**Α.2 Technical data sheet for Battery Energy Storage Systems**

**Contact Person[[1]](#footnote-1)**

|  |  |
| --- | --- |
| First name, Surname |  |
| Postal address |  |
| Mobile phone |  |
| e-mail |  |

**Plant data[[2]](#footnote-2)**

|  |  |
| --- | --- |
| Plant name – location of installation |  |
| High Voltage substation |  |
| nominal kV at HV | kV |
| nominal kV at MV | kV |
| reference environmental conditions (ambient temperature range, pressure range, radiation range, humidity range) |  |
| Installed Capacity (BoL) | MWh |
| Nominal Capacity | MWh |
| Nominal active power during charge | MW |
| Nominal active power during discharge | MW |
| State of charge (SOC) min, max (% of nominal capacity) | % - % |
| Max auxiliary Load consumption | MW, MVAr |
| Charging losses (% of nominal capacity) | % |
| Discharging losses (% of nominal capacity) | % |
| Charge Efficiency | % |
| Discharge Efficiency | % |
| Round Trip Efficiency full cycle (incl. auxiliaries and losses) | % |
| Self-discharge (MWh/h) | MWh/h |
| Stand-by energy consumption (% of Nominal Capacity per day, at 100% SoC, incl. self-discharge) | %/day |
| Availability (%, mean factor of 2 years period) | % |
| Single-line diagram of the facility, showing the main components of the BESS:  (a) HV components (main transformer, switchgears, switches and the earthing system)  (b) main components of the BESS including ancillaries, the LV/MV internal electric network (underground cables, converters, LV/MV transformers) and their relevant switchgears, switches and the earthing system | Provide single-line diagram |
| Capacity augmentation method | Provide description |
| Fast Frequency Response capability | (yes / no) |
| Provide high-level description |

**Reactive power compensation (to be filled only if provided)**

|  |  |
| --- | --- |
| Nominal voltage at the CP | kV |
| Compensation means (capacitor/reactor, STATCOM, SVC, other) |  |
| Reactive power range (fixed) | kVAr ind./kVAr cap. |
| Reactive power range (controllable) | kVAr ind./kVAr cap. |
| Step of regulation | kVAr ind./kVAr cap. |
| Short description of the compensating system and manufacturer data sheet |  |

**Battery Energy Storage System data**

|  |  |
| --- | --- |
| **Array** | |
| Provide description of main array components (number of cells, racks, containers, Power Conversion Systems, LV/MV transformer stations) | Description and technical data sheets |
| **Cells** | |
| Manufacturer |  |
| Model |  |
| Cell chemistry |  |
| Cell ampacity, Ah |  |
| Rated capacity, kWh |  |
| Rated voltage, V |  |
| Discharge cut-off voltage, V |  |
| Charge cut-off voltage, V |  |
| Maximum charge/discharge current, A |  |
| Rated charge/discharge current, A |  |
| Operating temperature (oC) |  |
| Storage temperature (oC) |  |
| Provide data sheet of the battery cells | data sheets |

**Converter data[[3]](#footnote-3)**

|  |  |  |
| --- | --- | --- |
| Manufacturer |  | |
| Model |  | |
| Number of installed converters |  | |
| **DC side** | | |
| Nominal voltage DC | Vn-dc |  |
| Maximum, minimum voltage DC | Vmax-dc, Vmin-dc |  |
| Nominal current DC | In-dc, A |  |
| Maximum, minimum current DC | Imax-dc, Imin-dc, A |  |
| Maximum injected current DC → AC | % In-dc |  |
| **AC side** | | |
| Nominal voltage AC | Un, kV |  |
| Maximum voltage AC | Umax, kV |  |
| Minimum voltage AC | Umin, kV |  |
| Nominal apparent power | Sn, kVA |  |
| cosφ range | cosφ - cosφ |  |
| Nominal active power | Pn, kW |  |
| Nominal current | In, A |  |
| Maximum active power | Pmax, kW |  |
| Maximum current | Imax, A |  |
| Pulse width modulation | (SPWM, PWM, other) |  |
| Switching frequency | Hz |  |
| **Grid performance** | | |
| Minimum short circuit ratio for connection | SCR, kVA |  |
| Minimum ratio of inductive reactance to resistance for connection | X/R, ratio |  |
| Maximum SC current (peak) | (I-peak), kA |  |
| Maximum sub-transient SC current (rms) | Ι’’k, kA |  |
| Maximum steady state SC current (rms) | Ιk, kA |  |
| Breaking current (rms) | Ib, kA |  |
| Maximum negative sequence voltage component for connection | % Un |  |
| Maximum negative sequence current component for connection | % In |  |
| Ramp up / down rate in steady state | kW/sec, kW/sec |  |
| Ramp up rate, after fault | kW/sec, kW/sec |  |
| P-Q capability diagram for the entire range of operating voltages, as a function of ambient temperature or other relevant parameters | Diagram | Provide diagram |
| apparent power – temperature derating curve (up to at least 50οC) | Diagram | Provide diagram |
| Current harmonic profile at AC terminals, at least up to the 50th harmonic | Table | Provide table |
| THD of AC current | < % at Sn |  |
| Low-Voltage-Ride-Through (LVRT) profile at AC or MV step-up transformer terminal | Diagram | Provide diagram |
| High-Voltage-Ride-Through (HVRT) profile at AC or MV step-up transformer terminal | Diagram | Provide diagram |
| Fast Fault Current at voltage dip or rise | Diagram | Provide diagram |
| “Q over P” priority capability | Yes/no |  |

