TECHNICAL SPECIFICATION

Design, Supply, Installation, Commissioning, Ownership, Operation and Maintenance of a Grid-Connected Solar PV Plant (Minimum 4 MW AC) on the Elevated Portion of the Delhi–Dehradun Expressway (NH 709B), BYPL Distribution Area

Connection at 11 kV level of the Discom (BYPL) network | Build–Own–Operate (BOO) basis | Document Review and Approval Framework

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1 Scope and Project Description

1.1 The Developer shall design, finance, supply, install, test, commission, own, operate and maintain a grid-connected solar PV power plant of **minimum 4 MW AC** capacity (measured at the 11 kV Point of Interconnection) on the elevated sections of the Delhi–Dehradun Expressway (NH 709B) falling within the BYPL distribution area (hereinafter referred as "the Project"), on the segments allotted in Schedule [__] (chainage and length to be listed by NHAI).

1.2 The plant shall be mounted on Module Mounting Structures (MMS) fixed to the existing crash barriers of the elevated corridor on the segments allotted in the Schedule [_]. The Developer is free to propose the layout, module and inverter technology, DC/AC ratio and inverter configuration, subject to this specification.

1.3 The installed AC capacity shall not be less than 4 MW. The DC capacity shall be as required to meet the minimum CUF in Section 3, subject to the available length and structural limits of the corridor and to the approved design.

1.4 The Developer's scope includes, design, finance, supply, install, test, commission, own, operate and maintain a grid-connected solar PV power plant of **minimum 4 MW AC** capacity without limitation: surveys and investigations; engineering and approvals; supply and installation of modules, MMS, inverters, transformers, 11 kV switchgear, cables, protection, metering, SCADA, weather monitoring, earthing, lightning protection, fire safety and signage; evacuation up to the Discom connection point including any dedicated 11 kV feeder and bay required by BYPL; traffic management during construction and O&M; all statutory approvals and inspections; performance testing; and O&M for the entire contract period which shall be coterminous with the term of Power Purchase Agreement to be executed between SPD & NHAI.

1.5 Ownership of the plant rests with the Developer. Review / Comments / Approval (as applicable) of any documents by the NHAI / SECI's (hereinafter referred as "Authority") does not relieve the Developer of responsibility for design adequacy, safety, performance or compliance with law.

1.6 Energy generated from the Project shall be purchased by the NHAI under a long term Power Purchase Agreement (PPA) and shall be utilized primarily for meeting its own consumption. Surplus energy (if any) shall be settled under applicable Group Net Metering / Net Metering policy**.**

2 Project-Specific Design Basis and Boundary Conditions

2.1 The following boundary conditions may be used by successful bidder in the energy yield simulation. Parameters left to the Developer shall be justified in the Design Basis Report.

S.No.	Parameter	Value / Requirement
1	Location (from alignment file)	Delhi, approx. latitude 28.6°–28.9° N, longitude 77.25°–77.28° E, altitude approx. 200–230 m, UTC+5:30. [to be confirmed by NHAI] (drawing file enclosed)
~~3~~	Module tilt	Fixed tilt (preferred), Developer to optimise; Tilt shall allow natural water drainage and self-cleaning.
4	Weather data	SolarGIS TMY or Meteonorm 8.x (P50) as the reference dataset;
5	Simulation software	PVsyst v7.4 or later (or equivalent approved software) with the actual module PAN file and inverter OND file. Shall also carry out shadow analysis.
6	Point of interconnection and metering	11 kV bus/feeder of BYPL as per connectivity approval. Energy Meter to be installed by SPD and shall be complaint with the applicable policy / regulations.

2.2 The installation preferably be shadow-free during the hours of generation.

3 Performance Requirements (Minimum CUF 19%)

3.1 **Definition.** CUF = (Net annual energy delivered at the POI main meter in kWh) ÷ (Contracted AC capacity in kW × 8,766 h), where contracted AC capacity is not less than 4,000 kW.

3.2 **Minimum CUF.** During the first year of operation, the plant shall achieve a CUF of not less than Declared CUF under PPA which shall not be less than **19%** and shall also maintain energy as par the applicable provisions of PPA. Energy Shortfall compensation shall be as per provisions of RfS and PPA.

3.4 **Performance Ratio.** Weather-corrected PR measured as per IEC 61724-1 shall be not less than [78]% at the Performance Acceptance Test.

