IMPROVING TRANSIENT STABILITY OF MICRO- GRID IN THE ISLANDING STATE AND AFTER IT USING DFACTS

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ABSTRACT

In this paper, the transient stability improvement of a real power distribution grid in the case of Dispersed Generation (DG) during the islanding and after it using DFACTS devices and specially DSTATCOM is examined. The proposed approach is evaluated through a case study on a 63/20 kV post, which is part of the medium voltage grid of the Isfahan city, and the grid parameters are real. In the proposed method, we attempt using the technical specifications of DSTATCOM to increase the stability range of system. This transient stability improvement largely depends on the way we control the aforementioned components. The control mode that the present research considers is DSTATCOM, based on fixing voltage and controlling the reactive power (V_{dc}-Q). The proposed method is evaluated using Digsilent 14.1.

1 INTRODUCTION

Connection of DG resources to the distribution grids can face these systems with new problems. Since in islandig mode, the grid has no control on voltage and frequency, thus the loads connected to the system can be damaged. Various solutions to this problem have been proposed, which are discussed in the following.

In [1], found the result that DG resources of synchronous generators are not alone able to maintain the stability of the micro-Grid certainly it is necessary in any micro-Grid having resources based on power electronic converters.

In [2], the benefits of using FACTS devices to improve transient stability in a micro-Grid were examined and concluded that these elements can improve transient stability of synchronous generators favorably.

In [3-4], it was shown that adopting appropriate strategies to manage the work of micro-Grid in both cases of being connected to a grid as well as in the islanding mode is of great importance. We can through adjusting the output current of the axe P to control voltage and frequency of DG resources.

2 SYSTEM MODELING

The study is done through a case including a distribution substation of 63.20 kV with actual data and structure. The intended grid is shown in Figure 1.

In this study, a synchronous generator (DG1) and an inverter base generator (DG2) are considered The compensator used in the system had a capacity of 10 MW and was connected to the distribution system through a 20.04 kV transformer.

The total load of system is 11 MW and 5.4 MVAR, 30% of which by DG1, DG2, and the rest of it by the main grid is being supplied. Characteristics of the intended system are shown in the annex.

To model DSTATCOM in Digsilent 14.1, the following elements are used:

- a PWM pulse generator with the carrier frequency of 1.68 KHZ to control each bridge of IGBT,
- a 95 mf capacitors for reactive power production,
- a PLL (phase locked loop), two measurement systems, a current regulation loop and a DC voltage regulator.

3 EXAMINING DIFFERENT ISLANDING STATES IN THE PRESENCE OF DSTATCOM

3.1 Temporary Three-Phase Short Circuit Fault on 63kv Line

Here, the transient state of micro-Grid subject to the temporary three-phase short circuit fault on line 63 kV is examined. The results show that the transient stability of micro-Grid to be preserved appropriately through fast performance of DG2 and of course rapid response of DSTATCOM in reactive power injection. Times for of short circuit, debugging and simulation intervals are 0.5, 0.7 and 4 seconds, respectively. Figure 2 shows the corresponding graphs.

