Transient Stability of Grid-connected IBR with Single-unit and Multi-unit Operation

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MOTIVATION

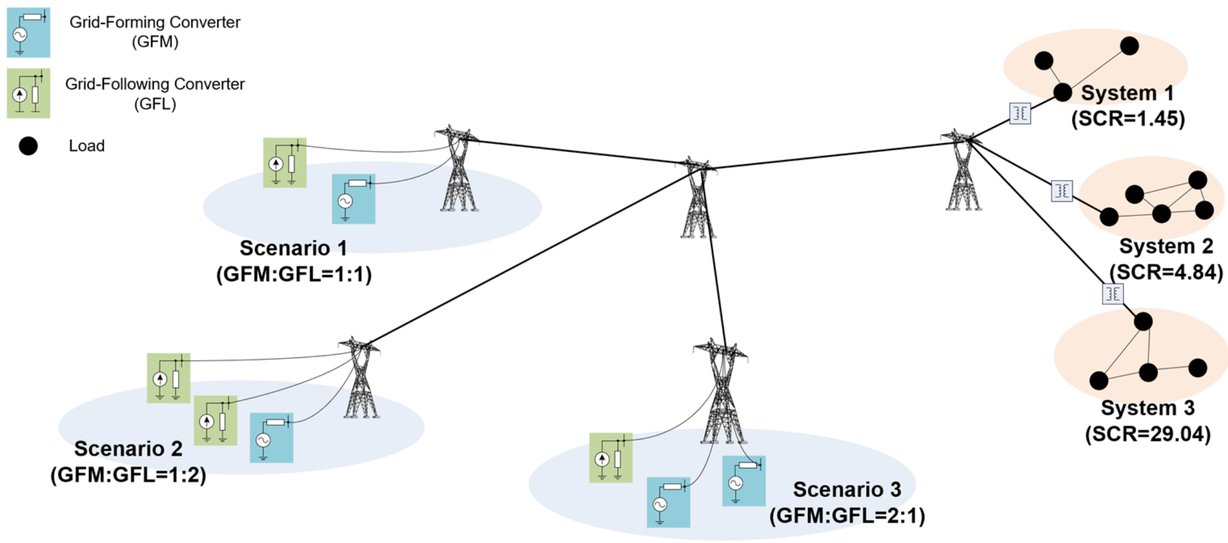
- The effectiveness of the proposed method is verified by the single-unit grid-connected simulation of GFM/GFL converter.
- The transient stability of multi-unit networked grids are studied, in the case of 100% renewable energy converters and different penetration rates of multiple units.
- Using the PLECS platform and a combination of RT Box and microcontroller, the transient stability simulation of the grid-connected converter is carried out to verify the effectiveness of the proposed control method in terms of transient stability improvement.

CONCLUSION

- The single-unit simulation of GFM/GFL converter shows GFM is more suitable for the weak grid and more stable under various faults.
- Based on the multi-unit operation results, GFM shows more adaptability to different SCR, in the case of 100% renewable energy converters and different penetration rates of multiple units.
- Among the scenarios considered here, the transient stability is best when GFM:GFL=2 : 1 and SCR=4.84 for the 100% renewable IBRs; and for high penetration (66.7%) SG+IBR situation, the system perform is best in the view of transient stability.

SCENARIO

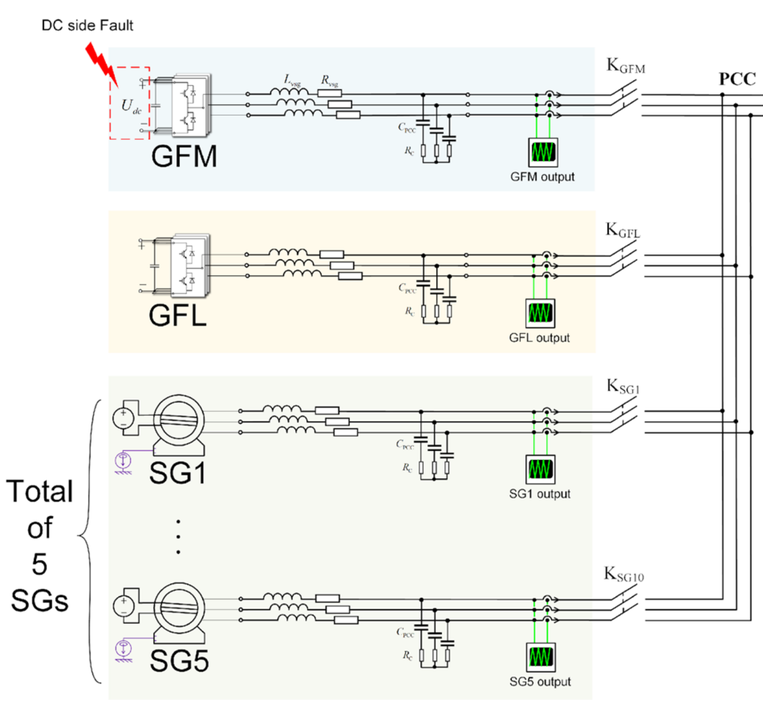
- Consider three scenarios of IBRs: Station 1 (GFM: GFL=1:1), Station 2 (GFM: GFL=1:2), and Station 3 (GFM: GFL=2:1);
- At the same time, consider three grid structures: system 1 (SCR=29.04), system 2 (SCR=4.84), and system 3 (SCR=1.45);
- The above-mentioned combination will be 9 different situations.