3.5 **Availability.** Plant availability shall be not less than 95% on an annual basis, excluding grid outages and approved force majeure. Inverter and SCADA availability shall be separately reported.

3.6 **Module quality.** Only high-efficiency modules shall be used (Section 7.1). The Developer shall not reduce the energy delivered by compromising on module power, tilt, shading or cable sizing below the approved design.

4 Applicable Standards and Regulatory Compliance

4.1 The entire project shall comply with the latest applicable edition, with amendments, of the following. Where an IS equivalent of an IEC standard exists, the IS is acceptable.

Area	Standards / regulations
Statute and electrical regulations	Electricity Act 2003 and Rules; CEA (Measures relating to Safety and Electric Supply) Regulations; CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations; CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations 2013 and CEA (Technical Standards for Connectivity to the Grid) Regulations 2007 as amended; CEA (Installation and Operation of Meters) Regulations 2006 as amended; CEA cyber-security guidelines. (Verify current versions.)
Delhi / Discom	DERC regulations in force for grid-connected renewable energy, net metering or open access as applicable; DERC Supply Code and Performance Standards; Delhi Grid Code and SLDC requirements; BYPL technical and metering specifications and connectivity approval; Delhi Solar Policy as in force; inspection and energisation by the Electrical Inspector (Govt. of NCT of Delhi).
PV modules	IS 14286 / IEC 61215 (series); IS/IEC 61730-1 and -2; IEC 61701 (salt mist); IEC 62716 (ammonia); IEC TS 62804-1 (PID); IEC 61853 (power and energy rating); IEC 60904 series; IEC 62790 (junction box); IEC 62852 (connectors); IEC TS 63209 / IEC 61215. BIS registration under the Solar PV Compulsory Registration Order; ALMM List-I for modules and List-II for cells as notified by MNRE and in force on the bid date.

Area	Standards / regulations
Inverters	IS 16221 / IEC 62109-1 and -2; IEC 62116 (anti-islanding); IEC 61727; IEC 61683 / EN 50530 (efficiency); IEC 61000-6-2, 6-4 and 61000-3-12; IEC 60068-2 (environment); grid-code compliance including LVRT/HVRT and reactive power capability per CEA/DERC; IEC 63027 (DC arc-fault detection) where applicable.
Structures and civil	IS 800:2007; IS 801 / IS 811 (cold-formed sections); IS 2062; IS 875 (Parts 1–3, 2015 for wind); IS 1893 (Part 1) for Delhi (seismic zone IV); IS 4759 / IS 2629 (galvanising); IS 456; IS 1367 (fasteners); IRC:6 (loads), IRC:112, IRC:119 (traffic safety barriers) and MoRTH Specifications for Road and Bridge Works; IRC:SP:55 (traffic management in work zones); post-installed anchors qualified for cracked concrete (EAD 330232 / ETAG 001 Annex C or ACI 355.2 / 318 equivalent). Or as intimated by NHAI.
Electrical equipment	IS/IEC 62271-100 and -200 (HV switchgear); IS 2026 / IS 1180 (transformers); IS 7098 (XLPE cables); IEC 62930 / EN 50618 (PV DC cable); IS 1554; IEC 60947-3 (DC switch-disconnector); IEC 61643-31/-11 (SPD); IEC 60255 (relays); IEC 62548 (array design); IEC 60364-7-712; IS 3043:2018 (earthing); IS/IEC 62305 (lightning protection); IEC 61850 / IEC 62443 (cyber-security).
Testing and monitoring	IEC 61724-1 (monitoring and PR); IEC 60891 and 60904 (I-V correction and measurement); IEC 61829 (array I-V testing).
Quality and safety	ISO 9001; ISO 14001; ISO 45001; National Building Code (fire); relevant NHAI safety circulars and site safety manual.

4.2 The Developer shall obtain and keep valid all permissions, permits, clearances and approvals including connectivity and feasibility approval from BYPL, energisation approval from the Electrical Inspector, metering approvals, NHAI permissions for work on the corridor and traffic diversions, and any environmental or local approvals. Any valid support or authorization required from NHAI for obtaining such permits, approval and consents shall be extended by NHAI.

5 Document Review Framework

5.1 Principle

5.1.1 No modification in structures or existing facility of NHAI or its agencies shall be carried out by the Developer without prior approval / intimation (as applicable) to NHAI or its Agencies.

