DG Management for Real Time System using Artificial Intelligence

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***Abstract*—The most common and reliable renewable sources of generation like PV system and wind based units are connected to power system network to increase the electrical power potential benefits.These distributed generation (DG) units are connected to SLV feeder distribution system, Mysuru. Artificial intelligence is used to manage these DGs along grid supply for various consumer load condition so as to meet the demand. The simulation is carried on this system using MATLAB/Simulink 2014a.**

***Index Terms*—Fuzzy Logic, Unit Commitment, DG, Simulation.**

I. INTRODUCTION

Renewable sources of electrical energy are gaining importance in power system network. These alternate sources are connected to power system network mainly to meet consumer power demand along with conventional means of electrical power generation. It definitely alleviates the congestion in network. This type of hybrid connection not only meet demand effectively will also have reduction in environmental aspect. The two DGs penetrated are solar based and wind based generation. This hybrid system is connected to 33 node SLV feeder, Mysuru. Fuzzy logic is applied for generation commitment.

II. PROPOSED MODEL

A. Modelling of Solar Based Power Generation

The simulation parameters are set in par with actual solar generating station at Shivnasamudra, Mandya. The following are parameters set Irradiance 1000W/M^2, Temperature 25^{o}C, Number of modules in series = 40, Number of modules in parallel = 60, Open circuit voltage = 32.6 V, Short circuit current = 8.2 A. MATLAB simulation model as shown is carried out as per the mathematical obtainedequations. The voltage and current profile is as shown in figure 2.2

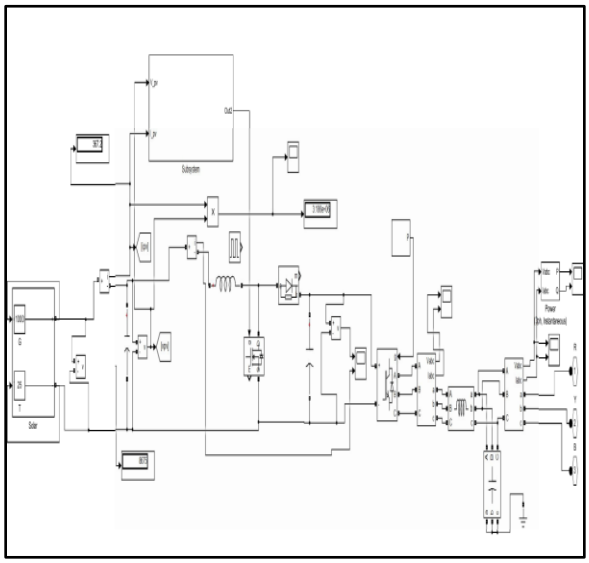
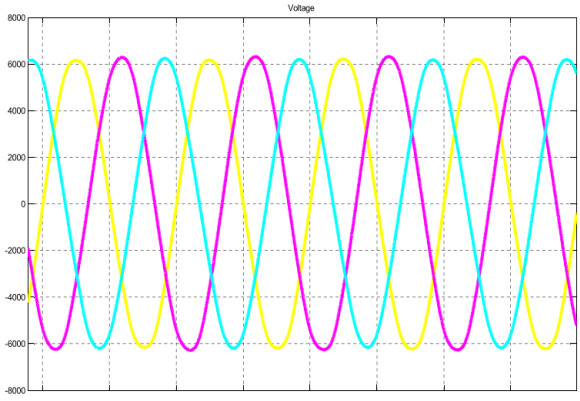


Fig 2.1: AC Side Simulation Module of Solar Based Generation



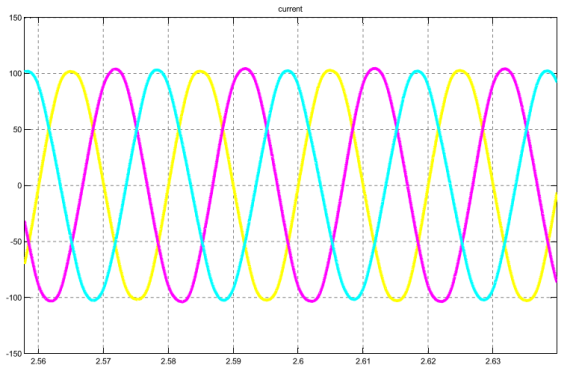


Fig2.2: Voltage and Current Profiledue to Solar Based Generation

B. Modelling of Wind Based Power Generation

Doubly Fed Induction Generator (DFIG) mathematical model is used to simulate wind based electrical power generation