CASE STUDY

- Case1: Single generator grid connect
- Case2: 100% IBR multi-generator network
- Case3: Low penetration SG+IBR network
- Case4: High penetration SG+IBR network

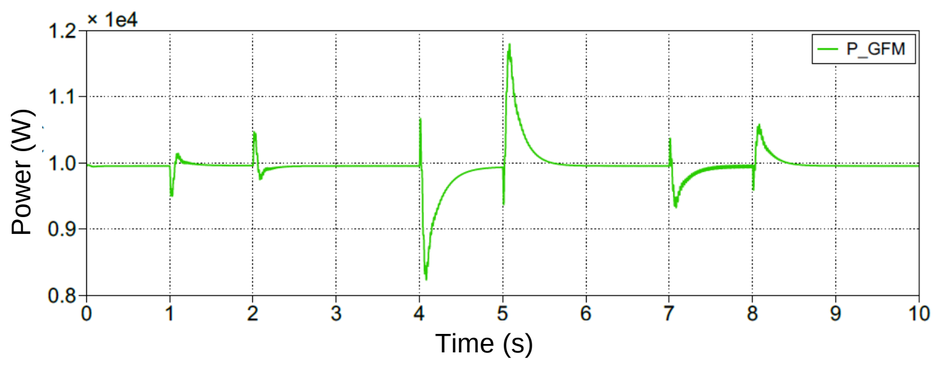
	Fault type	Fault location	Occur time (s)	Amplitude (V)
F_{DC}	DC voltage drop	DC side	1.0–2.0	–50
F_{3Phase}	3 phase short	AC line	4.0–5.0	–50
F_{PhaseA}	1 phase short	AC line	7.0–8.0	–50



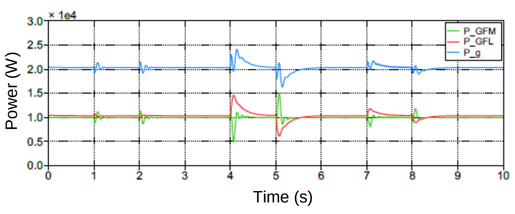
Illustrative figure of the topology of the studied system.

SIMULATION RESULTS

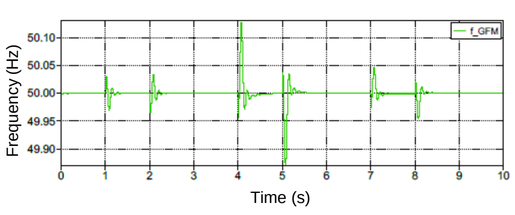
- Case1: Single generator grid connect



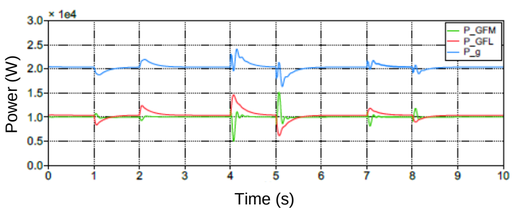
- Case2: 100% IBR multi-generator network



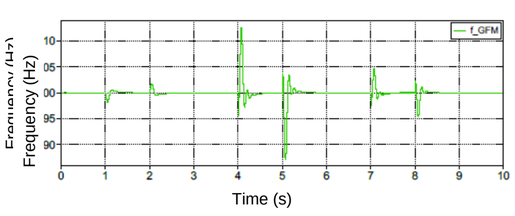
(a) Power of GFM under fault



(b) Frequency of GFM under fault



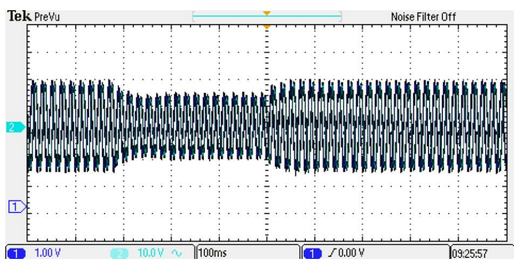
(c) Power of GFL under fault



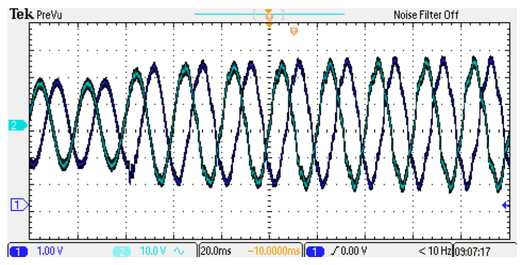
(d) Frequency of GFL under fault

HARDWARE-IN-LOOP

Multiple RT-Box Back-to-Back Simulation



(a) U_{PCC}



(b) I_{PCC}

HIL waves for case 4 high penetration.