5.1.2 The Developer shall submit documents through the project document-management system (if applicable) (or by e-mail to a designated address) with a unique document number, revision, date, preparer, checker and approver signature. Incomplete submissions will be returned without review.

5.1.3 Documents / Drawings submitted by the Developer shall be reviewed by SECI / NAHI and input if any shall be communicated for suitable incorporation. to the Developer as per the below given details.

5.2 Review timelines

5.2.1 The reviewer shall respond within [15] working days of a complete submission, and within [30] working days for the structural design and road-safety submissions to NHAI. Resubmissions shall be reviewed within [10] working day.

5.2.2 Statutory approvals by BYPL and the Electrical Inspector shall follow their own timelines under the DERC Supply Code and applicable rules; the Developer shall allow for this in its schedule. Delay in the Developer's own submissions or repeated non-incorporation of comments shall not be a ground for extension of time.

5.2.3 Review of a document by SECI/ NHAI is limited to its compliance with the tender requirements and shall neither absolve the Developer from compliance including performance as per the tender documents nor create any liability / claim to SECI/NHAI.

5.3 Table 5-A: Documents for review

No.	Document	To be submitted by
1	Energy Yield Report (EYR) with PVsyst files (PAN, OND, .PRJ/.VCx), hourly output and loss tree	Within 45 days of PPA Signing

No.	Document	To be submitted by
2	Design Basis Report (DBR)	Within 45 days of PPA Signing
3	PV array layout (with segment-wise chainage, azimuth, rows, clearances)	Within 45 days of PPA Signing
4	Single line diagram (SLD) and protection and metering scheme	Within 60 days of PPA Signing
5	MMS structural design report, drawings, calculations, anchor design and proof-check certificate	Within 60 days of PPA Signing
7	PV module datasheet (GTP), BOM, test reports, ALMM and BIS certificates, MQP	Within 75 days of PPA Signing
8	Inverter datasheet (GTP), grid-code compliance, test reports, OND file	Within 75 days of PPA Signing
9	Traffic safety and driver-impact assessment (glare, sight distance, debris, vehicle-impact scenarios)	Within 60 days of PPA Signing
10	Traffic Management Plan and construction methodology	Before mobilization
11	O&M plan (cleaning, inspection, access, safety, spares), structural inspection programme	Within 30 days of Commissioning
12	As-built drawings, test reports, operation manuals, warranty certificates	Within 60 days of Commissioning

6 (Indicative) Content Requirements for Each Document Submitted for Approval

6.1 Energy Yield Report (EYR): EYR should provide a comprehensive detail in regard to the energy to be generated from the Project. An indicative content of report is given below:

- Site description, coordinates per segment, azimuth, tilt, row layout and the shading scene

- Weather data: source, period, GHI, DHI, temperature, with comparison between SolarGIS TMY or Meteonorm (or another independent source) and justification of the one used. Any on-site measurements shall be included.
- PVsyst input files and the simulation report: PAN and OND files from the OEM and the full loss tree.
- Monthly and hourly energy generation; CUF and PR calculation as defined in Section 3; P50, P75 and P90 with uncertainty breakdown.
- 25-year (and contract-period) energy projection.

6.2 Design Basis Report (DBR): It should comprehensively deal with various assumptions, considerations, codes and standards considered for the designing the plant. Report should contain following:

- Project description, segments, chainages and capacity.
- Design Parameters / Consideration: wind speed per IS 875 (Part 3) including height and terrain factors for the elevated deck, seismic parameters for Delhi, temperature, humidity, rainfall, pollution, corrosivity category or any other criteria if specified by NHAI
- Electrical design basis: DC and AC system voltages, DC:AC ratio and string sizing, cable sizing criteria and voltage-drop limits, fault level etc.
- Structural design basis: load cases, load combinations and limit-state criteria, material grades, corrosion protection, connection details, design life (minimum 25 years).
- Interface with the existing structure: crash-barrier and deck details from NHAI drawings, the permissible additional loads on the crash barrier and deck as confirmed by NHAI, and the method of confirming the as-built condition.

