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***Research paper***

# A Comparison of α-Sutte Indicator and ARIMA Methods in Renewable Energy Forecasting in Indonesia

**Ansari Saleh Ahmar*[1,2]**

[1] *Department of Statistics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar, Indonesia, 90223*
[2] *AHMAR Institute, Makassar, Indonesia, 90223*
**Corresponding author E-mail: ansarisaleh@unm.ac.id*

**Abstract**

Humans in this world are very dependent on petroleum and energy. Petroleum and other energies are a major source in supporting human life. Regarding the reduced petroleum availability, a new energy is needed to replace the role of petroleum. Nowadays, there is much renewable energy that have been discovered and used. The purpose of this research is to predict the total primary energy supply in Indonesia by using α-Sutte Indicator and ARIMA method, and comparing those four methods which are effective in predicting data. Data from the research is renewable energy (total primary energy supply) which is obtained from OECD from 1971-2015. From the research, it is found that the α-Sutte Indicator method is more suitable to predict renewable energy (total primary energy supply) data in Indonesia compared to ARIMA (0,1,0).

***Keywords***: *α-Sutte Indicator, ARIMA, Forecasting renewable energy.*

## 1. Introduction

Petroleum and energy have an important role in human life today. Petroleum and energy are used by humans in their daily routine, for example we to go to office by a private vehicle (car or motor), then it surely requires petroleum such as gasoline. It's not only that kind of routine, but also cooking or any other activities related to the livelihood of humans. Petroleum is derived from fossils of plants and animals. The problems that occur in the world, especially in Indonesia is the amount of oil and energy consumption which is not comparable with the production of petroleum and energy. However, if this continues to happen, the petroleum will be finished and certainly it has an impact on human life. Based on the predictions of production and consumption of oil in Indonesia described by Kuncahyo, Fathallah, and Semin [1], it shows that the production of oil will be finished between year 2052-2053 and consumption of oil (diesel) increased each year (figure 1) .

To solve this problem, energy diversification needs to be done, therefore. Diversification of energy has been developed in several countries, including Indonesia. One of them is renewable energy. Under the Organisation for Economic Cooperation and Development (OECD) [2], renewable energy is defined as a renewable contribution to the total energy supply of power. Furthermore, OECD [2] explains that renewable energy included primary energy that equal to hydro (excluding pumped resources), solar, wind, geothermal source, tidal and wind waves. In addition, the energy that is derived from biogasoline, solid biofuels, biodiesel, biogase, and other liquid biofuels, as well as renewable municipal wastes are also one of renewable energy. To develop renewable energy in Indonesia in the future based on total power energy supply, one way is by predicting renewable energy data. In predicting data, the most commonly used are ARIMA method [3], Sutte Indicator [4][5] , ARIMA-AO [6] , α-Sutte Indicator [7][8], Artificial Neural Network [9][10] and Holt-Winters [3]. In this research, ARIMA and α-Sutte Indicator predicting method will be used.

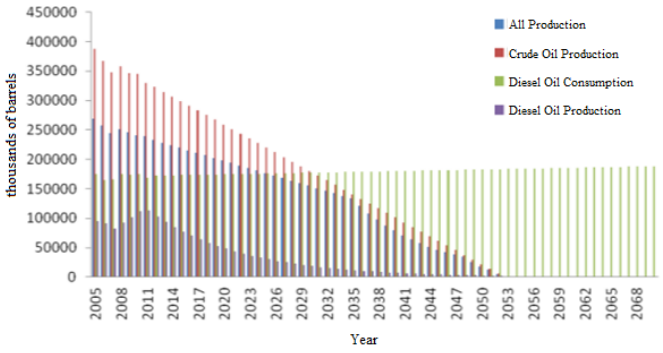


**Fig. 1:** Predicted Production and Consumption of Oil in Indonesia

### α-Sutte Indicator

α-Sutte Indicator is a developer of the Sutte Indicator method which was previously used to predict data on the stock field. This development was done due to the Sutte Indicator not only able to predict data on the stock field, but also on all-time series data. α-Sutte Indicator was developed in 2017 [11]. In predicting, α-Sutte Indicator uses the previous 4 data and doesn't require any assumption test, so it is more flexible to use on any data. The formula of α-Sutte Indicator as follows [8].

$$a_t = \frac{\alpha\left(\frac{\Delta x}{\frac{\alpha+\delta}{2}}\right)+\beta\left(\frac{\Delta y}{\frac{\beta+\alpha}{2}}\right)+\gamma\left(\frac{\Delta z}{\frac{\gamma+\beta}{2}}\right)}{3} \quad (1)$$

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where :
$\delta = a_{t-4}$
$\alpha = a_{t-3}$
$\beta = a_{t-2}$
$\gamma = a_{t-1}$
$\Delta x = \alpha - \delta = a_{t-3} - a_{t-4}$
$\Delta y = \beta - \alpha = a_{t-2} - a_{t-3}$
$\Delta z = \gamma - \beta = a_{t-1} - a_{t-2}$
$a_t$ = series observations at $t$ time
$a_{t-k}$ = series observations at $(t - k)$ time

As time goes by, in order to make it easier to use, α-Sutte Indicator created both R packages, i.e. CLI versions and GUI versions. For the CLI version, the R package name is sutteForecastR [7][12] and for the GUI version uses the R Commander plugin whose name is RcmdrPlugin.sutteForecastR [13][14]. Both packages can be downloaded in Cran-R website.