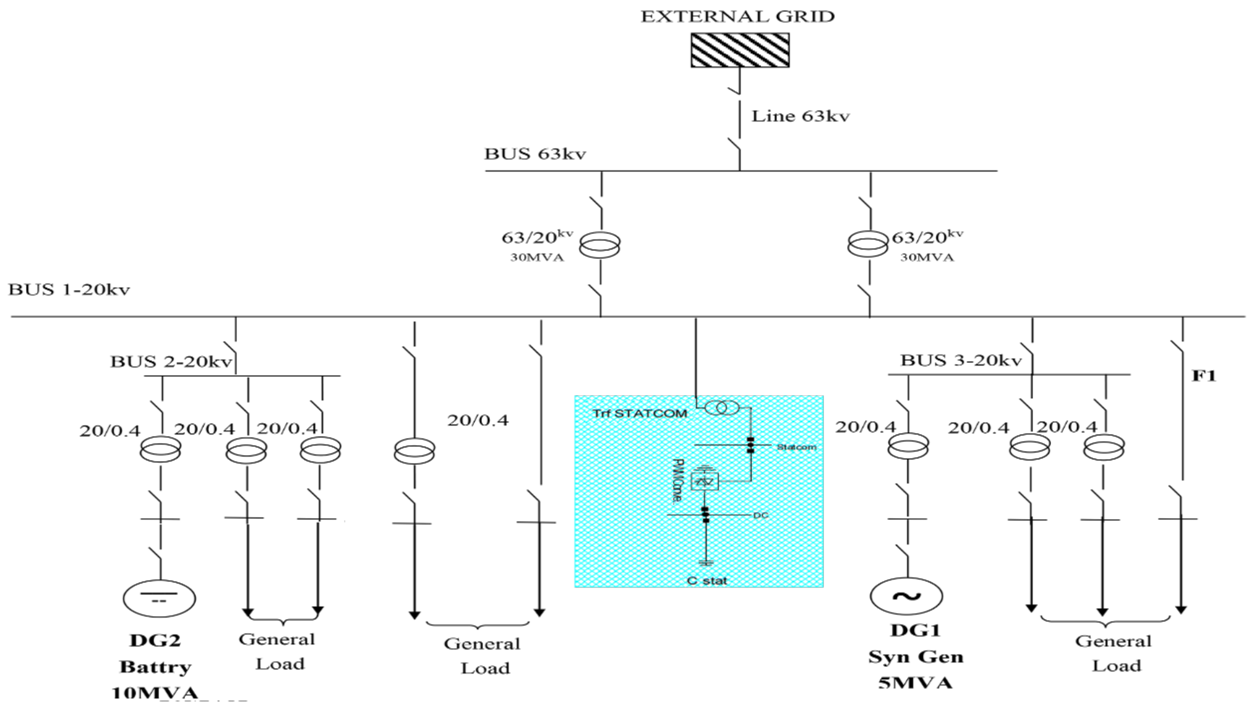
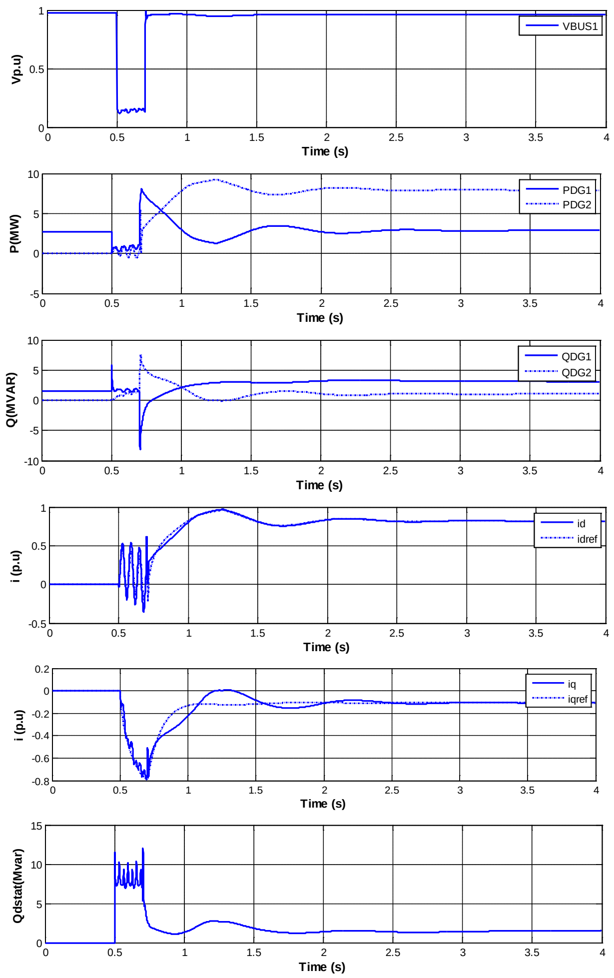


Fig. 1. Single-Line diagram of study system



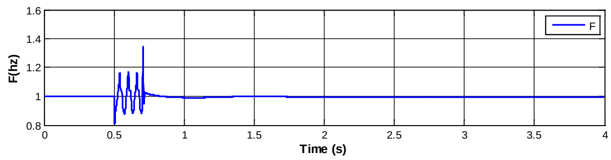
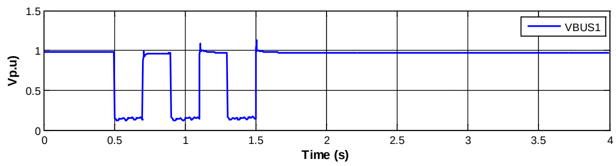


Fig. 2. Case(3.1)temporary L-L-L-G fault

3.2 Permanent Short-Circuit Failure on Line 63 kV

Here, as in before, the fault occurs but the difference is that the transient parts of system form due to three times non-successful switching. So after three unsuccessful opening and closing operation of key, micro-Grid permanently shapes and its function continues like an autonomous system in the presence of DSTATCOM. The results show that a combination of different dg resources and DSTATCOM compensator in the micro-Grid improves the transient stability and increases the time of resolving faults. Figure 3 shows graphs relating to this case.