6.3 PV Array Layout: PV array layout should contain following details:

- Layout drawings on the NHAI alignment with chainage, LHS/RHS, string and inverter allocation, DC and AC cable routes, junction/combiner locations, earthing and lightning protection layout.
- Minimum clearances: to the carriageway edge, to the barrier, to light poles and signs, to overhead lines (as per CEA regulations) and the vertical clearance below the structure.
- Locations and sizes of inverters, transformers, switchgear and the control room (if applicable);.
- Expansion-joint, drainage and deck-slope crossing details for the MMS and cables.

6.4 Single Line Diagram (SLD)

- Complete diagram from modules to the 11 kV POI: strings, combiner boxes, inverters, inverter or step-up transformers, 11 kV switchgear (incomer, outgoer, bus section if any), auxiliary supply, metering CT/PT points, protection relays, SPDs, earthing, and the connection to the BYPL network.
- Statement that the diagram conforms to the BYPL connectivity approval; the BYPL approval reference shall be recorded on the drawing.

6.5 Structural Design of the Module Mounting Structure (MMS)

6.5.1 The submission shall include: design report with calculations (STAAD / ETABS / SAP or equivalent) and the model files; drawings of members, connections, base plates and anchors; fabrication and galvanising specification; bill of materials; and an installation method statement.

6.5.2 The report shall comply with the requirements specified by the NHAI including structural stability, seismic load , wind pressure etc.

6.5.3 **Interface with the crash barrier and deck.** The report shall state the forces transferred to the crash barrier and deck, show that the barrier still satisfies its containment performance (IRC:119 or the original design basis) and that its structural capacity and durability are not reduced, and show that the load on the deck is within the limit approved by NHAI. Any anchor or core that could affect reinforcement or prestressing shall be justified; no work on the deck slab or prestressing elements shall be permitted without NHAI's written approval.

6.5.5 **Fall prevention.** The design shall prevent modules, clamps, structural members, cables and tools from falling onto the carriageway or onto areas below. Secondary retention (such as safety wires, captive clamps, catch trays or nets where needed) shall be provided at modules and at the cantilever ends. Fasteners shall be locked against vibration loosening.

6.5.6 **Materials and corrosion.** Primary structural steel shall be galvanised as per IS 4759 for thinner sections or an approved equivalent coating suitable for corrosivity category C4; Module fasteners shall be stainless steel (A2-70 / SS 304 or better). Site welding of galvanised members is not permitted except as approved with repair of the coating.

6.5.7 **Proof checking.** The design shall be proof-checked by an independent structural consultant approved by NHAI (or an IIT/NIT) at the Developer's cost, and the proof-check certificate submitted with the design.

6.6 Electrical Protection Scheme

- Protection philosophy at all levels: DC (string fuses, DC switch-disconnectors, SPD, arc-fault detection where provided), inverter protections, transformer protections (including buchholz, temperature and differential for larger ratings), and 11 kV feeder and bus protection.
- Relay list with functions: over-current and earth-fault (50/51, 50N/51N), directional where needed, under/over voltage (27/59), under/over frequency (81), anti-islanding and rate-of-change protections as required by BYPL, neutral displacement, breaker failure where applicable, and trip circuit supervision.
- Short-circuit study using the BYPL fault level; relay setting and coordination calculations (with time-current curves) between the plant and the BYPL upstream protection; relay setting sheets for approval by BYPL.
- LVRT/HVRT and reactive power capability.
- Earthing design per IS 3043
- Lightning protection risk assessment per IS/IEC 62305 with the design of air terminals, down conductors and surge protection. Bridge reinforcement shall not be used as a down conductor or earth electrode without NHAI's written approval and evidence of no corrosion or stray-current risk.
- Fire detection and protection for the control room and transformers; arrangement for isolating the DC and AC supply from ground level in an emergency, with signage.
- Metering scheme: main, check and standby meters at the POI as per BYPL requirements, meter sealing, and test certificates.

6.7 PV Module Datasheet (GTP) and Supporting Documents

- Completed Guaranteed Technical Particulars as per Annexure A, with component datasheets and Bill of Materials (cell, glass, encapsulant, backsheet or rear glass, frame, junction box, connectors, cable).
- IEC and IS test reports from a NABL-accredited or IEC-recognised laboratory for the exact model and BOM, with Constructional Data Forms; BIS registration and ALMM List-I / List-II enlistment certificates; PID, ammonia, salt mist and extended-stress reports where required.
- Flash-test data, PAN file, IAM data, temperature coefficients, low-light performance, degradation guarantee and warranty terms.

