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DISTRIBUTED FINITE-TIME OPTIMAL DISPATCH FOR HYBRID AC/DC MICROGRIDS

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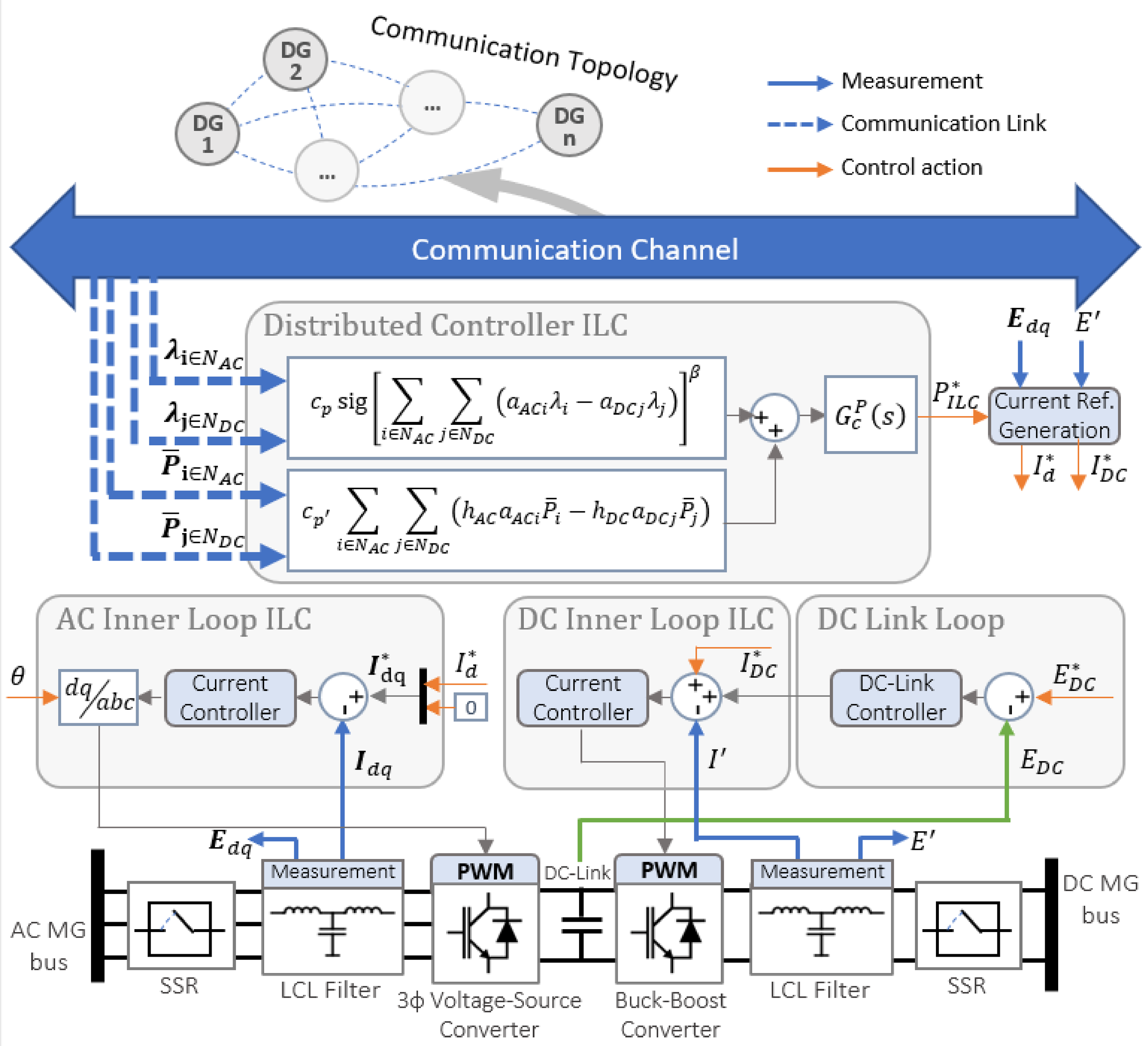
1. Introduction