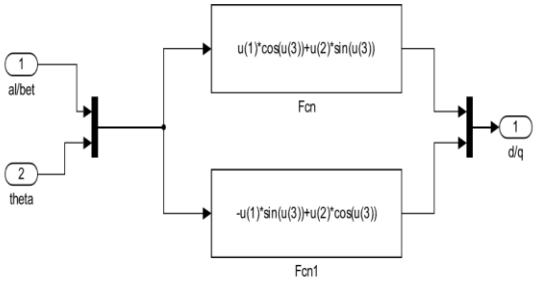


Fig 2.3: Simulation Model of Clarke's to dq transformation

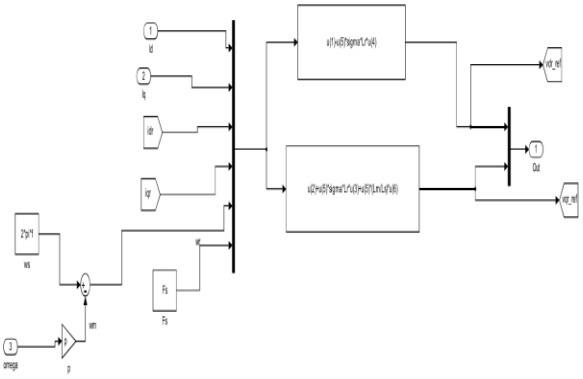


Fig 2.4: Simulation Model of Rotor Voltage Control Circuit

Simulation parameters set are as follows base wind speed 12M/Sec, Nominal mechanical output power is 2MW, Maximum power at base wind speed is .73pu. The stator voltage, stator current profile and rotor current due to wind based power generation is as shown in fig 2.5.

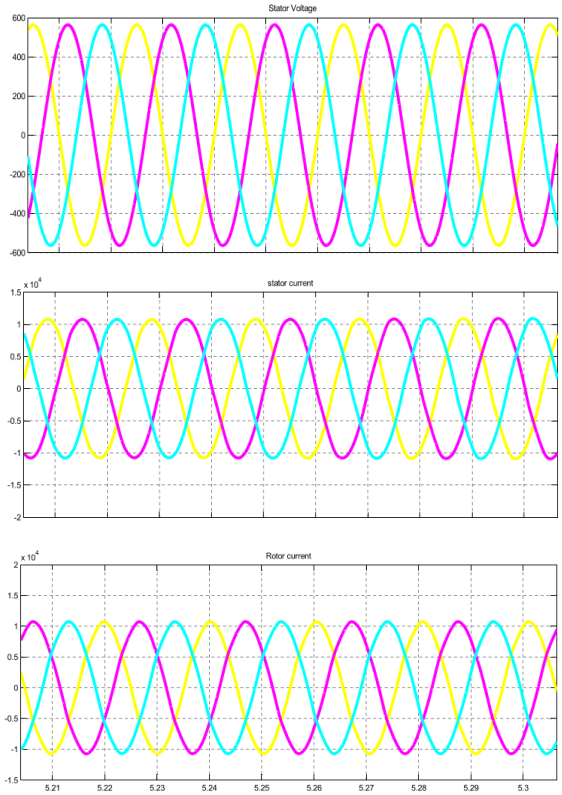
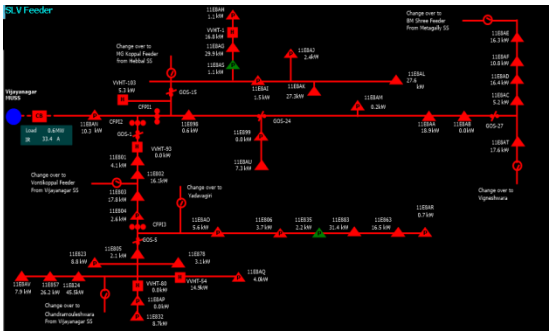
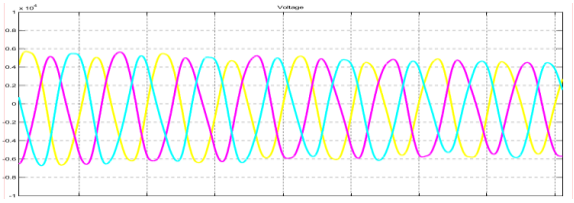


