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“FUZZY LOGIC TO IMPROVE RELIABILITY INDICES AND VOLTAGE INSTABILITY CONSTRAINTS FOR CONTINGENCY ANALYSIS AND OPTIMAL POWER FLOW WITH RENEWABLE ENERGY SOURCES”

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***Synopsis:*-Its survey's aim is to learn more about raising awareness about reliability indices in a distribution framework while using the predicates of optimum power flow approaches. The voltage unpredictability is evaluated by using an L-index, a VCPI-Centroid, and a triangle membership function to illustrate the compared input limits vulnerability as fuzzy sets. The method's practicality is facilitated by the results, which include a fuzzy burden stream for basic and critical scenarios without and with DG units. The suggested approach will be extremely useful in assuring the power grid's overall voltage security by estimating the probability of voltage breakdown under current load circumstances. This will assist in estimating the framework's maximum load capacity without causing voltage instability. A software tool is used to evaluate the method's effectiveness on an example IEEE 14-bus framework.**

***Keyword:* - VCPI, DG, FL, VSC-OPF.**

I. THE INTRODUCTION

In the current mass power system, voltage insecurity would result in a power outage. In an ideal power framework, the voltage should be controlled within acceptable limits to ensure a high level of customer service which is a serious issue in the power system's design and operation. As voltage falls to a sharp value, power flow from the stack to the source is reduced. This phenomenon is referred to as "voltage insecurity" [1]. Before voltage insecurity, both the bus angle and frequency remained constant, but fluctuations in reactive power are also increasing in the power transmission system to the stage where it is difficult to maintain up with the voltage magnitude inside the cutoff. As a result, voltage insecurity happen as a consequence of the framework's inability to deliver reactive power to the load. It might also be caused by network distribution issues, a transformer failure, or the failure of a vital transmission line orgenerator, a line problem or bus fault, or a heavy HVDC power stream with insufficient shunt capacitance and inverters [20]. The OPF in the power framework is a problem of optimization under various restrictions. It is essentially a large and well-studied area of restricted optimization. The use of load flow equations in the layout of uniformity restrictions is an important feature of OPF. For minimizing scalar optimization tasks, OPF heavily depends on static optimization techniques. In 1968, Domed and Tunney [12] proposed OPF for the purpose of minimization, in which the main request angle computation is based on correspondence and disparity constraints. OPF was utilized by Mormon et al. [3] to draw attention to the issues with the unregulated electricity grid. In addition, OPF has been used by researchers to address problems with the vertical electric grid. Normally controlling equipment, such as tap changing transformers, are used to overcome the aforementioned difficulties. In any case, they are not executed in a reasonable timeframe to prevent voltage breakdown. The majority of the proposed indices are based on a framework or on bus orientation. There hasn't been a lot of research on employing a line-based voltage steadiness list to evaluate voltage stability. The voltage strength index is used in this way to determine which lines are critical for a given load scenario, allowing the system to be evaluated before line blackout.

II. SOURCE OF POWER FOR RENEWABLE ENERGY SYSTEM

2.1. Distributed Production

In 2005, Harrison and Wallace [10] set out the government's goals and justifications for raising the distribution generation linkage limit for distribution networks. In 2011, Amanita and Hamadan Goshen [4] proposed the PSO computation to find the optimal placement of distribution networks, areas and sizes of DGs Reduce the framework's total cost, power loss, and the number of DGs necessary. In 2012, Pushier et al. [5] proposed a financial/natural dispatching (EED) issue elaboration for a hybrid energy storage system that includes heat-producing units, sunlight-based, wind, and long-term storage. The inquiry is completed using a MATLAB simulation for a solar-powered setting with a lot of light. In 2014, Nick et al. [17] demonstrated a multi-objective streamlining issue to discover the best balance between specialized and economic objectives to determine in active distribution networks, the best allocation of distributed storage systems (DSSs). Ma et al. [11] provided a techno-economic study of a solar wind pumped storage system for an isolated micro-hybrid grid in 2015. Sichilalu et al. [6] developed an Open Circuit model of a heat pump water heater (HPWH) that is powered by a breeze generator-photovoltaic network design in 2017.Energy cost minimization is used to determine real capacity, which takes into consideration the hour of power duty.

2.2 Micro-grids

Sanseverino et al. [3] suggested an execution monitoring and deplaning technique in 2011 to handle the optimum generation dispatch problem in a smart grid by reducing fossil fuel byproducts and production costs while improving quality. In 2012, Battistelli et al. [15] offered a streamlining apparatus for energy executives operating within modest energy frameworks that were fused with V2G frameworks. In 2015, Riva Sanseverino et al. developed a new OPF approach for micro-grid MG. The approach yields the fewest mistakes and a stable working point with considerable droop parameters, which are utilized for essential voltage and recurrence guideline calculations.

2.3. Solar

Lin et al. [8] employed a working power limit system in 2012 to reduce PV power injection during top sunlight-based illumination in order to avoid voltage infringement. Martin [18] revealed the idea of a focused sun-based plant that relies on a regenerative Ranking cycle in 2015. Furthermore, quantitative modeling strategies are used to boost dry cooling innovations.

2.4. Wind

In 2016, Sedgwick et al. [13] proposed an approach for describing appropriate battery area, limit, and power rating while restricting the expense work under the particular imperatives. The goal function includes monetary components, investment, operation, and reliability expenses are part of the technical penalty element.