In hybrid AC/DC microgrids (MGs), the economic dispatch of the AC and DC subgrids requires communication to achieve near-optimal solutions, which makes cooperative control a promising approach for the MG's interlinking converter (ILC). This paper proposes a distributed finite-time control strategy over the ILC, which ensures an economic operation while taking care of the MG's power utilisation. This multi-objective control of the ILC uses incremental costs and average powers from the distributed generators (DGs) in the AC and DC sides. For implementation, a finite-time algorithm is chosen due to its decoupling and convergence improving capabilities.

2. Proposed control for ILC

The multi-objective control design of the ILC begins by adding two compensation terms for the differences between both MGs; one term for incremental cost (λ) and other for average power ($\bar{P}$). The distributed controller is given as follows



where a_{AC} and a_{DC} are communication vectors, c_P, c'_P, β are control parameters, $G_C^P(s)$ is a PI controller, $h_{AC}$and h_{DC} are weights regulating the trade-off in the control objective.

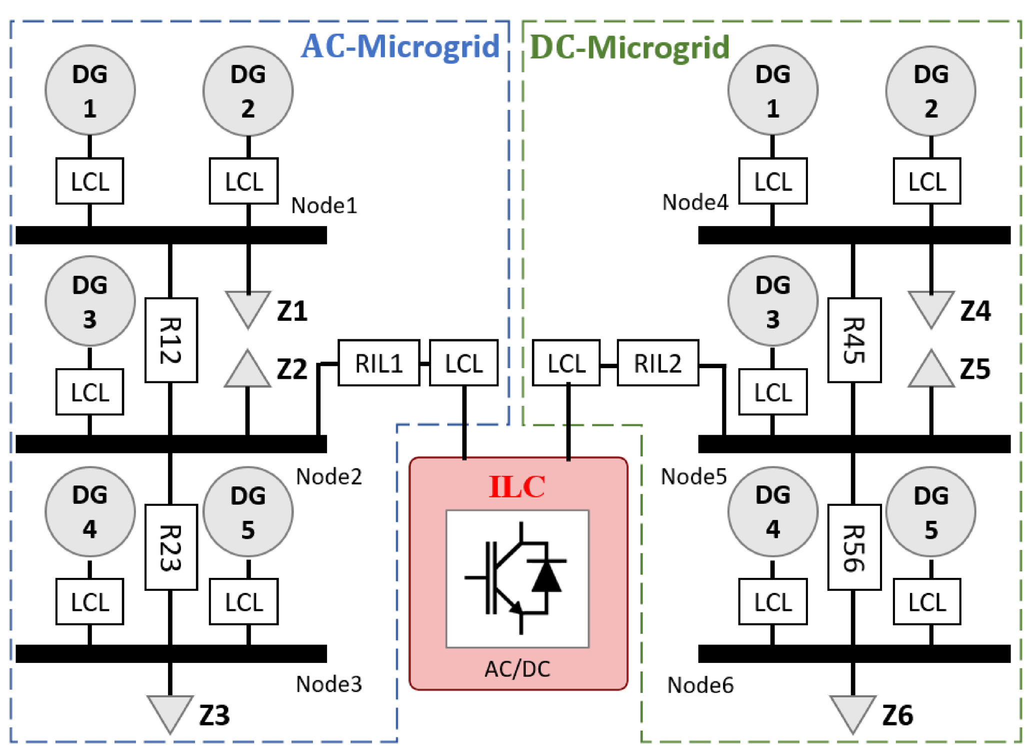
Regarding the weights used for the trade-off, this paper proposes an adaptive formula depending on the MG saturation given by

$$h(x) = 0.0000001\, e^{(16x)} \qquad (1)$$

where x represents the average power of either AC or DC MG. The parameters of (1) are selected such that $h(1.0) = 0.9$, i.e. nearly 90% of the ILC capacity is employed for average power balance when a MG is at maximum capacity.