Fig 2.5: Stator Voltage, Current and Rotor Voltage

C. Modelling of 33 nodes SLV Feeder



The SLV feeder which is considered for simulation study comprises of 33 nodes.The type load is PQ load with star connection. The active and reactive power is extracted from smart grid centre for 12 hrs.



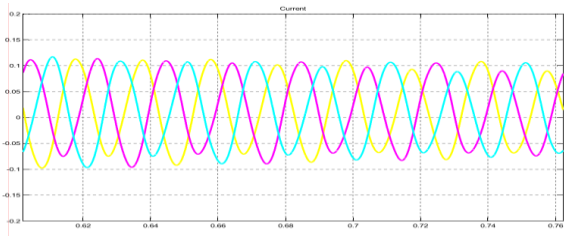


Fig 2.5: Voltage and Current Profile at 11E832 Node due to Solar Based Power Generation

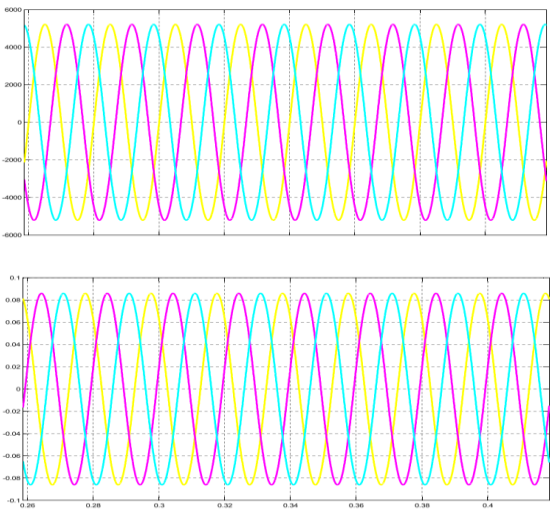


Fig 2.6: Voltage and Current Profile at 11E832 Node due to Wind Based Power Generation

III. RESULTS AND DISCUSSION

Simulation work on 33 nodes SLV feeders is carried out with four generation units. Unit1 and 2 are thermal units, Unit 3 is solar unit and Unit 4 is wind unit. Fuzzy logic with 24 rules and 3 member functions are designed for four generation units to meet the load.

Case 1:

Sl. No.	Generation Unit	P_{min} in MW	P_{max} in MW
1	1	0	0
2	2	0	0
3	3	20	30
4	4	20	30

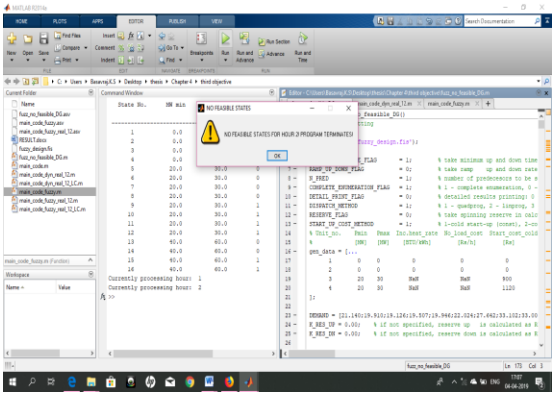


Fig 3.1: No Feasible State in hour 2 as Load is Less than 20MW

Case 2:

Sl. No.	Generation Unit	P_{min} in MW	P_{max} in MW
1	1	0	0
2	2	0	0
3	3	15	30
4	4	20	30