III. RADIAL DISTRIBUTED NETWORK FOLLOWED BY DIFFERENT STEPS.

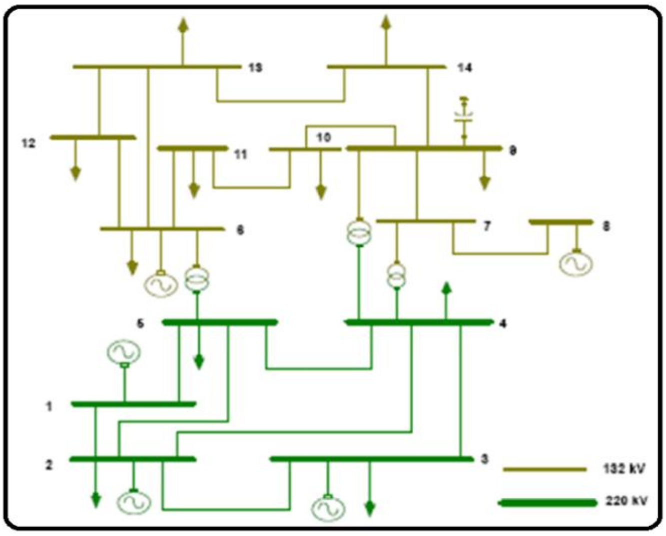


Fig.1: Sample Test system for 14-Bus IEEE

Algorithm

The Evaluated Reliability Index, OPF, Load Flow Analysis Fuzzy Logic algorithm is comprised of six basic steps. These would be respective names:

1] Perform a load flow study using contingency scenarios without DG to estimate reliability indices, voltage profile, VSC-OPF, and line loss.
2] Accurately predicts DG allocation and size in varied bus sites and demand.
3] Perform the load flow study again using Fuzzy Logic with DG to evaluate reliability indices, voltage profiles, VSC-OPF, and line loss..
4] A results will be compared with and without the need for energy sources.
5] Using the Mi-Power software, assess the performance of features and whether a long-term voltage instability scenario can be controlled with DG units.
6] Enhance overall voltage stability indices to help in the detection for voltage collapse.

IV. FUZZY INFERENCE SYSTEM

Along with a load bus value, a voltage index value with a value of 1 and a value of 0 were automatically normalized into a [0, 1] domain. Voltage profiles (VP), OPF-(P-Q), and Voltage instability constraints (VSC) are contributions to the fuzzy framework that utilize fuzzy inference to evaluate the seriousness lists of voltage profiles. In fuzzy logic-based systems, the information entry and exit variables are connected via if-then statements. A severity index of voltage profile(SI_{VP})& a voltage instability constraint (SI_{VSC})are assessed using a range of multiple-antecedent fuzzy rules, the contribution to the standards VP and VSC. The principles are represented in the table's fuzzy decision framework. Upon attaching the information factors to the outcome variable, the fuzzy outcomes are de-fuzzified using a Defuzzyifcationinteraction to achieve an exact a number value. The centroid or Centre of gravity Defuzzyifcation method was utilized. The fuzziness toolbox in MATLAB R2014a is used to analyze the fuzzy inference structure. With and without DG units, we validate the location obtained by the fuzzy technique.

4.1 VSC (Selected Fuzzy Input & Output) &Network Voltage Level: -

According to the triangle membership function, low voltage (LV) is less than 0.9 pu, normal voltage (NV) is 0.9-1.02 pu, and over voltage (OV) is greater than 1.02 pu. Using fuzzy set notation, triangular membership functions, which are widely used to characterize the severity of a post-unexpected quantity, are divided into three categories: Below Sever (BS), Above Sever (AS), and Most Sever (MS). The Overall Severity Index is calculated when OSI_{VP} has identified the severity indices for all voltage profiles &OSI_{VSC}has identified the severity indices for all voltage instability constraints is computed as follows for a single-line blackout:

$$\boxed{\begin{aligned}&OSI_{VP} = \sum W\,SI \text{ -----------------------------------} \ (1)\\ &OSI_{VSC} = \sum W\,SI \text{ -----------------------------------} \ (2)\\ &CI = \Sigma W^{*}SI_{VP} + \Sigma W^{*}SI_{VSC}\end{aligned}}$$

The composite index (CI) combines both indices by taking into consideration that weighting coefficient used during severity indices, which seem to be severity index (SI) of the post-dependent quantity values is denoted by this variable. For BS = 0.30, AS = 0.60, and MS = 1.00, the weighting coefficients are BS = 0.30, AS = 0.60, and MS = 1.00. Due to the evident influence of these weighting variables, the three divisions of the severity index (MS) dominate the overall Severity Index, the second and first categories of the severity index; classify the system's vulnerabilities as fair severity.

4.2. Fuzzy Base Rules

Lists the severe indexes for bus voltage profiles and VSC indexes using fuzzy rules as shown in below

Table 1: Fuzzy Base Rules

INPUT VARIABLE	OUTPUT VARIABLE
VP	SI_{VP}
LV NV OV	BS AS MS
VSC	SI_{VSC}
LV NV OV	BS AS MS

4.3. Composite Index

As illustrated in Fig. 2, the general seriousness record CI = SI_{VP} + SI_{VSC} is the composite index for a particular section blackout. SI_{VP} indexes all load bus voltage profiles, while SI_{VSC} is the severity index of all voltage instability constraints in Optimal Power Flow (P and Q limits), L-index, and VCPI for choose possibilities. As a result, the final severity index for a particular scenario indicates the true severity of the framework.

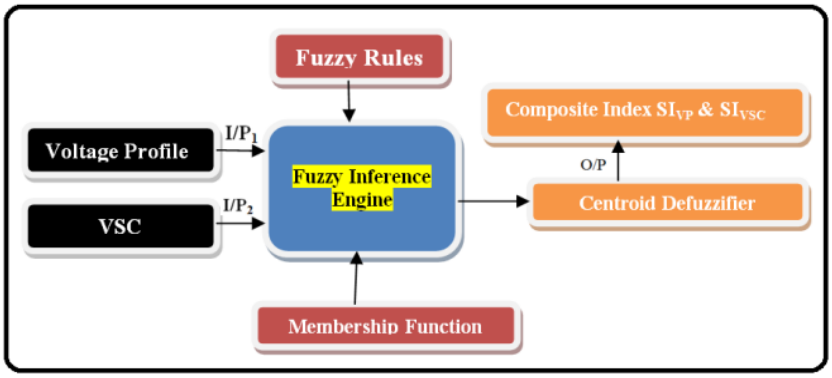


Fig.2: Shows the parallel fuzzy output.

V. OUTCOMES AND DISCUSSION

The IEEE 14-bus system is used to test fuzzy logic on line failures (outages) in Table 2, which lists outages assessed for ranking.

Table 2: A list of the contingencies failure cases that have been selected.

