Technical Rules for Connecting a High–Power Electrolyser to the Medium–Voltage (MV) Network

1 Introduction

This document summarizes the essential technical rules, protection requirements, limits, and standards involved in connecting an MW–scale electrolysis plant to the Italian medium–voltage (MV) distribution network, with a focus on CEI 0-16 compliance and A2A Reti Elettriche specifications.

2 Voltage and Frequency Levels

- Most Italian MV networks operate at **15 kV** or **20 kV**. Some sections operate at **23 kV** or **9 kV**.
- The nominal frequency is **50 Hz**.
- A2A Reti Elettriche operates MV networks at:
  - 23 kV
  - 15 kV
  - 9 kV
  - residual portions at 6.4 kV
- The long–term development plan is the transition to a single MV operating level of **23 kV**.
- The maximum three–phase short–circuit current for equipment sizing is:

$$I_{k3,\max} = 16 \text{ kA}$$

3 Reference Standard: CEI 0–16

- CEI 0-16 is the mandatory rule for MV/HV grid connections.
- All new MV connections must fully comply with CEI 0-16.
- Every user must install a **General Device (DG)** and a **General Protection System (SPG)** according to Allegato D.
- An electrolyser is classified as:

– **Passive User (Utente Passivo)** if it cannot contribute to short–circuit current;
– **Active User (Utente Attivo)** if it includes generation/storage capable of injecting fault current.

4 Mandatory Connection Devices

4.1 General Disconnector (Sezionatore Generale)

- Installed immediately downstream of the point of connection.
- Provides electrical isolation from the MV grid.

4.2 General Circuit Breaker (Interruttore Generale)

- Installed immediately downstream of the General Disconnector.
- Provides total disconnection of the user installation.

4.3 Omission of the General Circuit Breaker

It may be omitted only if:

- The user's busbar is located immediately downstream of the PCC.
- The busbar contains at most one set of three VT transformers/transducers.
- No more than two feeder circuits (with protection breakers) are connected.

If omitted:

- Each feeder breaker must assume the protection functions of the DG.
- MV Surge Protection Devices (SPDs) must be installed downstream of the DG or feeder breakers.

5 Key CEI 0–16 Requirements Summary

Area	Requirement	Reference
Classification	User as Passive or Active depending on fault–current capability	4.1, 8.2
Voltage Level	MV generally at 15/20 kV; DSO selects voltage based on load profile and size	5.2.1.1
Network Type	MV operated with impedance–grounded or isolated neutral; affects earth–fault protection	5.2.1.2
Service Quality	Compliance with voltage quality, flicker, harmonics, unbalance	4.1, 5.1.3

Disturbance Limits	Converter loads must respect harmonic and flicker limits	4.1.2
Connection Cable	Max 20 m; min cross–section 95 mm^2 Cu–equiv	8.5.3.2
Earthing	Single earthing system for user + delivery plant, sized per IF and tF	CEI 11-1

6 General Device (DG) and Protection (SPG)

6.1 General Device

- Must include a disconnector + simultaneous 3–pole circuit breaker.
- Short–circuit breaking capacity must match DSO specifications.

6.2 General Protection System (SPG)

Mandatory protections:

- Phase overcurrent:
$$I >>, \quad I >>>$$
- Earth–fault protection:
$$I_0 >, \quad I_0 >>$$
- Protection must guarantee selective fault clearing within CEI 0–16 limits.

Protection	**Threshold**	**Max Time**	**Purpose**
$I >>$	250 A	500 ms	High–impedance faults
$I >>>$	600 A	120–170 ms	Bolted zero–impedance faults
$I_0 >>$	140% of DSO earth–fault current	170 ms	Double–earth faults

6.3 Auxiliary Supply

- DG + SPG must be powered from a guaranteed auxiliary supply (UPS or batteries).
- Minimum autonomy: **1 hour**.

6.4 Protection Selectivity

For passive users with power > 5 MW:

- Time–delayed selectivity schemes (Case 2 or 3 of CEI 0–16, §8.5.12.7) are allowed.
- Must be coordinated with DSO upstream protections.

7 Transformer Limits and Inrush Management

- Maximum transformer power on a single LV busbar:

$$\text{20 kV: 2000 kVA}, \quad \text{15 kV: 1600 kVA}$$

- Maximum simultaneous energization:

$$\text{Total power} \leq 3 \times \text{max section power}$$

- Sequential energization required with at least 1 s delay.

8 Associated International Standards

8.1 Power Quality at the PCC

- CEI EN 50160: voltage characteristics of public distribution networks.
- CEI 0–16 refers to EN 50160 limits.

8.2 Emission Limits from the User

- IEC/TR 61000-3-6: harmonic current limits for MV/HV.
- IEC/TR 61000-3-7: flicker emission limits.
- IEC/TR 61000-3-13: voltage unbalance emission limits.
- IEC 61000-2-12: compatibility levels for MV.

8.3 Measurement Standards

- IEC 61000-4-30: Class A PQ measurement.
- IEC 62586-1/2: PQ instruments.
- IEC 61000-4-7 (harmonics), 61000-4-15 (flicker meter).

8.4 Earthing and Substation Design

- CEI EN 50522: Earthing of power installations >1 kV.
- CEI EN 61936-1: General rules for MV/HV substations.

9 Recommended Engineering Workflow

1. Define the PCC with the DSO and obtain short–circuit power and emission allocations.
2. Verify converter THD, flicker, and unbalance comply with IEC/TR 61000-3-6/7/13.
3. Design earthing according to CEI EN 50522 and CEI EN 61936-1.
4. Specify MV switchgear per EN 62271 and transformer parameters for PQ compliance.
5. Install PQ monitoring instruments (Class A) at the PCC.