Short Term Load Forecasting of Eid Al Fitr Holiday By Using Interval Type-2 Fuzzy Inference System

by Jamaaluddin Jamaaluddin

Short Term Load Forecasting of *Eid Al Fitr* Holiday By Using ***Interval Type – 2 Fuzzy Inference System***

(Case Study: Electrical System of Java Bali in Indonesia)

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Abstract*— *An important religious holiday celebrated by Muslims in the world including in Indonesia is Eid Al Fitr. Holiday of Eid Al Fitr causing decreased demand of electrical energy until 28.66% in case of Java Bali electricity system in Indonesia. The reduction of electrical demand needs to be known because it related to the efficiency of generation power system. To know the load changes on the future then required the forecasting of load. Forecasting of load is related with generation power systems, the power delivery schedule (dispatch scheduling), maintenance planning for the generating unit (maintenance units) and evaluation regarding the reliability of the electric power system stability (stability). Forecasting methods used in this research is IT-2 FIS. By analyzing the peak load on the day and 4 days before Eid Al Fitr in the previous year continued analysis by using IT-2 FIS will be obtained at the peak load forecasting Eid Al-Fitr in the coming year. The accuracy of this method is shown with the average of error value in 2012, 2013 and 2014 amounting to 0,24%. This value is better than using the IT-1 FIS which has a value of error amounting to 0.3%. The research concluded that IT-2 FIS can be used to Short Term Load Forecasting.

Keywords ; Type-2 Fuzzy Inference System, Short Term Load Forecasting, Eid Al Fitr.

I. INTRODUCTION

Since the Industrial Revolution, the need for electrical energy has increased. Most of the energy required by modern society is supplied in the form of electrical energy [1]. Therefore, electrical energy is a basic necessity today, aside from other major needs (such as eating, clothing and housing). Without electricity in one minute, modern society cannot perform activities [2][3]. Electric power is used in various sectors, among others: the industrial sector, public services, hospitality, research centers, education and household. The Java Bali electrical system is one of the big providers electricity in Indonesia. Java-Bali electricity system has its own loading characteristics, among others: Seasons and commuting patterns.

Every year, Indonesian people, especially Muslims always celebrate *Eid Al Fitr*, or the *Eid* holiday, which marks the end of *Holy Ramadhan*, the fasting month. In celebrating *Eid Al Fitri*, a great deal of work activities, including idustrial activities are closed for about 1 (one) week. This holiday season greatly results in a decrease in the electrical load. In the Java-Bali electricity system, the average decrease of this load is 28.66%.

The decrease of this load must be carefully estimated. Operators of electricity require accurate estimation of electricity needs. To obtain a high level of power generation efficiency. Load prediction is very closely related to the operation of power systems, for example, the power delivery schedule (dispatch scheduling), maintenance planning for the unit generating unit (maintenance units) and evaluation regarding the reliability of the electric power system stability (stability) [4][5].

Over the past two decades, there has been atremendous growth in the use of fuzzy logic controllers in power systems applications [6]. One method that can be used to make short-term load forecasting is: *Interval Type – 2 Fuzzy Inference System (IT-2 FIS)*. This method is an extension of previous methods, ie : *Type –1 Fuzzy Inference System (T-1 FIS)*. By using the method of *IT-2 FIS*, load demand can be predicted in the upcoming *Eid Al Fitr* celebrations. By doing So, the schedule of power delivery (dispatch scheduling), maintenance planning for the unit generating unit (maintenance units) and employee working hours arrangements can be planned early, with an expectation to increase the efficiency of power generation [7].

II. METHODE

A. *Structure of Interval Type- 2 Fuzzy Logic System (IT-2 FLS)*

An *IT-2 FLS* contains five interrelated components, ie: ***fuzzifier, rules base, inference engine, type-reducer* and**

defuzzifier shown in Figure 7 Process mapping of crisp value input x to output crisp value can be expressed quantitatively in equation $Y = f(x)$.

