LOSSES ALLOCATION DUE TO PENETRATION OF DG AND SELF-CONSUMPTION OPERATION IN DISTRIBUTION SYSTEMS. CASE: PV SOLAR ENERGY

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1. INTRODUCTION

Traditionally, the regulatory allocation of electricity losses as belonging to the system load has been discussed, for which there are several methods for their allocation applied to transmission, and lately in the distribution networks as is the case of allocation by pro-rata, proportional and marginal. In turn, it has been explained that the allocation of these losses is different from their determination. Therefore, once calculated or modelled, they are allocated. The establishment will depend on the needs of the network operator and the resources available to obtain the measurement information in the system. In this work, the **objective** is **to establish the minimum criteria that must be met to produce an efficient allocation of losses**, having the self-consumption as a nodal model of power balance and starting point of the proposed procedure

2. METHODOLOGY: Loss allocation by time series using quasi-static simulation.

This procedure is validated for power injections in medium voltage (MV) and low voltage (LV). (11, 4 /0,208 kV)

"All generators within a zone, topologically connected, will have the same loss coefficient value. The assigned value of losses will vary depending on the size of each DG unit".

The allocation coefficient over time would be given by ALC:

$$ALC_t = \frac{[\Delta Losses]_{t-1,t}}{[\Delta (Pg_i - Pd_i)]_{t-1,t}} \quad (1)$$