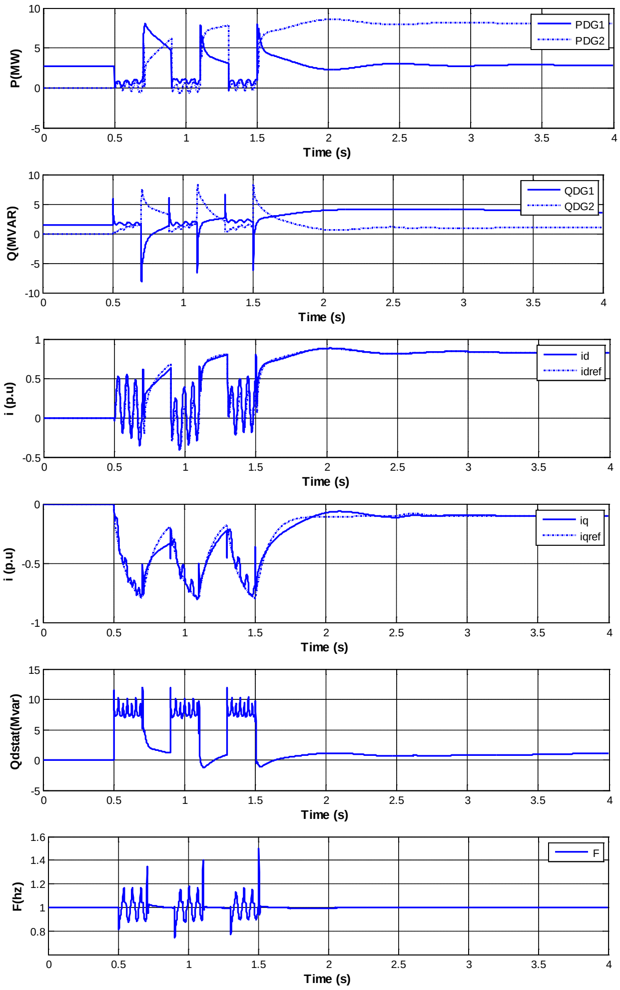


Fig.3. Case(3.2):permanet L-L-L-G fault

at t = 0.5 s, fault occurs and at t = 0.7 s the keys opens and errors resolve. Similar events, i.e. occurrence and resolving of fault, do occur at times 0.9, 1.1, 1.3 and 1.5 seconds. Simulation time is considered equal to 4 seconds.

4 COMPARISON OF DIFFERENT TRANSIENT STATES IN BOTH THE PRESENCE AND ABSENCE OF DSTATCOM

4.1 In this study, graphs relating to the transient behavior of the micro-Grid subject to the pre-planned scenario of islanding in the case of presence and the lack of presence of DSTATCOM are drawn next to each other. As is shown, at t = 0.5s, a pre-designed islanding command applies in breaker of line 63 kV. Figure 4.a shows the main bus voltage of 20 kV (bus 1) in both cases.

4.2 In this study, graphs relating to the transient behavior of the micro-Grid due to temporary three-phase short circuit fault on line 63 kV in the case of presence and the lack of presence of DSTATCOM are drawn next to each other.

The time intervals for short current, debugging and simulation are considered 0.5, 0.7 and 4 seconds, respectively. Figure 4.b shows the main bus voltage of 20 kV in both cases. Here at t = 0.5s, the fault on line 63 kV occurs and t = 0.7s keys are open the fault is resolved. Similar events, i.e. occurrence and resolving of error, do occur at times 0.9, 1.1, 1.3 and 1.5 seconds. Simulation time is considered equal to 4 seconds. Figure 4.c shows the main bus voltage of 20 kV in both modes.