Figure 1. below indicates that the value a good crisp of defuzzification input into type 0 (known as single fuzzification), *Type-1* or *Interval Type – 2 Fuzzy Sets* (*IT-2 FSs)*, then the inference engine to produce an output of rule base *IT-2 FSs*. IT-2 FSS is then processed by the type-reducer (combining of set output and then calculating the centroid), leading to T-1 FIS called a type of reduced set. A Defuzzifier and then get it defuzzification type-reduced set to produce a crisp output. Formulation process mapping from input to output using *Interval Type-2 fuzzy logic* called *IT-2 FIS*. *IT-2 FIS* structure is in MATHLAB objects that contain all of the information *IT-2 FIS*. This structure is kept in any GUI tool [4].

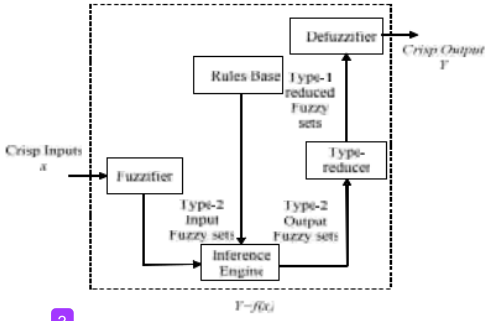

Fig. 1. *Type-2 Fuzzy Logic System (T2FLS)* [8]

B. *Membership functions and fuzzy rules*

The advantage of the fuzzy inference is easy to formulate the experience and knowledge of experts and highly flexible in forecasting by changing the rules. Fuzzy IF-THEN rules are used in this method for a maximum load is expressed by Equation 1. As follows:

$$IF\ X\ is\ A_i\ AND\ Y\ is\ B_i\ THEN\ Z\ is\ C_i \qquad (1)$$

Input of variable values Y obtained from the adjacent holiday in one year. Fuzzy sets A_i, B_i, C_i makes eleven sets, where each set consists fuzzy, fuzzy type-1 top and bottom, then restricted as *FOU* and called *interval type-2 fuzzy sets (IT2FSs)* [7].

C. *Operation on Membership Function Type-2*

The following operations on the set of fuzzy, membership function of type-2. As shown Fig.2 :

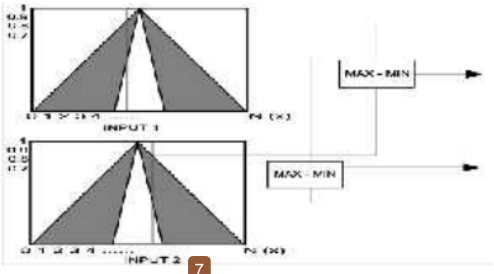

Fig. 2. Operations on Membership Function *Type-2*

Operations on fuzzy set *Interval Type-2 Fuzzy Set* is almost the same as type-1, only the *fuzzy logic system Interval Type-2*, the operation is performed on the two intervals, the top (upper function) and bottom (lower membership function) at once.

D. *Type-2 Fuzzy Inference System (FIS)*

FIS in type-2 is almost the same as the *FIS* in type-1, using the same stage. *FIS* operation of type-2 can be seen in Figure 3 for completion "tips" meals together as follows [9].

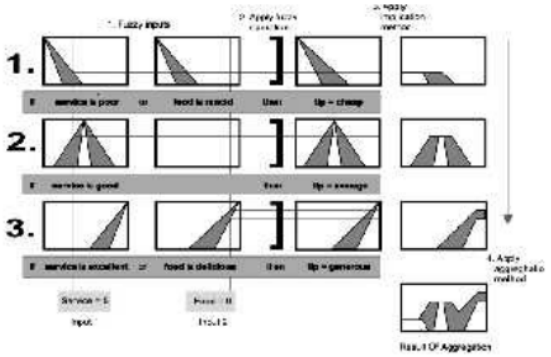

Fig. 3. Mamdani *FIS* on *Type-2*

E. *Defuzzification*

Defuzzification is the process of mapping the fuzzy, logic control through type-reducer with an iterative method for calculating the centroid IE Karnik Mendel algorithm to control the actions nonfuzzy (crisp). This is possible because the central area of a *IT-2 FSs* is the *Type-1 Fuzzy*, *sets* (*T-1 FSs*) and the set really marked by the end point on the left and right then, calculating the centroid of *Interval Type-2 Fuzzy*, sets simply requires computing two end points. Using a centroid defuzzification process in *IT-2 FLS* been proposed by Karnik and Mendel [10].