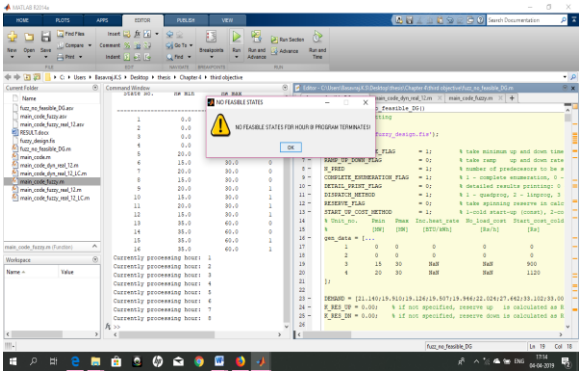


Fig 3.2: No Feasible State in hour 8 as Load is greater than 30 MW

Case 3:

Sl. No.	Generation Unit	P_{min} in MW	P_{max} in MW
1	1	0	0
2	2	0	0
3	3	10	35
4	4	10	35

Sl. No.	Demand (MW)	Total Generation (MW)	Pmin (MW)	Pmax (MW)	Generating Unit Combination				Cost - Unit 1 in Rs/Kwhr	Cost - Unit 2 in Rs/Kwhr	Cost - Solar in Rs/Kwhr	Cost - Wind in Rs/Kwhr	Total Amount Rs/Kwhr
1	21	21	10	35	0	0	1	0	0	0	113190	0	113190
2	20	20	10	35	0	0	1	0	0	0	107800	0	107800
3	19	19	10	35	0	0	1	0	0	0	102410	0	102410
4	20	20	10	35	0	0	1	0	0	0	107800	0	107800
5	20	20	10	35	0	0	1	0	0	0	107800	0	107800
6	22	22	10	35	0	0	1	0	0	0	118580	0	118580
7	28	28	10	35	0	0	1	0	0	0	150920	0	150920
8	33	33	10	35	0	0	1	0	0	0	177870	0	177870
9	33	33	10	35	0	0	1	0	0	0	177870	0	177870
10	30	30	10	35	0	0	1	0	0	0	161700	0	161700
11	25	25	10	35	0	0	1	0	0	0	134750	0	134750
12	25	25	10	35	0	0	1	0	0	0	134750	0	134750
Total Cost due to Individual Unit in Rs/Kwhr (12 Hrs)									**0**	**0**	**1595440**	**0**	**1595440**
Grand Total Cost in Rs/12 Hrs									**1595440**				

Fig 3.3: Generation Commitment using Dynamic Programming

Sl. No.	Demand (MW)	Total Generation (MW)	Pmin (MW)	Pmax (MW)	Generating Unit Combination				Cost - Unit 1 in Rs/Kwhr	Cost - Unit 2 in Rs/Kwhr	Cost - Solar in Rs/Kwhr	Cost - Wind in Rs/Kwhr	Total Amount Rs/Kwhr
1	21	21	20	70	0	0	1	1	0	0	113190	63000	176190
2	20	20	10	35	0	0	0	1	0	0	0	60000	60000
3	19	19	10	35	0	0	0	1	0	0	0	57000	57000
4	20	20	10	35	0	0	0	1	0	0	0	60000	60000
5	20	20	10	35	0	0	0	1	0	0	0	60000	60000
6	22	22	10	35	0	0	0	1	0	0	0	66000	66000
7	28	28	10	35	0	0	0	1	0	0	0	84000	84000
8	33	33	10	35	0	0	0	1	0	0	0	99000	99000
9	33	33	10	35	0	0	0	1	0	0	0	99000	99000
10	30	30	10	35	0	0	0	1	0	0	0	90000	90000
11	25	25	10	35	0	0	0	1	0	0	0	75000	75000
12	25	25	20	70	0	0	1	1	0	0	134750	75000	209750
Total Cost due to Individual Unit in Rs/Kwhr (12 Hrs)									**0**	**0**	**247940**	**888000**	**1135940**
Grand Total Cost in Rs/12 Hrs									**1135940**				

Fig 3.3: Generation Commitment using Fuzzy Logic Programming.

It is observed that fuzzy logic concept will give effective generation combination to meet the demand. The amount saved is Rs. 4,59,500 per 12 hrs.