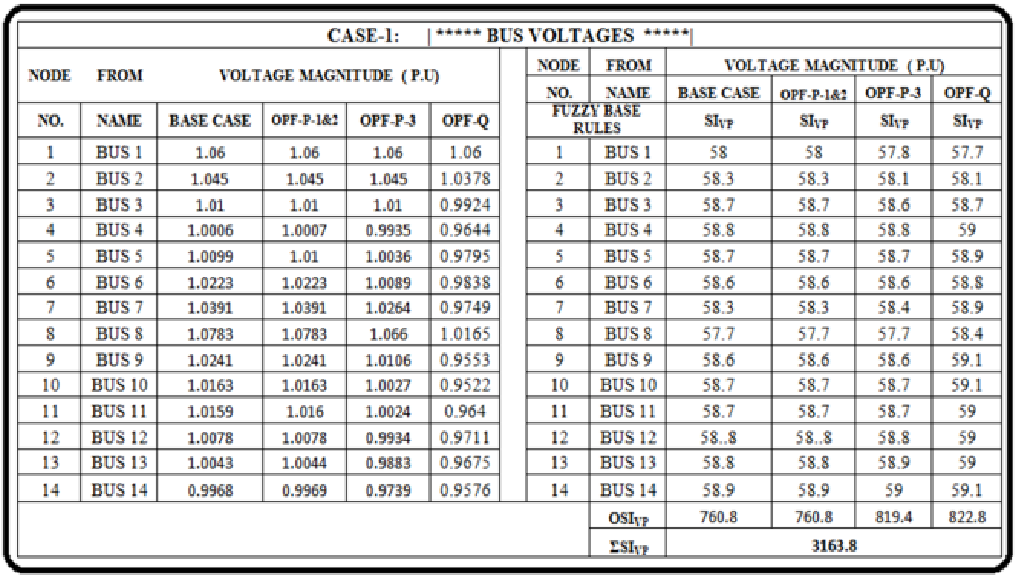
CASES	**TYPE OF FAILURES**	**BETWEEN LINES**	
I	Single line failure	2	4
II	Single line failure	10	11
III	Double line failure	2	4
		10	11

A. FUZZY LOGIC CONTINGENCY ANALYSIS FOR DIFFERENT CASES

5.1. Analysis of Contingency Cases

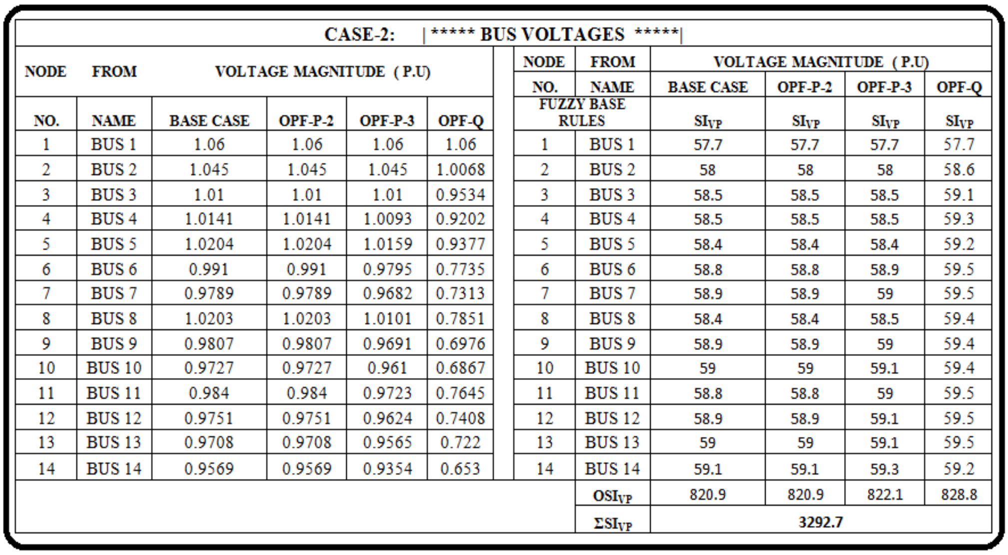
Table 3 shows the severity indices for voltage profiles generated using Fuzzy Logic without the use of DG.

Table 3: Voltage Profiles (VP) index for severity indices employing Fuzzy Logic withoutDG in different cases.



CASE-1: | ***** BUS VOLTAGES *****|

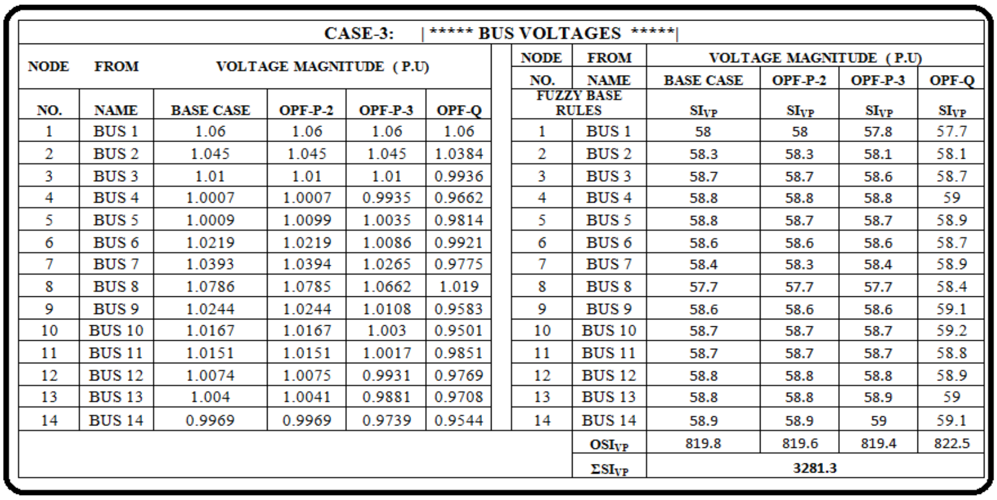
NODE	FROM	VOLTAGE MAGNITUDE (P.U)				NODE	FROM	VOLTAGE MAGNITUDE (P.U)			
NO.	NAME	BASE CASE	OPF-P-1&2	OPF-P-3	OPF-Q	NO.	NAME	BASE CASE	OPF-P-1&2	OPF-P-3	OPF-Q
						FUZZY BASE RULES		SI_{VP}	SI_{VP}	SI_{VP}	SI_{VP}
1	BUS 1	1.06	1.06	1.06	1.06	1	BUS 1	58	58	57.8	57.7
2	BUS 2	1.045	1.045	1.045	1.0378	2	BUS 2	58.3	58.3	58.1	58.1
3	BUS 3	1.01	1.01	1.01	0.9924	3	BUS 3	58.7	58.7	58.6	58.7
4	BUS 4	1.0006	1.0007	0.9935	0.9644	4	BUS 4	58.8	58.8	58.8	59
5	BUS 5	1.0099	1.01	1.0036	0.9795	5	BUS 5	58.7	58.7	58.7	58.9
6	BUS 6	1.0223	1.0223	1.0089	0.9838	6	BUS 6	58.6	58.6	58.6	58.8
7	BUS 7	1.0391	1.0391	1.0264	0.9749	7	BUS 7	58.3	58.3	58.4	58.9
8	BUS 8	1.0783	1.0783	1.066	1.0165	8	BUS 8	57.7	57.7	57.7	58.4
9	BUS 9	1.0241	1.0241	1.0106	0.9553	9	BUS 9	58.6	58.6	58.6	59.1
10	BUS 10	1.0163	1.0163	1.0027	0.9522	10	BUS 10	58.7	58.7	58.7	59.1
11	BUS 11	1.0159	1.016	1.0024	0.964	11	BUS 11	58.7	58.7	58.7	59
12	BUS 12	1.0078	1.0078	0.9934	0.9711	12	BUS 12	58..8	58..8	58.8	59
13	BUS 13	1.0043	1.0044	0.9883	0.9675	13	BUS 13	58.8	58.8	58.9	59
14	BUS 14	0.9968	0.9969	0.9739	0.9576	14	BUS 14	58.9	58.9	59	59.1
							OSI_{VP}	760.8	760.8	819.4	822.8
							ΣSI_{VP}	3163.8			