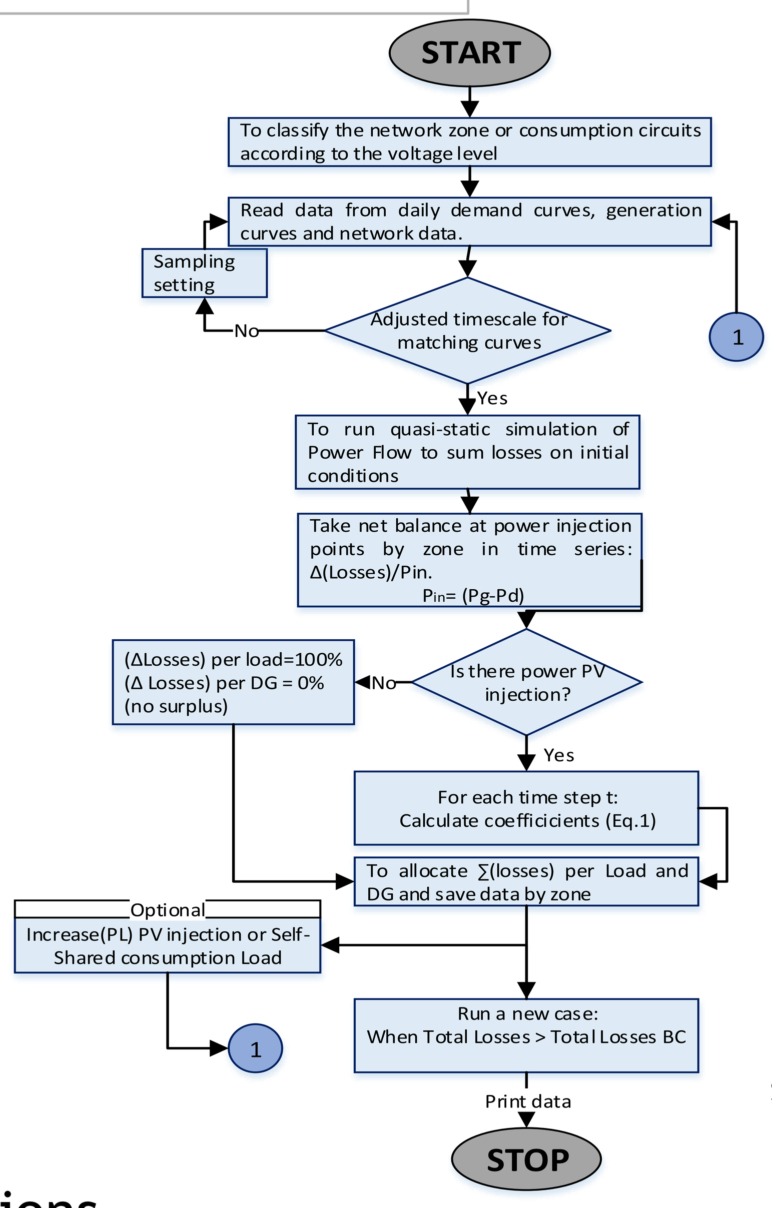


Figure 2. Flow chart for simulation and results analysis

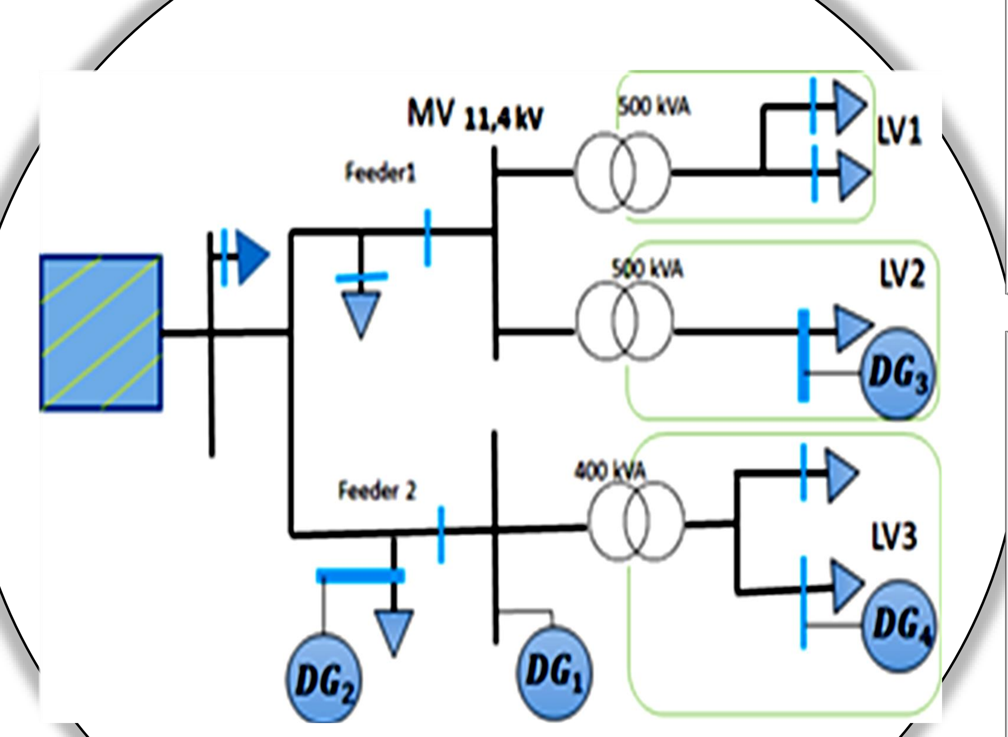


Figure 1. **Radial network for MV and LV.**

Assumptions

- The main transformer has sufficient reserve and the peak hourly demand does not exceed its nominal capacity.
- Penetration rate (midday peak)
- Real-time injection and consumption, no batteries.

3. RESULTS

Steady state analysis based on monitoring criteria of the impact (Time Series) include: i) From the actual load and solar data, determine the response of the feeder. ii)Comparison between steady state analysis and time series response. iii) To examine the Solar PV DG on the control elements.

The penetration level PL_{PV} is:

$$PL_{PV} = \sum_{i=1}^{n} P_{gi}/P_d$$

Where: Pg= Peak power of solar PV plant in zone. Pd= Peak power demanded

$PL_{PV} = 0$ is the base case (BC). $C1$: $PL_{PV} = 0.25$, $C2$: $PL_{PV} =$ 0,5, $C3$: $PL_{PV} = ,75$ and $C4$: $PL_{PV} =$ 1, C1 to C4 are cases with power injection