III. STAGES OF RESEARCH

A. *Preprocessing*

In the preprocessing stage is a grouping of data national religious holidays. Then calculate the peak load 4 days before national religious holidays [11].

$$MaxWD_{(i)} = \frac{WD_{(i)h-4} + WD_{(i)h-3} + WD_{(i)h-2} + WD_{(i)h-1}}{4} \qquad (2)$$

The next step is calculating the difference in peak load (Load Difference) on national holidays will be predictable.

$$LD_{MAX}(i) = \frac{MaxSD(i) - MaxWD(i)}{MaxWD(i)} x100 \qquad (3)$$

Then look for a Peak Load Variation (Variation Load Reference) on a day that would be predictable.

$$VLD_{\max}(i) = LD_{\max}(i) - TLD_{\max}(i) \qquad (4)$$

B. *Processing*

At this stage a short-term load forecasting model for the national religious holidays Java Bali electricity system into the

Interval Type-2 Fuzzy Inference Systems and *Neural Network*. The steps as follows:

1. Creating a membership function input *interval type-2 fuzzy logic system* that inputs *X* and *Y*, and *Z* that Output membership function for a religious national holiday to be predictable. With the following conditions:
   X: VLD_{max} (i) the same public holidays in the year before forecasting.
   Y: VLD_{max} (i) previous holidays (adjacent) in the same type of holiday in forecasting
   Z: Forecast *VID_{max}* (on) a holiday that will forecast

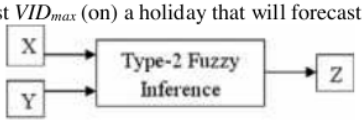

Fig. 4. Input and Output for Data Processing

2. Create a fuzzy rules (fuzzy rules) *Interval Type-2 Fuzzy, Inference System (IT-2FIS)* as follows[11]:
   IF X is A_i AND *Y* is B_i THEN *Z* is C_i
3. Applying operation on the (*IT-2 FIS*).
4. Applying the *MIN* function on fuzzy, implications.
5. Applying the composition *MAX* on each fuzzy, implication results.
6. Calculating firm output (non fuzzy, values) with the assertion method Centroid through reducer type using Kernik Mendel algorithm so as to get the value Forecast *VLD_{max}*

C. Flowchart of Forecasting by Using IT-2

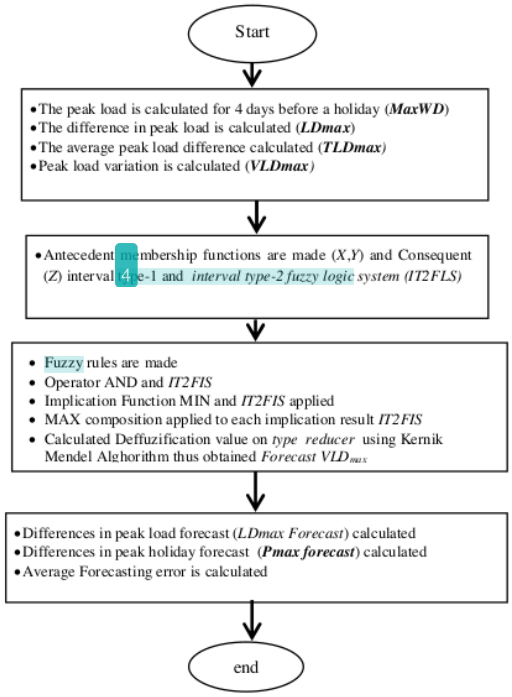

Fig. 5. Diagram of Forecasting for *IT-2 Fuzzy*

D. Post processing

In the post-processing stage of the calculation results of short-term load forecasting for a religious, national holiday on the Java-Bali electrical system, the following:

1. Calculate the difference peak load forecast (load forecast reference) for a holiday of forecast:

$$Forecast\ LD_{MAX}(i)=ForecastVLD_{MAX}(i)-TLD_{MAX} \quad (5)$$

2. Calculate the difference of the holiday peak load forecast:

$$P'_{MAX}(i) = MaxWD(i) + \frac{(ForecastLD_{MAX}\ xMaxWD(i))}{100} \quad (6)$$

3. Calculating error forecasting results:

$$Error\% = \frac{P_{forecast} - P_{actual}}{P_{actual}} x100$$

$$Error\% = \frac{P'_{MAX}(i) - MaxSD(i)}{MaxSD(i)} x100 \quad (7)$$

IV. DATA AND EXPERIMENT PROCEDURE

To perform the analysis, it is necessary the data calendar of religious holidays occur (See Table 1.) and the data load on the holiday and four days before the holidays (See table 2.).