CASE-2: | ***** BUS VOLTAGES *****|

NODE NO.	FROM NAME	VOLTAGE MAGNITUDE (P.U) BASE CASE	OPF-P-2	OPF-P-3	OPF-Q
1	BUS 1	1.06	1.06	1.06	1.06
2	BUS 2	1.045	1.045	1.045	1.0068
3	BUS 3	1.01	1.01	1.01	0.9534
4	BUS 4	1.0141	1.0141	1.0093	0.9202
5	BUS 5	1.0204	1.0204	1.0159	0.9377
6	BUS 6	0.991	0.991	0.9795	0.7735
7	BUS 7	0.9789	0.9789	0.9682	0.7313
8	BUS 8	1.0203	1.0203	1.0101	0.7851
9	BUS 9	0.9807	0.9807	0.9691	0.6976
10	BUS 10	0.9727	0.9727	0.961	0.6867
11	BUS 11	0.984	0.984	0.9723	0.7645
12	BUS 12	0.9751	0.9751	0.9624	0.7408
13	BUS 13	0.9708	0.9708	0.9565	0.722
14	BUS 14	0.9569	0.9569	0.9354	0.653

NODE NO.	FROM NAME	VOLTAGE MAGNITUDE (P.U) BASE CASE	OPF-P-2	OPF-P-3	OPF-Q
FUZZY BASE RULES		SI_{VP}	SI_{VP}	SI_{VP}	SI_{VP}
1	BUS 1	57.7	57.7	57.7	57.7
2	BUS 2	58	58	58	58.6
3	BUS 3	58.5	58.5	58.5	59.1
4	BUS 4	58.5	58.5	58.5	59.3
5	BUS 5	58.4	58.4	58.4	59.2
6	BUS 6	58.8	58.8	58.9	59.5
7	BUS 7	58.9	58.9	59	59.5
8	BUS 8	58.4	58.4	58.5	59.4
9	BUS 9	58.9	58.9	59	59.4
10	BUS 10	59	59	59.1	59.4
11	BUS 11	58.8	58.8	59	59.5
12	BUS 12	58.9	58.9	59.1	59.5
13	BUS 13	59	59	59.1	59.5
14	BUS 14	59.1	59.1	59.3	59.2
	OSI_{VP}	820.9	820.9	822.1	828.8
	ΣSI_{VP}	3292.7			

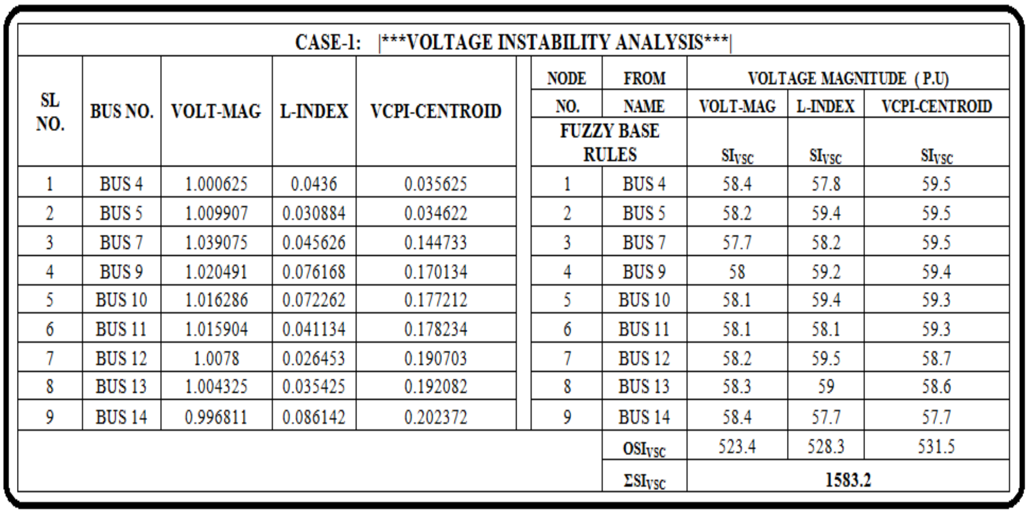


CASE-3: | ***** BUS VOLTAGES *****|

NODE NO.	FROM NAME	VOLTAGE MAGNITUDE (P.U) BASE CASE	OPF-P-2	OPF-P-3	OPF-Q
1	BUS 1	1.06	1.06	1.06	1.06
2	BUS 2	1.045	1.045	1.045	1.0384
3	BUS 3	1.01	1.01	1.01	0.9936
4	BUS 4	1.0007	1.0007	0.9935	0.9662
5	BUS 5	1.0009	1.0099	1.0035	0.9814
6	BUS 6	1.0219	1.0219	1.0086	0.9921
7	BUS 7	1.0393	1.0394	1.0265	0.9775
8	BUS 8	1.0786	1.0785	1.0662	1.019
9	BUS 9	1.0244	1.0244	1.0108	0.9583
10	BUS 10	1.0167	1.0167	1.003	0.9501
11	BUS 11	1.0151	1.0151	1.0017	0.9851
12	BUS 12	1.0074	1.0075	0.9931	0.9769
13	BUS 13	1.004	1.0041	0.9881	0.9708
14	BUS 14	0.9969	0.9969	0.9739	0.9544