**HV/MV Transformer**

|  |  |  |
| --- | --- | --- |
| Manufacturer |  | |
| Rated apparent power | Str, MVA |  |
| Nominal High voltage (primary) | V1n, kV |  |
| Nominal Medium voltage (secondary) | V2n, kV |  |
| Rated current | Itr-n, A |  |
| Vector group | (e.g. DYn1) |  |
| Resistance @ rated MVA/kV | in (p.u.) |  |
| Reactance @ rated MVA/kV | in (p.u.) |  |
| OLTC capability | (yes/no) |  |
| High voltage tap ratio range | (e.g., ± 8 x 1.25%) |  |
| Voltage control range @ secondary winding | ± % of V2n |  |
| Magnetizing Current @ nominal voltage | % Itr-n |  |
| No-Load Losses @ rated power | kW |  |
| Zero sequence inductive reactance (neutral tap position) | Xo, %@ Str |  |
| Neutral grounding system (unearthed, direct earthed, through earthing resistance, other) |  | |
| Earthing resistance and inductive reactance (Ω) |  | |

**MV/LV Transformer**

|  |  |  |
| --- | --- | --- |
| **Two-winding transformer** | | |
| Manufacturer |  | |
| Rated apparent power | Str, MVA |  |
| Nominal voltage (primary) | V1n, kV |  |
| Nominal voltage (secondary) | V2n, kV |  |
| Rated current | Itr-n, A |  |
| Vector group | (e.g. DYn1) |  |
| Resistance @ rated MVA/kV | in (p.u.) |  |
| Reactance @ rated MVA/kV | in (p.u.) |  |
| OLTC capability | (yes/no) |  |
| High voltage tap ratio range | (e.g., ± 8 x 1.25%) |  |
| Voltage control range @ secondary winding | ± % of V2n |  |
| Magnetizing Current @ nominal voltage | % Itr-n |  |
| No-Load Losses @ rated power | kW |  |
| Zero sequence inductive reactance (neutral tap position) | Xo, %@ Str |  |
| Neutral grounding system (unearthed, direct earthed, through earthing resistance, other) |  | |
| Earthing resistance and inductive reactance (Ω) |  | |

|  |  |  |
| --- | --- | --- |
| **Three-winding transformer** | | |
| Manufacturer |  | |
| Rated apparent power primary, secondary, tertiary (H/L1/L2) | Str, MVA |  |
| Nominal voltage (primary, H) | VH, kV |  |
| Nominal voltage (secondary, L1) | VL1, kV |  |
| Nominal voltage (tertiary, L2) | VL2, kV |  |
| Rated current | Itr-n, A |  |
| Vector group | (e.g. DYn1Yn1) |  |
| Resistance (H-L1) @ rated MVA/kV | in (p.u.) |  |
| Reactance (H-L1) @ rated MVA/kV | in (p.u.) |  |
| Resistance (H-L2) @ rated MVA/kV | in (p.u.) |  |
| Reactance (H-L2) @ rated MVA/kV | in (p.u.) |  |
| Resistance (L1-L2) @ rated MVA/kV | in (p.u.) |  |
| Reactance (L1-L2) @ rated MVA/kV | in (p.u.) |  |
| OLTC capability | (yes/no) |  |
| High voltage tap ratio range | (e.g., ± 8 x 1.25%) |  |
| Voltage control range @ secondary winding | ± % of VL1 |  |
| Voltage control range @ tertiary winding | ± % of VL2 |  |
| Magnetizing Current @ primary nominal voltage | % Itr-n |  |
| No-Load Losses H-L1 @ rated power | kW |  |
| No-Load Losses H-L2 @ rated power | kW |  |
| No-Load Losses L1-L2 @ rated power | kW |  |
| Zero sequence inductive reactance H-L1 (neutral tap position) | XHo, %@ Str |  |
| Zero sequence inductive reactance H-L2 (neutral tap position) | XL1o, %@ Str |  |
| Zero sequence inductive reactance L1-L2 (neutral tap position) | XL2o, %@ Str |  |
| Neutral grounding system (unearthed, direct earthed, through earthing resistance, other) |  | |
| Earthing resistance and inductive reactance (Ω) |  | |

