_1 \quad 2$$

$$i_s = \epsilon^{exm} \ (-\sigma_s \nabla \emptyset_s) \quad 3$$

$$N_1 = -D_l \nabla c_l + uc_l \quad 4$$

Information :

N_l= total electrolyte flux (mol/m2s)

D_l= electrolyte diffusion coefficient (m2/s)

F= faraday constant (C/mol

$\emptyset_l$ = electrolyte voltage;

$\emptyset_s$= electrode voltage

u = speed (m/s)

cl = electrolyte concentration (mol/m3)

t= time(s)

Q l = source of charge from the electrolyte ;

Qs = source of charge from the electrode

il= current distribution in the electrolyte (A/m2)

is= current distribution in the electrolyte (A/m2)

R= ideal gas constant

2.Modeling System

MA (Moving Average) modeling is used to describe an event where the observations at time t are expressed as a linear combination of a number of residuals. The equation form of the MA Model can be written as follows:

$$\dot{\hat{y}}_t = \frac{1}{k}\sum_{n=1}^{k} y_{t-n} \quad 5$$

ARIMA (Autoregressive Integrated Moving Average) modeling is a periodic series analysis method known as BoxJenkins. This method is derived from the combination of Autoregressive (AR) and Moving Average (MA) developed by George Box and Gwilym Jenkins. Based on Box-Jenkins ARIMA consists of four stages, namely identification of time series methods, estimation of parameters for alternative methods, method tests, and estimation of time series values [8]. Assume stationary is an assumption that must be met in time series modeling. A non-stationary series can be converted into a stationary series by means of differentiation [9]. Non-stationary time series can include non-constant mean, non-constant variance, or both. Autoregressive is a method where the data in the previous period is very influential or influential on the current data [10], [11].

$$Z_t = \phi_1 Z_{t-1} + \phi_2 Z_{t-2} + \ldots + \phi_p Z_{t-p} - e_t \quad 6$$

Information

Z_t: time series

ϕ_p: autoregressive parameters

e_t: error value

III. RESULTS AND DISCUSSION

The results of modeling battery monitoring system (BMS) for photovoltaic based on moving average and autoregressive integrated moving average (ARIMA) are as follows:

1. Moving Average

This modeling is done by taking the dataset, looking for the average, and then using the average as a forecast for the next period.

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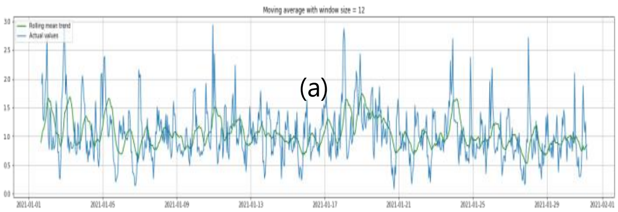

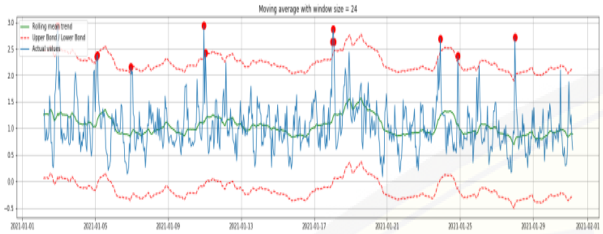

(b)

Fig 1. Test results (a) using a moving average with a window of 12, (b) a moving average with a window of 24.

Figure 1 (a), (b) is the result of feature prediction with a higher deviation/loss value. the applied model is not able to predict the data at the highest deviation, the graph above uses window sizes 12 and 24. While the rolling mean trend is the value of the prediction using a moving average. This is because the applied model is not able to predict the data at the highest deviation.

2.Autoregressive IntegratedMoving Average Model (ARIMA)

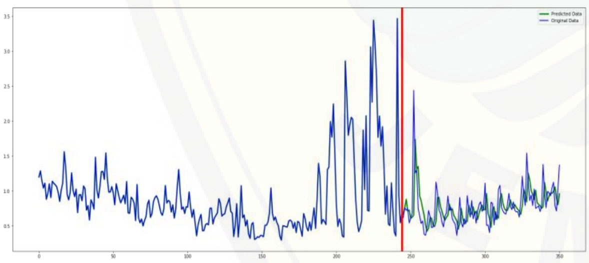

Fig 2. Test results from ARIMA

In Figure 2, this data shows that the ARIMA modeling is able to follow the actual value pattern quite significantly, this proves that this model is able to make predictions with MSE loss calculations: 0.076

IV. CONCLUSION

BMS forecasting has been carried out using ARIMA-based modeling. The ARIMA method applied is able to predict data with a significant, relatively small error deviation value. The tests that have been carried out on the power consumption dataset show that the results of the MSE test calculation: 0.076

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