NODE NO.	FROM NAME	VOLTAGE MAGNITUDE (P.U) BASE CASE	OPF-P-2	OPF-P-3	OPF-Q
FUZZY BASE RULES		SI_{VP}	SI_{VP}	SI_{VP}	SI_{VP}
1	BUS 1	58	58	57.8	57.7
2	BUS 2	58.3	58.3	58.1	58.1
3	BUS 3	58.7	58.7	58.6	58.7
4	BUS 4	58.8	58.8	58.8	59
5	BUS 5	58.8	58.7	58.7	58.9
6	BUS 6	58.6	58.6	58.6	58.7
7	BUS 7	58.4	58.3	58.4	58.9
8	BUS 8	57.7	57.7	57.7	58.4
9	BUS 9	58.6	58.6	58.6	59.1
10	BUS 10	58.7	58.7	58.7	59.2
11	BUS 11	58.7	58.7	58.7	58.8
12	BUS 12	58.8	58.8	58.8	58.9
13	BUS 13	58.8	58.8	58.9	59
14	BUS 14	58.9	58.9	59	59.1
	OSI_{VP}	819.8	819.6	819.4	822.5
	ΣSI_{VP}	3281.3			

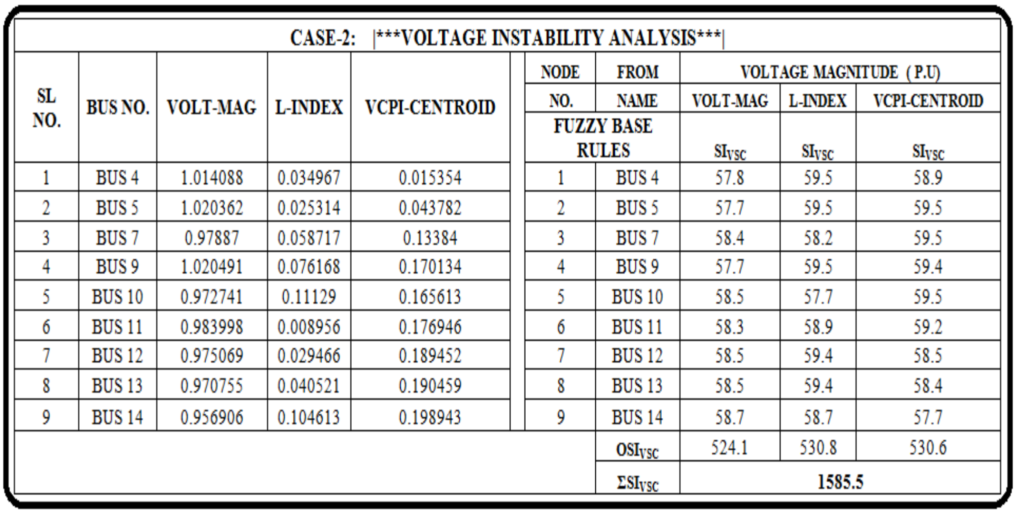
Table 4: Voltage instability constraints (VSC) index severity indices employing Fuzzy Logic without DG in different cases.



CASE-1: |***VOLTAGE INSTABILITY ANALYSIS***|

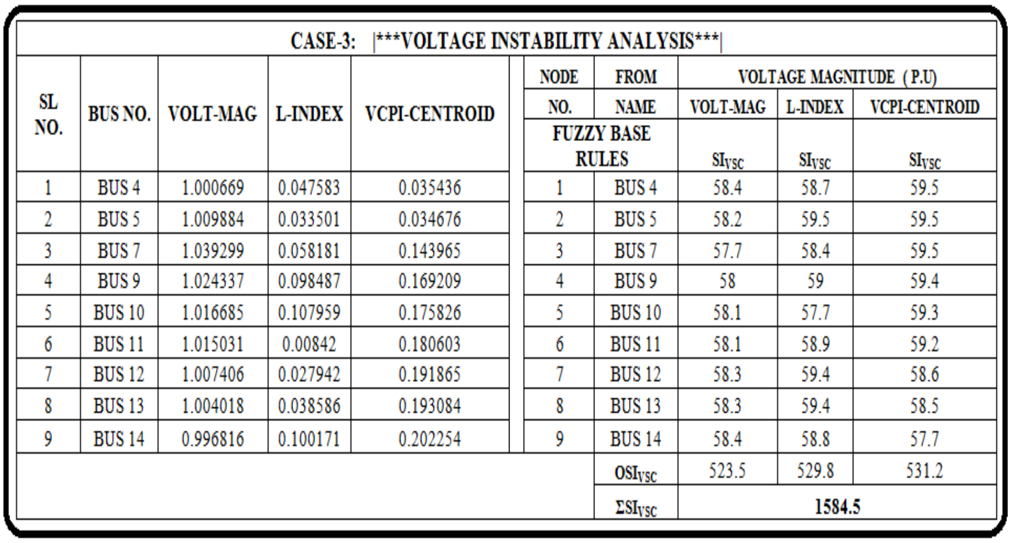
SL NO.	BUS NO.	VOLT-MAG	L-INDEX	VCPI-CENTROID
1	BUS 4	1.000625	0.0436	0.035625
2	BUS 5	1.009907	0.030884	0.034622
3	BUS 7	1.039075	0.045626	0.144733
4	BUS 9	1.020491	0.076168	0.170134
5	BUS 10	1.016286	0.072262	0.177212
6	BUS 11	1.015904	0.041134	0.178234
7	BUS 12	1.0078	0.026453	0.190703
8	BUS 13	1.004325	0.035425	0.192082
9	BUS 14	0.996811	0.086142	0.202372