Table 1. Date of the *Isra 'Mi'raj* and *Eid Al Fitr*

1	Isra' Mi'raj	17 June	6 June	27 May
2	Idul Fitri I	19 August	8 August	28 July

Table 2. Load (in MW) during holidays and 4 days before it

	Days to				
	H-4	H-3	H-2	H-1	H
2012					
1. Isra Mi' raj	18,072.00	19,547.00	19,877.00	18,547.00	17,595.00
2.Idul Fitri	18,122.00	16,805.00	14,771.00	14,280.00	13,175.00
2013					
1. Isra Mi' raj	19,099.00	21,123.00	21,734.00	21,506.00	19,071.00
2.Idul Fitri	17,337.00	17,151.00	16,201.00	14,942.00	13,777.00
2014					
1. Isra Mi' raj	22,843.00	21,480.00	20,429.00	21,913.00	20,687.00
2.Idul Fitri	19,707.00	17,920.00	16,180.00	15,214.00	14,227.00

Due to religious holidays are observed is *Eid Al Fitr*, the data of load and calendar displayed is *Eid Al-Fitr* and holiday earlier and close to the holiday *Eid Al Fitr* day is *Isra 'Mi'raj*.

A. *Calculation of X value*

The calculation of the value of the input variable X at the peak load forecasting of *Eid Al Fitr* holidays in 2014 is to find the value of *Variable Load inference (VLDMAX)* year before (*Eid Al Fitr 2013*).

VID_{MAX} value calculation *Eid Al Fitr 2013* calculated based on the equation 2, 3 and 4 :

1. *Eid Al Fitr, 2012*
   Looking for MaxWD and LDMAX value from data of load peaks 4 days before holidays and on Eid Al Fitri 2012 holidays as follows:
   $MaxWD_{H-4}$ = 18122.00 MW
   $MaxWD_{H-3}$ = 16805.00 MW
   $MaxWD_{H-2}$ = 14771.00 MW
   $MaxWD_{H-1}$ = 14280.00 MW
   MaxSD = 13175.00 MW

$$MaxWD\ (Idul\ Fitri 2012) = \frac{MaxWD_{H-4} + MaxWD_{H-3} + MaxWD_{H-2} + MaxWD_{H-1}}{4}$$

$$MaxWD\ (Idul\ Fitri 2012) = \frac{18122.00 + 16805.00 + 14771.00 + 14280.00}{4}$$

$$= 15994.50\ MW$$

$$LDMAX(Idul\ Fitri\ 2012) = \frac{MaxSD(Idul\ Fitri\ 2012) - MaxWD(Idul\ Fitri\ 2012)}{MaxWD(Idul\ Fitri\ 2012)} x100\%$$

$$= \frac{13175.00 - 15994.50}{15994.50} x100\%$$

$$= -17.63$$

2. *Eid Al Fitr, 2013*
   Looking for MaxWD and LDMAX value from data of load peaks 4 days before holidays and on *Eid Al Fitr* 2013 holidays as follows:
   $MaxWD_{H-4}$ = 17337.00 MW
   $MaxWD_{H-3}$ = 17151.00 MW
   $MaxWD_{H-2}$ = 16201.00 MW
   $MaxWD_{H-1}$ = 14942.00 MW
   MaxSD = 13777.00 MW
   in the same way, the obtained results as Table 3.
3. *Eid Al Fitr, 2014*
   Looking for MaxWD and LDMAX value from data of load peaks 4 days before holidays and on *Eid Al Fitr* 2014 holidays as follows:
   $MaxWD_{H-4}$ = 17337.00 MW
   $MaxWD_{H-3}$ = 17151.00 MW
   $MaxWD_{H-2}$ = 16201.00 MW
   $MaxWD_{H-1}$ = 14942.00 MW
   MaxSD = 13777.00 MW
   in the same way, the obtained results as Table 3. To find the value *TLDMAX (Eid Al Fitr 2014)* as follows :