## 2. Method

This research is using data obtained from the OECD. Based on OECD [2]:
*"Renewable energy is defined as the contribution of renewables to total primary energy supply (TPES). Renewables include the primary energy equivalent of hydro (excluding pumped storage), geothermal, solar, wind, tide and wave sources. Energy derived from solid biofuels, biogasoline, biodiesels, other liquid biofuels, biogases and the renewable fraction of municipal waste are also included. Biofuels are defined as fuels derived directly or indirectly from biomass (material obtained from living or recently living organisms). This includes wood, vegetal waste (including wood waste and crops used for energy production), ethanol, animal materials/wastes and sulphite lyes. Municipal waste comprises wastes produced by the residential, commercial and public service sectors that are collected by local authorities for disposal in a central location for the production of heat and/or power. This indicator is measured in thousand toe (tonne of oil equivalent) as well as in percentage of total primary energy supply."*

Data that will be predicted from this research is Indonesia's renewable energy which is based on total primary energy supply from 1971-2015. In the data prediction process, this research uses the R package of sutteForecastR and RcmdrPlugin.sutteForecastR. The forecasting method of ARIMA: (1) Identification, (2) Estimation (and selection), (3) Diagnostic checking,and (4) Model's use. The forecasting method of α-Sutte Indicator: (1) Identification, and (2) Estimation and Forecasting.

## 3. Result and Discussion

In this research, the data is divided into two parts: training data and test data. Training data was starting from the year 1971-2008 and test data starting from the year 2008 -2015. This test data is used to test the accuracy of a method by using training data as reference data. The results of the analysis are as follows.

```
Series: al_mi_10
ARIMA(0,1,0) with drift

Coefficients:
        drift
     1162,5595
s.e.  284,9416

sigma^2 estimated as 2519757:  log likelihood= -263,15
AIC=530,31   AICc=530,75   BIC=533,11
```

Based on the analysis result, it obtained predicting model for ARIMA method is ARIMA (0,1,0) with drift. To see the accuracy of each method, then comparison of the value of MAE, RMSE, and MSE from the results of predicting test data is done. Prediction results of the next 7 periods of training data are presented in table 1 and the comparison of the accuracy values is presented in Table 2.

**Table 1:** Results of Forecasting Data using sutteForecastR

| Year | Actual Data | Result of Forecasting | |
|---|---|---|---|
| | | α-Sutte Indicator | ARIMA(0,1,0) with drift |
| 2009 | 68289,08 | 67859,5 | 67520,21 |
| 2010 | 68184,82 | 70001,05 | 68602,37 |
| 2011 | 69236,88 | 69651,42 | 69684,53 |
| 2012 | 72139,48 | 70181,01 | 70766,69 |
| 2013 | 73518,76 | 73445,53 | 71848,85 |
| 2014 | 75483,64 | 75323,64 | 72931 |
| 2015 | 75255,27 | 77598,75 | 74013,16 |

**Table 2.** Comparison of Error Levels Measurement of α-Sutte Indicator and ARIMA Method

| Error Levels Measurement | α-Sutte Indicator | ARIMA(0,1,0) with drift |
|---|---|---|
| MAE | 1027,93 | 1210,22 |
| RMSE | 1363,48 | 1398,87 |
| MSE | 1859076,54 | 1956835,72 |

Table 1 and table 2 above show that the method of predicting α-Sutte Indicator is more suitable in predicting Indonesia's renewable energy data when compared with ARIMA method. This can be seen from the RMSE value of each method which are α-Sutte Indicator (1363,48) and ARIMA (1398,87). This can also be seen in figure 2 on the results of data prediction.

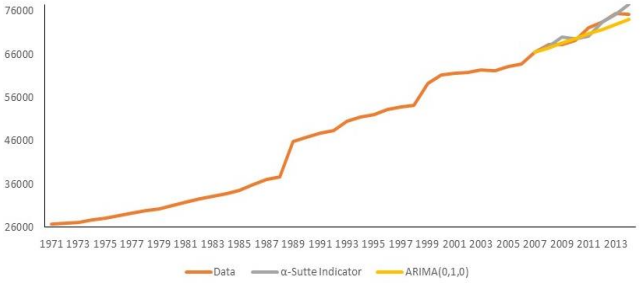


**Fig. 2:** Comparisons of Data Prediction Results

## 4. Conclusion

Based on the result of data analysis and discussion, this research concludes that the method of predicting α-Sutte Indicator was more suitable to forecasting the data of renewable energy (total primary energy supply) in Indonesia when compared with ARIMA(0,1,0) with drift. This was reinforced by the RMSE value of α-Sutte Indicator of 1363,48 which is less than the RMSE value of ARIMA (0,1,0) that is 1398.87.

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