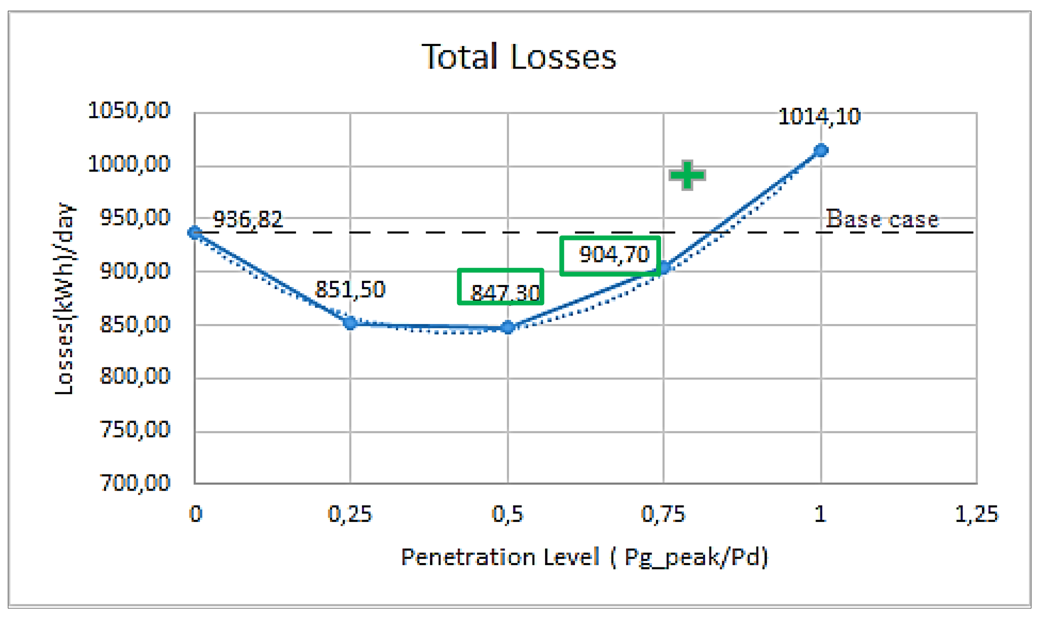


Figure 3 Total losses by case

At Low and Medium Voltage Levels: Similar Behaviors

For low penetration levels of DG, the correlation between power injection into the grid and zone losses is not significant.

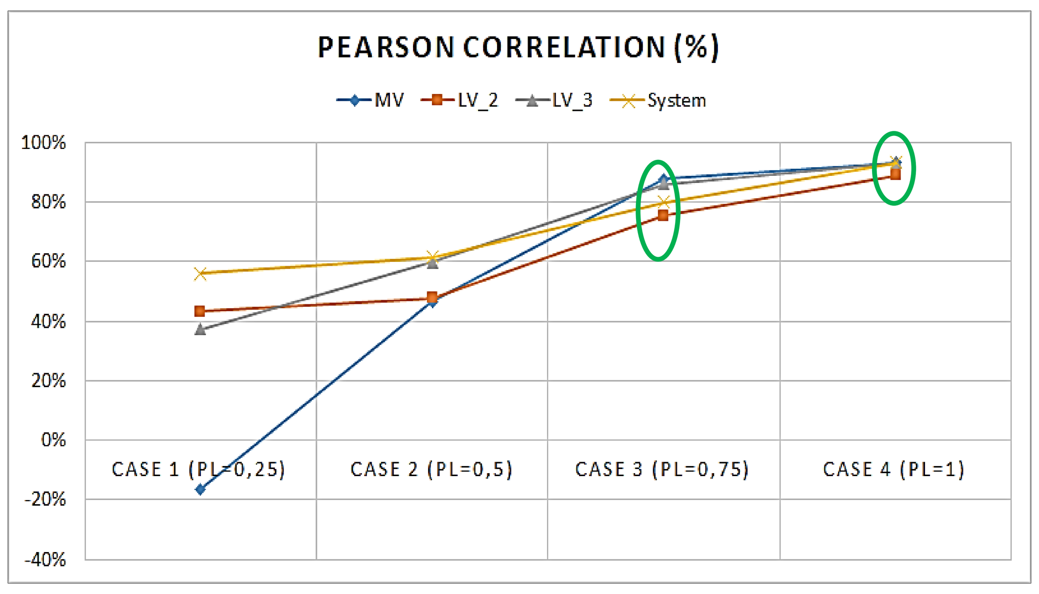
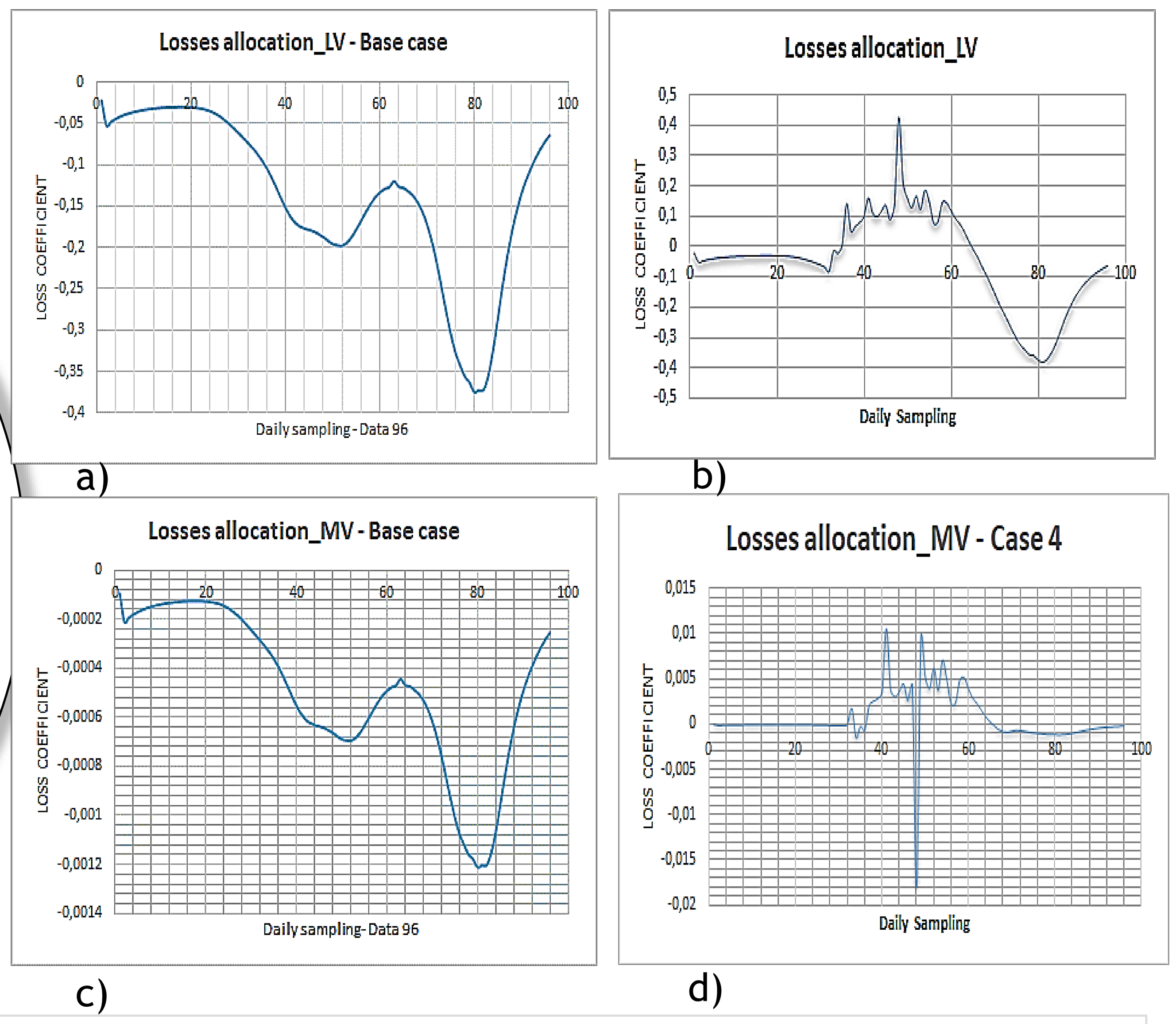