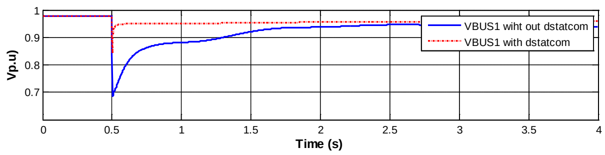


Fig .4.a. Comparing stability of micro-Grid voltage in the presence and absence of DSTATCOM with respect to pre-planned islanding effect

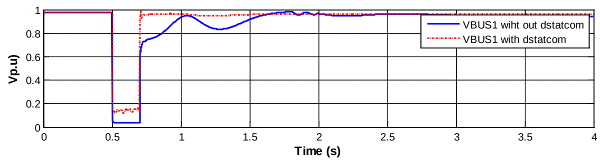


Fig. 4.b. Comparing stability of micro-Grid voltage in the presence and absence of DSTATCOM with respect to temporary three-phase short current on line 63 kV

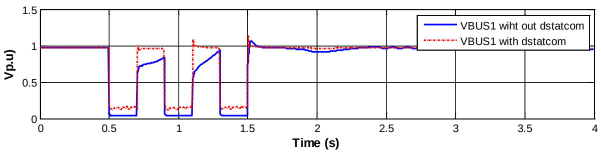


Fig. 4.c. Comparing stability of micro-Grid voltage in the presence and absence of DSTATCOM with respect to permanent three-phase short current on line 63 kV

The results show that voltage changes of system is significantly improved compared to the state in which DSTATCOM is not used, which is due to quick and appropriate response of devices to the transient state of system.

5 COMPARING THE CRITICAL TIME OF FAULT HANDLING IN BOTH THE PRESENCE AND ABSENCE OF DSTATCOM

The results of the simulations show that the critical time of fault handling of synchronous generator (CCT) increase when DSTATCOM are present. Table 1 shows the results.

The site of a three-phase short circuit	Critical time (ms) in the lack of presence of DSTATCOM	Critical time (ms) in the presence of DSTATCOM
BUS-3	336	339
BUS-1	338	342
F1	360	365
BUS-2	390	405

Table 1. Comparison of critical time of fault handling in the presence and the lack of presence of DSTATCOM

As can be observed, whatever distance of the junction location of the synchronous generator is more, critical time of fault handling will increase and proportional to this, the effect of DSTATCOM will increase.

6 CONCLUSIONS

One of the practical and sure ways, which is also used in this article, to improve micro-Grid transient stability in the islanding mode is the use of DFACTS elements. In this article, we saw that with the help of distribution's static compensation (DSTATCOM) and using the capability of its quick reaction, we can control the bus voltages in grids so that it was proved that the transient stability of micro-Grid compared to the case in which these devices are not used significantly improves. When using DSTATCOM, we can handle the stimulation of generators with the production of reactive power generators and maintaining the grid's voltage by using this element. DSTATCOM also eliminate the negative and zero components at the junction point and this improves the power quality in the islanding mode so that we can use the grid in the islanding mode.

7 REFERENCES

[1] Microgrid Autonomous Operation During and Subsequent to Islanding Process "January 2005 IEEE

[2] Impact of Generators and Dstatcom Devices on the Dynamic Performance of Distribution System "April 2005IEEE

[3] Defining Control Strategies for Microgrid Islanded Operation "may 2006 IEEE

Control for Grid-connected and intentional islanding Operation of Distributed Power generation" January 2011 IEEE

[4] Control for Grid-connected and intentional islanding Operation of Distributed Power generation" January 2011 IEEE

8 APPENDIX

Parameter	**Value**
R	$0.13\ \Omega / km$
X	$0.46\ \Omega / km$
R0	$0.15\ \Omega / km$
X0	$0.4\ \Omega / km$
L	3 km
TYPE	Ground aluminum

Table 1. Parameters of 63 kV line

Parameter	Value
R_{AL}	$0.211\ \Omega / km$
X_{AL}	$0.165\ \Omega / km$
R_{CU}	$0.247\ \Omega / km$
X_{CU}	$0.178\ \Omega / km$
L	Different
TYPE	Ground aluminum and copper

Table 2. Parameters of 20 kV line

Parameter	Value
S	5 MVA
V	13.8 KV
Xd	2.76 p.u
Xd'	0.7 p.u
Xd"	0.22 p.u
Ra	0.543 p.u
H	2.9 S

Table 3. Parameters of synchronous generator with power of 5 MVA

Parameter	Value
S	10 MVA
V	10 KV
R/X	0.1

Table 4. Parameters of inverter base resource with power of 10 MVA