NODE NO.	FROM NAME	VOLTAGE MAGNITUDE (P.U) VOLT-MAG	L-INDEX	VCPI-CENTROID
FUZZY BASE RULES		SI_{VSC}	SI_{VSC}	SI_{VSC}
1	BUS 4	58.4	57.8	59.5
2	BUS 5	58.2	59.4	59.5
3	BUS 7	57.7	58.2	59.5
4	BUS 9	58	59.2	59.4
5	BUS 10	58.1	59.4	59.3
6	BUS 11	58.1	58.1	59.3
7	BUS 12	58.2	59.5	58.7
8	BUS 13	58.3	59	58.6
9	BUS 14	58.4	57.7	57.7
	OSI_{VSC}	523.4	528.3	531.5
	ΣSI_{VSC}	1583.2		



CASE-2: |*VOLTAGE INSTABILITY ANALYSIS***|**

SL NO.	BUS NO.	VOLT-MAG	L-INDEX	VCPI-CENTROID	NODE NO.	FROM NAME	VOLTAGE MAGNITUDE (P.U) VOLT-MAG	L-INDEX	VCPI-CENTROID
					FUZZY BASE RULES		SI_{VSC}	SI_{VSC}	SI_{VSC}
1	BUS 4	1.014088	0.034967	0.015354	1	BUS 4	57.8	59.5	58.9
2	BUS 5	1.020362	0.025314	0.043782	2	BUS 5	57.7	59.5	59.5
3	BUS 7	0.97887	0.058717	0.13384	3	BUS 7	58.4	58.2	59.5
4	BUS 9	1.020491	0.076168	0.170134	4	BUS 9	57.7	59.5	59.4
5	BUS 10	0.972741	0.11129	0.165613	5	BUS 10	58.5	57.7	59.5
6	BUS 11	0.983998	0.008956	0.176946	6	BUS 11	58.3	58.9	59.2
7	BUS 12	0.975069	0.029466	0.189452	7	BUS 12	58.5	59.4	58.5
8	BUS 13	0.970755	0.040521	0.190459	8	BUS 13	58.5	59.4	58.4
9	BUS 14	0.956906	0.104613	0.198943	9	BUS 14	58.7	58.7	57.7
						OSI_{VSC}	524.1	530.8	530.6
						ΣSI_{VSC}	**1585.5**		



CASE-3: |*VOLTAGE INSTABILITY ANALYSIS***|**

SL NO.	BUS NO.	VOLT-MAG	L-INDEX	VCPI-CENTROID	NODE NO.	FROM NAME	VOLTAGE MAGNITUDE (P.U) VOLT-MAG	L-INDEX	VCPI-CENTROID
					FUZZY BASE RULES		SI_{VSC}	SI_{VSC}	SI_{VSC}
1	BUS 4	1.000669	0.047583	0.035436	1	BUS 4	58.4	58.7	59.5
2	BUS 5	1.009884	0.033501	0.034676	2	BUS 5	58.2	59.5	59.5
3	BUS 7	1.039299	0.058181	0.143965	3	BUS 7	57.7	58.4	59.5
4	BUS 9	1.024337	0.098487	0.169209	4	BUS 9	58	59	59.4
5	BUS 10	1.016685	0.107959	0.175826	5	BUS 10	58.1	57.7	59.3
6	BUS 11	1.015031	0.00842	0.180603	6	BUS 11	58.1	58.9	59.2
7	BUS 12	1.007406	0.027942	0.191865	7	BUS 12	58.3	59.4	58.6
8	BUS 13	1.004018	0.038586	0.193084	8	BUS 13	58.3	59.4	58.5
9	BUS 14	0.996816	0.100171	0.202254	9	BUS 14	58.4	58.8	57.7
						OSI_{VSC}	523.5	529.8	531.2
						ΣSI_{VSC}	**1584.5**		

Tables 3–4 show all instances severity indexes for VP and VSC derived using fuzzy base rules, as well as all indices computed with the composite index (CI).

5.2. Contingency No.1 Analysis

$\Sigma SI_{VP} = 3163.8$
$\Sigma SI_{VSC} = 1583.2$
$CI = \Sigma SI_{VP} + \Sigma SI_{VSC} = 4747$

5.3. Contingency No.2 Analysis

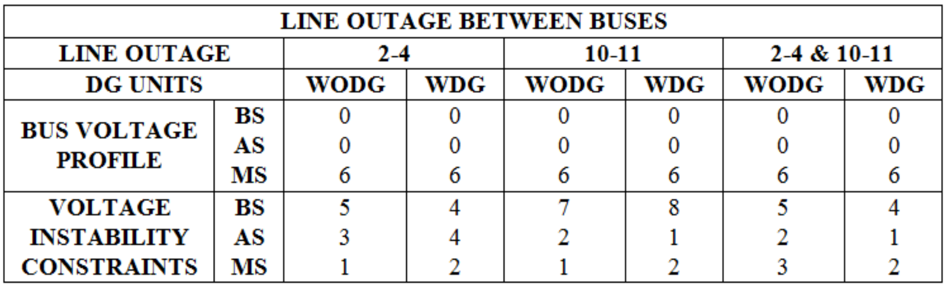
$\Sigma SI_{VP} = 3292.7$
$\Sigma SI_{VSC} = 1585.5$
$CI = \Sigma SI_{VP} + \Sigma SI_{VSC} = 4878.2$

5.4. Contingency No.3 Analysis

$\Sigma SI_{VP} = 3281.3$
$\Sigma SI_{VSC} = 1584.5$
$CI = \Sigma SI_{VP} + \Sigma SI_{VSC} = 4865.8$

Table 5: The criteria for the contingency analysis and fuzzy logic rankings are analyzed.

Contingency No.	**CS CI=VP+ VSC**	**Rank**	**FL CI = ΣSI_{VP} +ΣSI_{VSC}**	**Rank**
1	64.14174	3	4747	3
2	**67.62059**	**1**	**4878.2**	**1**
3	67.51764	2	4865.8	2



LINE OUTAGE BETWEEN BUSES							
LINE OUTAGE		**2-4**		**10-11**		**2-4 & 10-11**	
DG UNITS		**WODG**	**WDG**	**WODG**	**WDG**	**WODG**	**WDG**
BUS VOLTAGE PROFILE	**BS**	0	0	0	0	0	0
	AS	0	0	0	0	0	0
	MS	6	6	6	6	6	6
VOLTAGE INSTABILITY CONSTRAINTS	**BS**	5	4	7	8	5	4
	AS	3	4	2	1	2	1
	MS	1	2	1	2	3	2

Table 6: The number of lines/buses in each severity level.