3. Microgrid topology

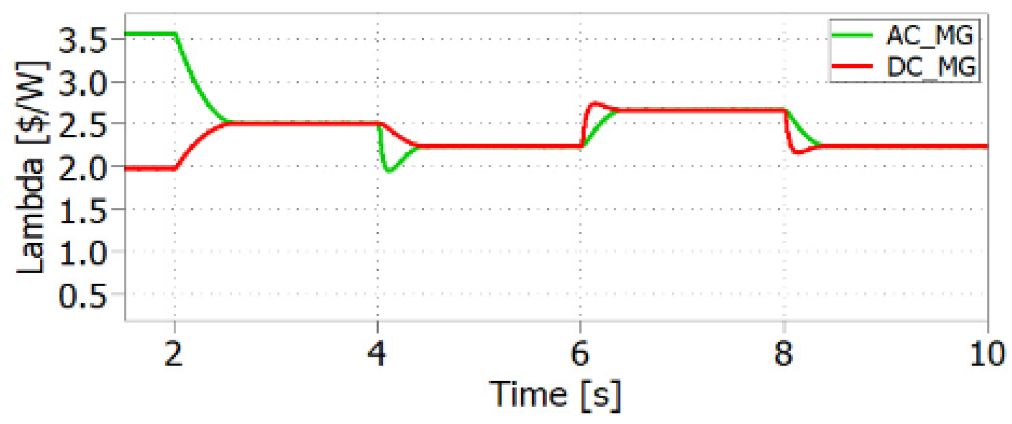
The hybrid MG used for simulations incorporates 5 DGs and 3 loads per MG. Global parameters of the MG are listed in Table I. Local controllers are communicated through an undirected graph. The operational constraints for MG are the following; $P_i^{\max}$=10 [kW]$\forall i \in \{N_{DC} \cup N_{AC}\}$, $Q_i^{\max}$ =3 [kVAR] $\forall i \in \{N_{AC}\}$ and $P_{ILC}^{\max}$=20 [kW].



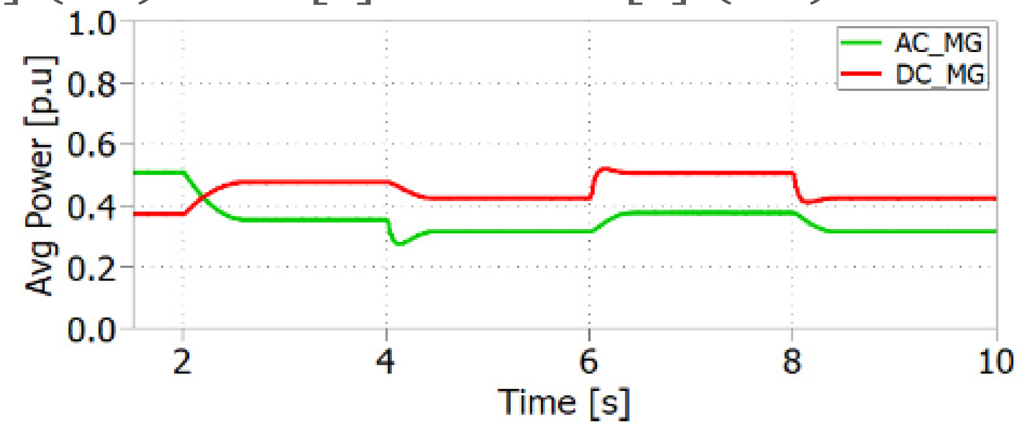
Param	Value	Param	Value
N. Power	50 [kVA]	R 1-2	0.15 [Ω]
N. Volt	220 [$V_{1\Phi}$]	R 2-3	0.20 [Ω]
Z1	30.30 [Ω]	L 1-2	0.30 [mH]
Z2	30.00 [Ω]	L 2-3	0.25 [mH]
Z3	10.10 [Ω]		
N. Power	50 [kW]	R 4-5	0.05 [Ω]
N. Volt	400 [V]	R 5-6	0.07 [Ω]
Z4	50.50 [Ω]	L 4-5	0.10 [mH]
Z5	40.00 [Ω]	L 5-6	0.10 [mH]
Z6	10.10 [Ω]		