Case 4:

Sl. No.	Generation Unit	P_{min} in MW	P_{max} in MW
1	1	15	35
2	2	10	40
3	3	10	15
4	4	10	15

Sl. No.	Demand (MW)	Total Generation (MW)	Pmin (MW)	Pmax (MW)	Generating Unit Combination				Cost - Unit 1 in Rs/Kwhr	Cost - Unit 2 in Rs/Kwhr	Cost - Solar in Rs/Kwhr	Cost - Wind in Rs/Kwhr	Total Amount Rs/Kwhr
1	21	21	20	55	0	1	1	0	0	103110	113190	0	216300
2	20	20	20	55	0	1	1	0	0	98200	107800	0	206000
3	20	20	20	55	0	1	1	0	0	98200	107800	0	206000
4	11	11	10	15	0	0	1	0	0	0	59290	0	59290
5	17	17	15	35	1	0	0	0	83470	0	0	0	83470
6	19	19	15	35	1	0	0	0	93290	0	0	0	93290
7	26	26	25	50	1	0	0	1	127660	0	0	78000	205660
8	32	32	25	50	1	0	0	1	157120	0	0	96000	253120
9	33	33	25	50	1	0	0	1	162030	0	0	99000	261030
10	33	33	25	50	1	0	0	1	162030	0	0	99000	261030
11	29	29	25	50	1	0	0	1	142390	0	0	87000	229390
12	24	24	15	35	1	0	0	0	117840	0	0	0	117840
Total Cost due to Individual Unit in Rs/Kwhr (12 Hrs)									**1045830**	**299510**	**388080**	**459000**	**2192420**
Grand Total Cost in Rs/12 Hrs									**2192420**				

Fig 3.4: Generation Commitment using Dynamic Programming

Sl. No.	Demand (MW)	Total Generation (MW)	Pmin (MW)	Pmax (MW)	Generating Unit Combination				Cost - Unit 1 in Rs/Kwhr	Cost - Unit 2 in Rs/Kwhr	Cost - Solar in Rs/Kwhr	Cost - Wind in Rs/Kwhr	Total Amount Rs/Kwhr
1	21	21	10	40	0	1	0	0	0	103110	0	0	103110
2	20	20	10	40	0	1	0	0	0	98200	0	0	98200
3	20	20	10	40	0	1	0	0	0	98200	0	0	98200
4	11	11	10	40	0	1	0	0	0	54010	0	0	54010
5	17	17	10	40	0	1	0	0	0	83470	0	0	83470
6	19	19	15	35	1	0	0	0	93290	0	0	0	93290
7	26	26	25	50	1	0	0	1	127660	0	0	78000	205660
8	32	32	25	50	1	0	0	1	157120	0	0	96000	253120
9	33	33	25	50	1	0	0	1	162030	0	0	99000	261030
10	33	33	25	50	1	0	0	1	162030	0	0	99000	261030
11	29	29	20	55	0	1	0	1	0	142390	0	87000	229390
12	24	24	10	40	0	1	0	0	0	117840	0	0	117840
Total Cost due to Individual Unit in Rs/Kwhr (12 Hrs)									**702130**	**697220**	**0**	**459000**	**1858350**
Grand Total Cost in Rs/12 Hrs									**1858350**				

Fig 3.4: Generation Commitment using Fuzzy Logic Programming

It is observed that amount saved is Rs. 3,34,070

IV. CONCLUSION

The four generating units like 2 thermal units, 1 solar based generating unit and 1 wind based generating unit are considered to obtain the cost effective combination of units using Dynamic Programming and Fuzzy Logic System. The generating units cost details are extracted from reference paper and practical units accordingly. The load consumption of real time system, SLV feeder , V.V. Mohalla, Mysuru is tabulated for two differnt12 hrs, dated 20/09/2017. Different cases from 1 to 11 are considered and compared the cost between Dynamic Programming and Fuzzy Logic System. It is found that fuzzy logic system gives most effective combinations of generating units.

REFERENCE

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[2] DánielDivényi, and András M. Dán,"Agent-Based Modeling of Distributed Generation in Power System Control", *IEEE Transactions On Sustainable Energy*, 2013