Ranking may be easily confirmed by looking at table 6, which provides the number of lines/buses in each severity class. Table 5 shows that the outage contingency number-2 without DG has a larger number of lines/buses in the MS severity category. As a consequence, it is rated first. As just a result, for contingency scenario second position on severity categories, optimal placement of DG based on allocations of size, location, & various sites is required. The proposed contingency ranking method is capable of clearly identifying the genuine severity of the system in terms of line loading and bus voltage profile from one scenario to the next. As a result, the proposed solution solves the masking effect issue.

Since the maximum rating is specified by the local distribution network design, it is not possible to specify the rating of sources that supply distributed generation (DG), for instance the load demand. However, DG grading subcategories must be introduced [3].

The classes are as follows:
Its Distribution Generation (DG) ranges from
1 watt to 5 KW
5 KW–5 MW slight DG
5MW-50MW moderate DG
A huge assortment of DG (50MW-300MW)

B. Opdg (Optimal Dg Placement) With Contingency Analysis For Distinct Case Studies Using Fuzzy Logic.

See Table-6 for a listing of additional effect categories (MS) on the IEEE 14-bus test system. Based on contingency scenarios and a fuzzy logic approach for Tables 4&5, the ideal placement of DG in Contingency No.2 for Table No.5 will be found. Improving voltage profile and reliability reduces line losses, improve the economic dispatch, but also reduces voltage instability dependency.

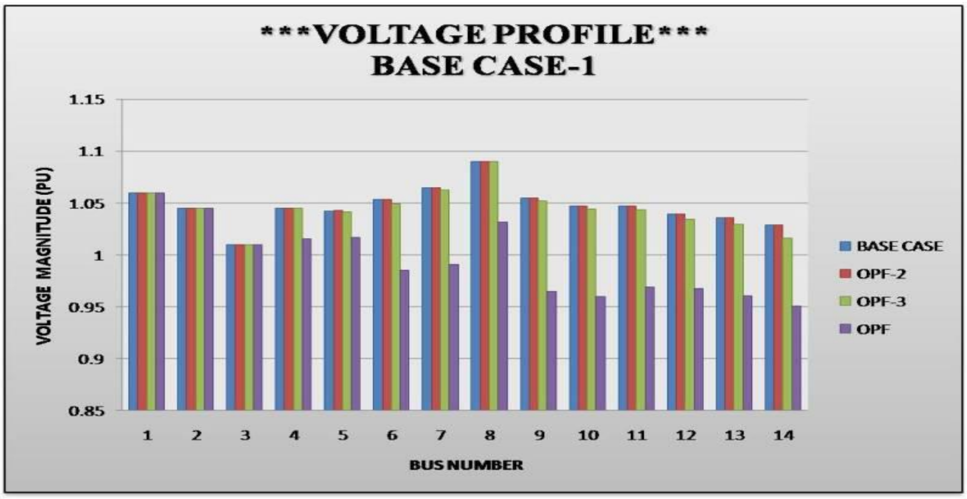


Fig.3: OPDG of Voltage Profile in the Post-contingency cases-1 using fuzzy logic with DG.

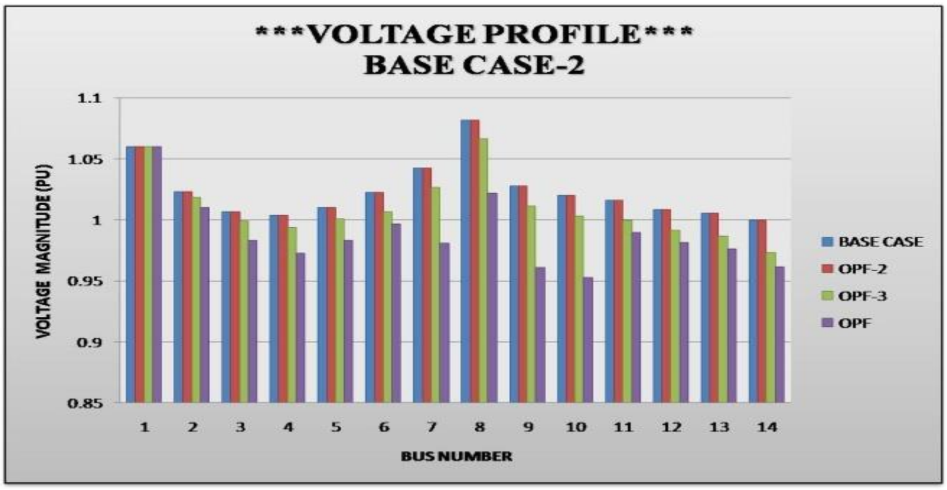


Fig.4: OPDG of Voltage Profile in the Post-contingency cases-2 using fuzzy logic with DG.

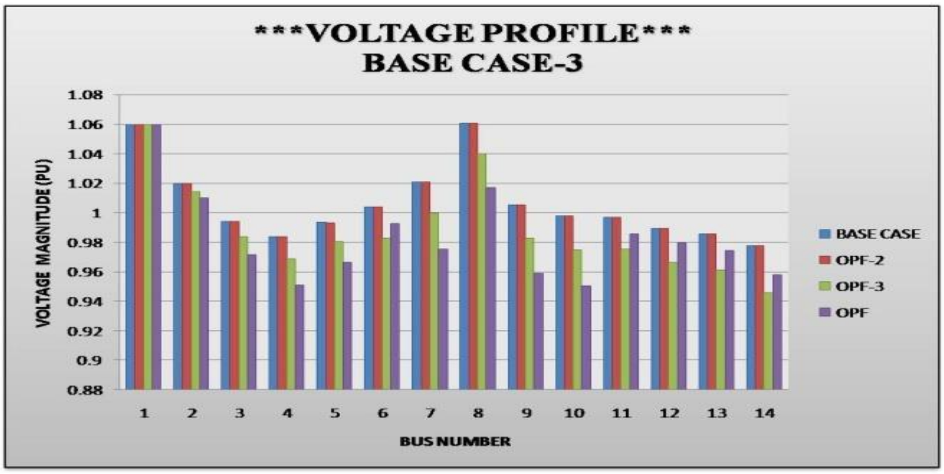


Fig.5: OPDG of Voltage Profile in the Post-contingency cases-3 using fuzzy logic with DG.