$$TLDMAX(Idul\ Fitri\ 2014) = \frac{LDMAX(Idul\ Fitri\ 2013) + LDMAX(Idul\ Fitri\ 2012)}{2}$$

$$= \frac{-17.55 + (-16.03)}{2}$$

$$= -16.79$$

$$VLDMAX(Idul\ Fitri\ 2014) = LDMAX(IdulFitri2014) - TLDMAX(Idul\ Fitri\ 2014)$$

$$= -17.55 - (-16.79)$$

$$= -0.76$$

B. *Calculation of Y value*

The calculation of the value input variable Y forecasting the peak load of *Eid Al Fitr* holidays in 2014 is looking for value difference of variable load *(VLDMAX)* holidays approaching that kind *VLDMAX (Isra 'Mi'raj 2014)*.

1. *Isra Mi'raj 2012*
   Looking for the value of *MaxWD* and *LDMAX* load peaks data 4 days before holidays and on *Isra' Mi'raj* 2012 holidays as follows:
   $MaxWD_{H-4}$ = 18072.00 MW
   $MaxWD_{H-3}$ = 19547.00 MW
   $MaxWD_{H-2}$ = 19877.00 MW
   $MaxWD_{H-1}$ = 18547.00 MW
   MaxSD = 17595.00 MW

$$MaxWD\ (Isra'Mi'raj 2012) = \frac{MaxWD_{H-4} + MaxWD_{H-3} + MaxWD_{H-2} + MaxWD_{H-1}}{4}$$

$$MaxWD\ (Isra'Mi'raj 2012) = \frac{18072.00 + 19547.00 + 19877.00 + 18547.00}{4}$$

$$= 19010.75\ MW$$

$$LDMAX(Isra'Mi'raj 2012) = \frac{MaxSD(Isra'Mi'raj 2012) - MaxWD(Isra'Mi'raj 2012)}{MaxWD(Isra'mi'raj 2012)} x100\%$$

$$= \frac{17595.00 - 19010.75}{19010.75} x100\%$$

$$= -7.45$$

2. *Isra Mi'raj 2013*
   Looking for the value of *MaxWD* and *LDMAX* load peaks data 4 days before holidays and on *Isra' Mi'raj* 2013 holidays as follows:
   $MaxWD_{H-4}$ = 19099.00 MW
   $MaxWD_{H-3}$ = 21123.00 MW
   $MaxWD_{H-2}$ = 21734.00 MW
   $MaxWD_{H-1}$ = 21506.00 MW
   MaxSD = 19071.00 MW
   in the same way, the obtained results as Table 3.
3. *Isra Mi'raj 2014*
   Looking for the value of *MaxWD* and *LDMAX* load peaks data 4 days before holidays and on *Isra' Mi'raj* 2014 holidays as follows:
   $MaxWD_{H-4}$ = 22843.00 MW
   $MaxWD_{H-3}$ = 21480.00 MW
   $MaxWD_{H-2}$ = 20429.00 MW
   $MaxWD_{H-1}$ = 21913.00 MW
   MaxSD = 20687.00 MW
   in the same way, the obtained results as Table 3. To find the value *TLDMAX* (*Isra' Mi'raj* 2014) is as follows :

$$TLDMAX(Isra'Mi'raj 2014) = \frac{LDMAX(Isra'Mi'raj\ 2013) + LDMAX(Isra'Mi'raj\ 2012)}{2}$$

$$= \frac{-8.60 + (-7.45)}{2}$$

$$= -8.025$$

$$VLDMAX(Isra'Mi'raj2014) = LDMAX(Isra'Mi'raj2014) - TLDMAX(Isra'Mi'raj2014)$$
$$= -4.25 - (-8.025)$$
$$= 3.775$$

C. Calculation of Z Value

The calculation of the value output variable Z is forecasting the peak load of *Eid Al Fitr* holidays in 2014 is looking for value difference of *Variable Load (VLDMAX)* in forecasting *Eid Al Fitr* 2014. Calculations in the same manner for the entire national religious holidays year period 2012-2014 to obtain the value *VLDMax* using Microsoft Office Excel 2010 software that results in a table as shown in Table 3 as follows:

Table 3. Value Of *MaxWD*, LD_{MAX} at 2012 – 2014

Name of Holiday	2012		2013		2014	
	MAXWD	LDMAX	MAXWD	LDMAX	MAXWD	LDMAX
1. Isra Mi'raj	19 010,75	-7,4471	20 665,5	-8,6023	21 655,25	-4,5197
2. Idul Fitri	15 964,5	-2,17629	16 407,75	-2,16336	17 255,25	-2,17407

V. Peak Load Forecasting for Holidays *Eid Al Fitr* Using *IT-2 FIS*

IT-2FIS to forecasting of peak load the holidays, national religious that the membership function variable input and output of *Interval Type-2 Fuzzy Inference System*.

A. Membership Function for Input and Output Variable

The set of *Interval Type-2 Fuzzy*, fuzzy sets similar to the type-1. *Interval Type-2 Fuzzy*, done twice a *fuzzy*, membership function type-1. Input variables (*X, Y*) and output variables (*Z*) consists of 11 *fuzzy* sets are described as follows:

Negative Very Big (NVB) *range of values -12 s/d -8*
Negative Big (NB) *range of values -10 s/d -6*
Negative Medium (NM) *range of values -8 s/d -4*
Negative Small (NS) *range of values -6 s/d -2*
Negative Very Small (NVS) *range of values -4 s/d 0*
Zero (ZE) *range of values -2 s/d 2*
Positive Very Small (PVS) *range of values 0 s/d 4*
Positive Small (PS) *range of values 2 s/d 6*
Positive Medium (PM) *range of values 4 s/d 8*
Positive Big (PB) *range of values 6 s/d 10*
Positive Very Big (PVB) *range of values 8 s/d 12*

The figure of the antecedent (*X, Y*) and consequent (*Z*) *IT-2 FIS* as follows:

Fig. 6. Membership Function Input Variable *X* (*IT-2 FIS*)

Fig. 7. Membership Function Input Variable *Y (IT-2 FIS)*

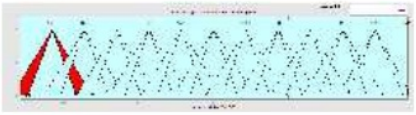

Fig. 7. Membership Function Input Variable *Z (IT-2 FIS*)

Translation of antecedent membership functions (*X, Y*) and consequent (*Z*) is used for the manufacture of the *Rules Base Fuzzy Inference System*. Making the basic rules of Fuzzy *(Fuzzy Rule Base)* short-term load forecasting in 2012 is shown table 4. Through table 7.

Table. 4. Input (*X, Y*) and output (*Z*) By VLD_{MAX} in 2012 and 2013

Name of Holiday	2012	2013	Input		Output
	VLD_{MAXX}	VLD_{MAX}	X	Y	Z
1. Isra Mi'raj	-0.20475	-4.34149	-0.2047	2.111261	-4.34149
2. Idul Fitri I	-6.34583	-2.17605	-6.3458	-4.341488	-2.17605

Table 5. Making Input (*X, Y*) and output (*Z*) By VLD_{MAX} in 2012 and 2013

Table. 6. Process Rules for Input *Y* in 2012

Table. 7. Process Rules for Output *Z* in 2012

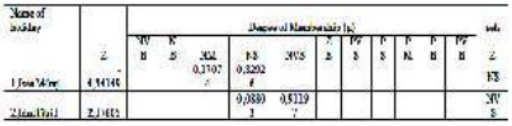

Table 8. Basic Rules table (*fuzzy rule*s) for forecasting the year 2012

X/Y	NVB	NB	NM	NS	NVS	ZE	PVS	PS	PM	PB	PVB
NVB											
NB											
NM				NVS	NVS						
NS					VS	NVS					
NVS								NVS			
ZE					PVS	PS	NS/ZE				
PVS					PS	ZE		NS			
PS				PS				PVS			
PM											
PB											
PVB											

If there is a fuzzy rule is the same for input values *X* and, but different *Z* output value, whichever is the greater the value of its output being more removed

Table 9. Conversion Table Basic Rules Forecasting the Year 2012 for Matlab Software Code