**Energy Management System**

|  |  |
| --- | --- |
| Manufacturer / Model |  |
| Architecture | Provide diagram of main components |
| Functionalities | Provide description |

**Plant Controller**

|  |  |
| --- | --- |
| Manufacturer / Model |  |
| Active power / frequency control functions | Provide list |
| Reactive power / voltage control functions | Provide list |
| Other control functions | Provide list |

**Grid Forming Capability[[4]](#footnote-4) (informative)**

|  |  |
| --- | --- |
| Are the installed BESS plant components capable of providing Grid Forming Capabilities to the grid? | (yes / no) |
| Can the installed BESS plant components expand\* to provide Grid Forming Capabilities to the grid?  \*e.g. by activating existing control loops or by installing additional HIL/SIL controllers or software and NOT by replacing existing components | (yes / no) |
| Can the installed BESS plant components switch from Grid Forming to Grid Following control and vice versa? | (yes / no) |
| Core capabilities of the GF behavior[[5]](#footnote-5) | |
| Voltage source response to voltage magnitude and phase changes at the connection point  Voltage response in the form an internal voltage source behind an impedance; active power output determined by the internal voltage phasor (magnitude and phase angle), the Connection Point (CP) voltage phasor, the internal impedance of the device, and the phase angle difference between the internal voltage phasor and the CP voltage phasor, without needing to directly control the current? | (yes / no) |
| Inertial response  To provide synthetic inherent bi-directional inertial response, in the form of fast change in active power during system transients; the provision of inertial response does not require the calculation of frequency or RoCoF measurement? | (yes / no) |
| Surviving the loss of the last synchronous connection  To operate stably in a grid that does not contain any synchronous machines, as per BESS designed capabilities? remain in uninterrupted operation for a transition from a grid containing synchronous machines to one that does not and provide frequency and reactive support, unaffected by the transition from one power system state to another | (yes / no) |
| Weak grid operation and system strength support  To operate stably under a very low short circuit ratio, both under normal operating conditions and when exposed to power system disturbances | (yes / no) |
| Oscillation damping  To add damping to rotor angle oscillation modes, sub-synchronous oscillations and oscillations at harmonic frequencies | (yes / no) |
| Power quality improvement  to provide “passive, damping response in the harmonic frequency range” thereby reducing harmonic voltage distortion within the power system; to reduce the level of unbalance caused by disturbances; to improve flicker and fast flicker phenomena; | (yes / no) |
| What is the grid forming control strategy applied?  (e.g., droop control, virtual synchronous machine (VSM), Enhanced direct power control (EDPC), Synchronverter, Virtual oscillator control (VOC), or other) |  |
| Comments / High level description |  |

**Plant safety (informative)**

Provide description of proactive and active safety design principles, measures and list of appliable standards.

1. IPTO shall be informed in case of any change in the details of the contact. [↑](#footnote-ref-1)
2. Unless otherwise specified, quantities are measured at HV connection point under reference environmental conditions. [↑](#footnote-ref-2)
3. Values refer at 25ο C. [↑](#footnote-ref-3)
4. As defined in [ACER’s recommendation to the EU for amendments to the Commission Regulation (EU) 2016/631 of 24 April 2016](https://www.acer.europa.eu/news/acer-proposes-amendments-electricity-grid-connection-network-codes), [RfG 2.0](https://www.acer.europa.eu/sites/default/files/documents/Recommendations_annex/ACER_Recommendation_03-2023_Annex_1_NC_RfG_clean.pdf) Article Y [↑](#footnote-ref-4)
5. As per [ENTSOe Expert Group om Advanced Capabilities for Grids with High Shares of Power Park Modules](https://www.entsoe.eu/documents/nc/GC%20ESC/ACPPM/TOP.2.b._GC-ESC_EG_ACPPM_Report_version_1.00.pdf) and [AEMO's Voluntary Specification for Grid-forming Inverters, May 2023](https://aemo.com.au/-/media/files/initiatives/primary-frequency-response/2023/gfm-voluntary-spec.pdf?la=en&hash=F8D999025BBC565E86F3B0E19E40A08E#:~:text=This%20%E2%80%98voluntary%20specification%E2%80%99%20is%20a%20preliminary%20document%20to,in%20order%20to%20be%20categorised%20as%20grid-forming%20inverters.) [↑](#footnote-ref-5)