4. Simulation results

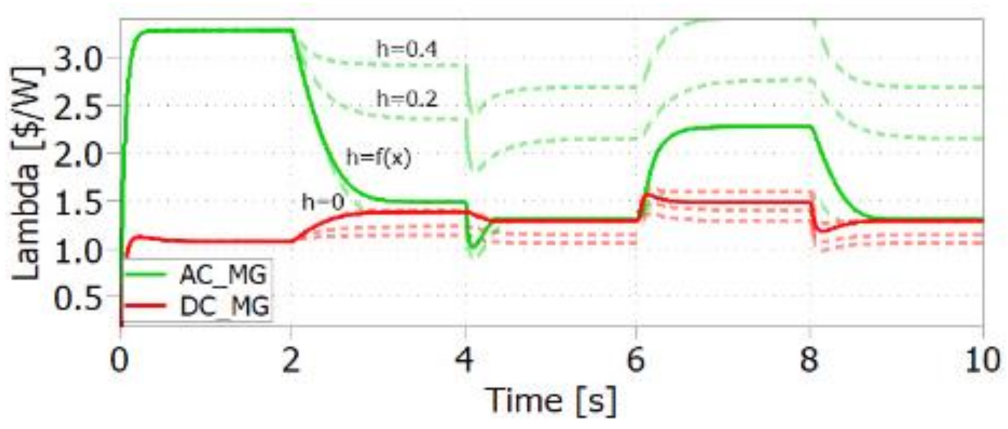
Simulations were performed in PLECS®. Figure 1 show the controller's operation under load changing and saturation weighting conditions. In t=2 [s] the ILC starts operating. There are impact loads at t=4[s] (AC), t=6 [s] and t=8 [s] (DC).



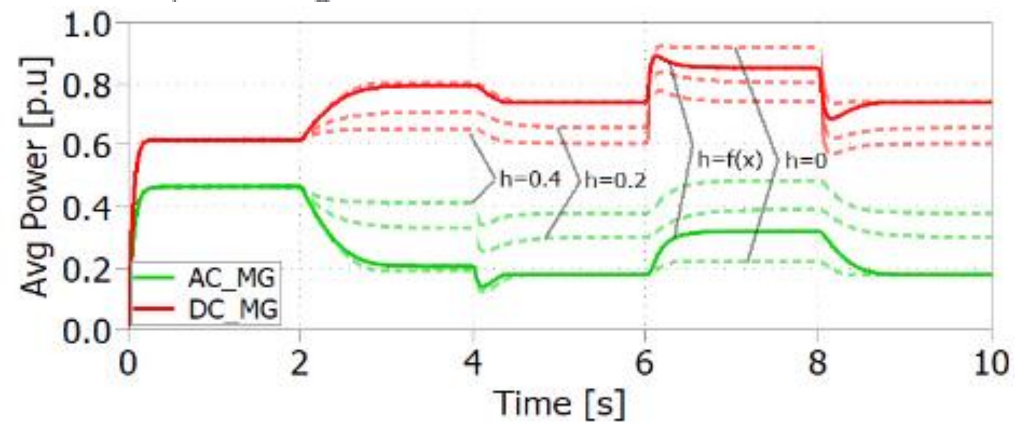
a) Incremental Costs of AC and DC MGs.



b) Average Powers of AC and DC MGs.



a) Incremental Costs of AC and DC MGs under different h-coefficients.



b) Average Powers of AC and DC MGs under different h-coefficients.

5. Conclusions

We proved the feasibility of a distributed controller that considers both incremental cost consensus and average power regulation for the ILC in a hybrid MG. The multi-objective proposal is applicable to prevent side MG saturations. Future work in multiple subgrids and ILCs are interesting subjects of study.

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