Figure 4. Pearson´s correlation. Power injection vs Losses

Figure 5. Curves of ALC. **a, c)** Without PV Solar (BC) for LV and MV respectively; **b, d)** With PV Solar (C4) for LV and MV.



The behavior of the coefficients shows better signs of reduction of loss during the day. Therefore, in each scenario, lower losses are assigned, before exceeding its hosting capacity by this impact factor.

The resulting losses could be assigned– % - as indicated in the following table:

Zones	C1		C2		C3		C4	
	L_G	L_D	L_G	L_D	L_G	L_D	L_G	L_D
LV1	0	100	0	100	0	100	0	100
LV2	5,4	94,6	9,2	90,8	14,2	85,8	20,6	79.4
LV3	4,99	95,01	9,4	90,6	16,8	83,2	25,6	74,4
MV	2	98	5.1	94.9	12,6	87,4	21.1	78,9

- **Denoting:** Efficiency signals and/or alerts the anomaly out of range at a certain time of day.
- Observable advantages for monitoring in network zones.
- Efficient allocation of losses between generation and demand.

4. CONCLUSION

- The allocations are made involving sensitivity to power injections to the network, and alerting the raising correlation between these and power losses. However, it is clear that there is loss reduction within a wide operating range of the network.
- The configuration of self-consumption for modelling requires separating losses and demand from their measurement and simulation.
- The optimal working of the system is due to the coexistence of the DG and the grid, monitoring technical impact parameters such as losses. Therefore, it is possible to evaluate a range of power-hosting capacity to maintain an operating criterion in the distribution network.