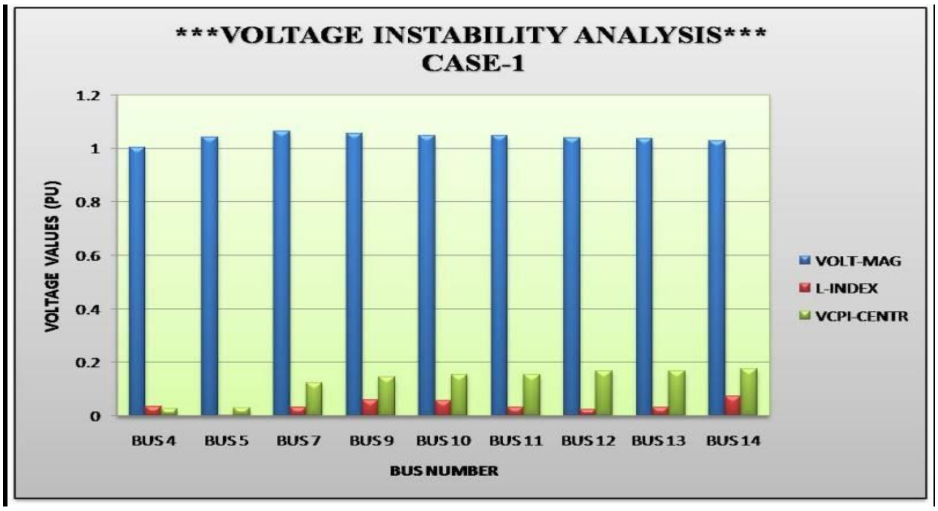


Fig.6: OPDG of Voltage Instability constraints in the Post-contingency cases-1 using fuzzy logic with DG.

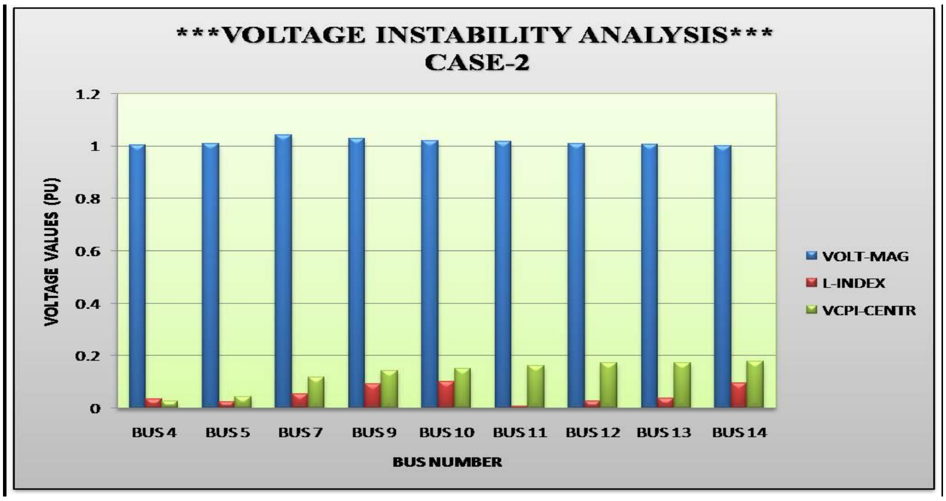


Fig.7: OPDG of Voltage Instability constraints in the Post-contingency cases-1 using fuzzy logic with DG.

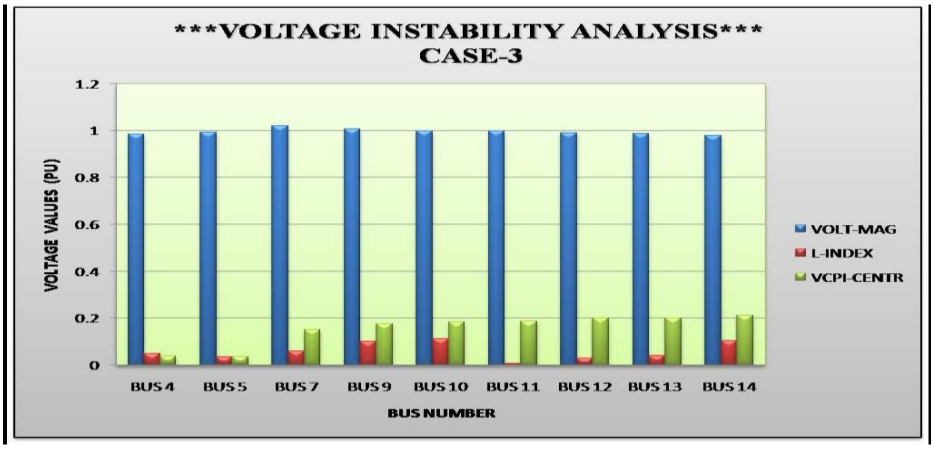


Fig.8: OPDG of Voltage Instability constraints in the Post-contingency cases-1 using fuzzy logic with DG.

Fig.9: Considering constant OPDG of Reliability Indices in the different contingency cases using fuzzy logic with DG.

When comparing the effect of interruption on dependability with and without DG, ENS & AENS will have a greater influence on the system. The rest of the indices will be the same.

VI. CONCLUSION

This paper proposes an effective investigation of voltage unpredictability and dependability indices using Fuzzy Based Rules, which works well on power frameworks in all conditions. However, because of quantity consecutive emphases in the fuzzy logic load stream approach is greater, the suggested algorithm does not require factorization, re-factorization, or Jacobin matrix computation at each cycle, demonstrating the correctness of the algorithm suggested This method will be tremendously valuable in assuring a power system's voltage security by predicting the likelihood of voltage fluctuations. breakdown under existing peak load and assisting us in measuring the optimum burden capacity of a particular system without causing voltage insecurity.

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