Integration of Grid-Forming Capabilities in Inverter-Based Resources (IBR)

David Velasco, Eduardo Burguete, Iker Esandi, Iker Oraa. *Ingeteam Power Technology, S.A.*

Introduction

Traditional grid-following (GFL) control strategies applied in present power converters do not actively contribute to grid stability. In IBR-dominated grids, this can result in instabilities. To overcome this issue, grid–forming (GFM) algorithms have been developed.

Methods (tools and validation process)

- Mathematical modeling [1] and control tuning.
- Model validation using average EMT SIL.
- EMT SIL and/or HIL validation.

Results

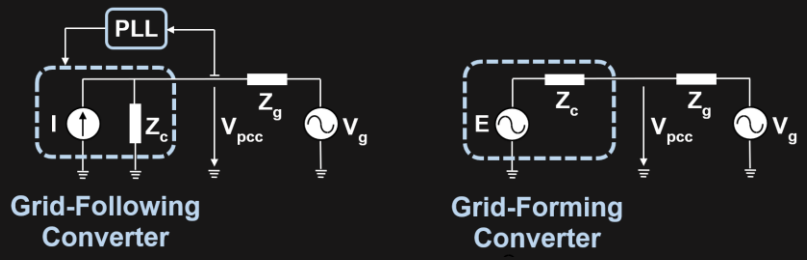
GFM control contributes to grid stability:

- ✓ In very low SCRs due to voltage source behavior and lack of PLL (Fig. 1).
- ✓ Inherently providing primary frequency and voltage support (Fig. 2 and Fig. 3).
- ✓ Integrating black-start capability.

Conclusions

Results show that Ingeteam's DFIG power converters are ready to include GFM control that contributes to enhance grid strength and stability. The developed control is suitable for today's grid, with an increasing number of IBRs, and will ensure the compliance of future grid codes.

INGETEAM DFIG converters ready to include **GRID-FORMING** control that enhances **GRID RESILIENCE**



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Figures

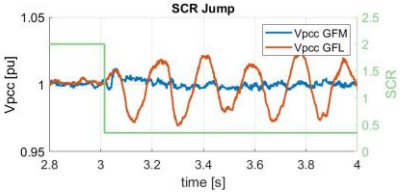

Fig. 1: Stability at low SCRs

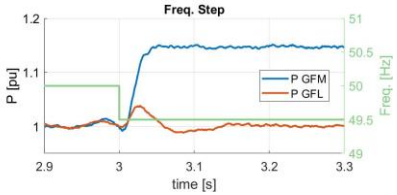

Fig. 2: Primary frequency regulation (P-f support)

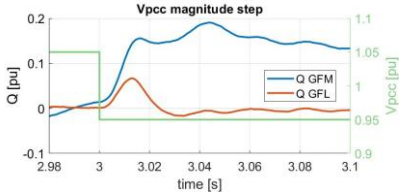

Fig. 3: Primary voltage regulation (Q-V support)

References:

[1] I. Oraa, J. Samanes, J. Lopez and E. Gubia, "Modeling of a Droop-Controlled Grid-Connected DFIG Wind Turbine," in IEEE Access, vol. 10, pp. 6966-6977, 2022

Contact Info: david.velasco@ingeteam.com

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