	Antecedent		Consequen
	X	Y	Z
1	PVS	PS	NS
2	PS	NS	PS
3	PVS	ZE	VE
4	ZE	ZE	PS
5	PS	PS	PVS
6	ZE	PVS	NS
7	NM	NS	NVS
8	NS	NVS	ZE
9	PE	NVS	PVS
10	ZE	PVS	ZE
11	NS	PE	NVS
12	PVS	NVS	PS
13	NVS	PS	NVS
14	NM	NVS	NVS

	Antecedent		Consequen
	X	Y	Z
1	7	8	4
2	8	4	8
3	7	6	6
4	6	6	8
5	8	8	7
6	6	7	4
7	3	4	3
8	4	5	6
9	6	5	7
10	6	7	6
11	4	6	5
12	7	5	8
13	5	8	5
14	3	5	5

B. Implementation forecasting of Short Term Load for Eid Al Fitr Holidays On Electrical Systems Java Bali using Method Interval Type-2 Fuzzy Inference System (IT2FIS) at 3 Years of data taking into account the Year Actual Data Forecasting.

Short-term load forecasting using the *Interval Type-2 Fuzzy Inference System* executed through m.file program in Matlab using the given function in the Toolbox *IT-2FLT*, to obtain the value of forecasting *VLDmax*. *Value of VLDmax forecasting* results continued (post processing) using software MS.Excell to get the peak load forecasting and forecasting error value. The results of short-term load forecasting error method *IT-2FIS* in 2012 through 2014 can be seen in Table. 10 below, then comparison with *T-1 FIS*.

Table 10. Comparison of Forecasting and Actual load on the holiday of *Eid in Fitri* 2012, 2013 and 2014

Year	T-1 FIS Forecast (MW)	Act (MW)	Er (%)	IT-2 FIS Forecast (MW)	Act (MW)	Er (%)
2012	13,139.53	13,175.00	0.2692	13,173.68	13,175.00	0.0100
2013	13,765.91	13,777.00	0.0805	13,754.87	13,777.00	0.1607
2014	14,196.79	14,227.00	0.2126	14,196.79	14,227.00	0.2126
		Sum	0.5623		Sum	0.4234
		Average	0.3026		Average	0.2431

In Table 10. The average error value in 2012-2014 by using *T-1 FIS* are: 0.3026%, whereas when used *IT-2 FIS* obtained: 0.2431%.

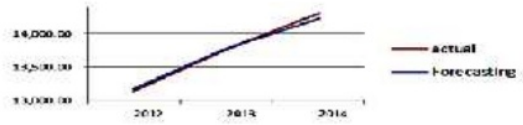

Fig. 8. Graph of comparison between actual and forecast by using *T-1 FIS*

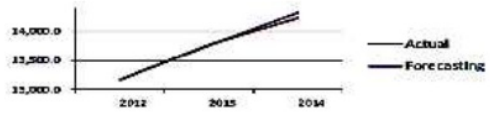

Fig. 9. Graph of comparison between actual and forecast by using *IT-2 FIS*

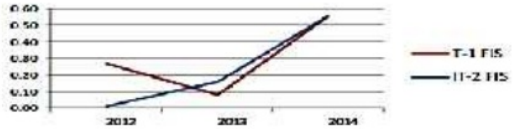

Fig. 10. Graph of comparison error value forecast between *T-1 FIS* and *IT-2 FIS*

In Figure 10, seen the error value of short-term load forecasting *T-1 FIS* and *IT-2 FIS*. *IT-2 FIS error value* has lower than *IT-1 FIS*.

VI. CONCLUSION

This paper presented Short Term Load Forecasting *Eid Al Fitr* holiday by using *Interval Type-2 Fuzzy Inference System (IT-2 FIS)*. Load forecasting is done is to predict the maximum load. Input analysis in the form of daily peak load value and calendar information. Input this analysis is the value of daily peak load and calendar information. Results obtained by using the *IT-2 FIS*, load forecasting in 2012, 2013 and 2014 have an average value of 0.2431% error, Whereas when using *Type-1 FIS* has an average value of 0.3026% error.

With the above results, the *IT-2 FIS* can be proposed as one of the methods used to conduct short-term load forecasting. To increase the accuracy of the model, it can be done expand the membership function of the current forecast model. When do expansion membership function, then the data will have a smaller range and will obtain more accurate forecasting results [12].

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