6.8 Inverter Datasheet (GTP) and Supporting Documents

- Completed GTP as per Annexure A; OND file; efficiency curves, DC and AC voltage and current ranges.
- Type test reports (IEC 62109, IEC 62116, IEC 61683 / EN 50530, EMC, environmental) and grid-code compliance certificates (LVRT/HVRT, reactive power, frequency response, harmonics, flicker, DC injection) from an accredited laboratory.

6.9 Other submissions [to be checked by NHAI]

6.9.1 **Traffic safety and driver-impact assessment** (Item 9 in Table 5-A) shall cover glare and reflection analysis (including at sunrise and sunset and for each curve), sight distance and shy distance, distraction and visual clutter, debris and falling-object risk, vehicle impact and post-impact behaviour, fire, and effects on noise reduction and street lighting.

6.9.2 **Traffic Management Plan** shall comply NHAI requirements and cover work-zone layouts, lane-closure timings (night-time or low-traffic periods), flagmen, signage, speed limits, emergency access and public communication.

7 Technical Requirements for Major Equipment and Systems

7.1 PV modules

Parameter	Requirement
Technology	Mono-crystalline silicon, N-type (TOPCon, HJT, back-contact or better). Glass-glass construction preferred; bifacial permitted if justified in the EYR.
Module efficiency at STC	Not less than [22.0]% (declared and verified by flash test)
Rated power at STC	Not less than [575] Wp; no negative power tolerance
Power temperature coefficient	Not worse than −0.30 %/°C
Degradation	Not more than 1.5% in year 1 and 0.8% per year thereafter (minimum 80% of rated power at 25 years); linear performance warranty for 25 years minimum

Parameter	Requirement
System voltage and class	1,500 V DC; Application Class II (IEC 61730); fire class as per IEC 61730; PID-resistant (IEC TS 62804-1)
Environmental	Ammonia, salt-mist and humidity tests passed; operating range −40 to +85 °C; mechanical load as per design pressures (minimum 5,400 Pa front, 2,400 Pa rear, higher if the structural design requires)
Components	Junction box IP68, minimum three bypass diodes; MC4-compatible connectors (IEC 62852); RFID tag with traceability data; Class A cells only; edge tapes not allowed
Origin and listing	BIS-registered; ALMM List-I and List-II compliant per MNRE orders in force;

7.2 Inverters (string or central)

7.2.1 The Developer may use grid-tied string inverters or central inverters. The choice shall be justified in the DBR with respect to energy yield, DC cable length and losses, space and weight, fault tolerance, maintenance access and safety on the elevated structure. String inverters mounted on the structure require NHAI's approval. Central inverters shall be housed in an approved enclosure at ground level or other location approved by NHAI; no equipment shall obstruct the carriageway, shoulder or required clear zone.

7.2.2 Minimum requirements: maximum efficiency not less than [98.5]% (string) / [98.6]% (central) and weighted efficiency not less than [98.0]%; ingress protection IP65 (outdoor, string) / IP54 or higher (central, in enclosure); operating range up to 60 °C ambient with stated derating; 1,500 V DC input; multiple MPPT; remote power limitation and active/reactive power control; LVRT/HVRT and frequency response as per CEA/DERC; THD of current not more than 3%; DC injection within limits; anti-islanding per IEC 62116; DC arc-fault detection or equivalent protection [as required by the Authority]; surge protection on DC and AC sides; data logging and communication via Modbus/IEC 60870-5-104..

7.3 Monitoring, SCADA and meteorological system

- A plant SCADA recording string/inverter/transformer/feeder parameters at not more than 1-minute resolution, with alarms, historical storage for the contract period and remote access to the Authority (read-only) and BYPL as required.
- Pyranometer at intervals along the corridor (not less than 2 nos.): ISO 9060 Class A (secondary standard) pyranometers for horizontal and for plane-of-array irradiance, ambient and module temperature. Calibration certificates required.
- Revenue meters and metering arrangements as per CEA/BYPL requirements for Group Net Metering / Net Metering;

8 Road Safety, NHAI Interface and Impact on Driving

8.1 **Barrier performance.** The installation shall not reduce the containment performance, structural capacity or durability of the crash barrier, nor increase the risk of injury to vehicle occupants or the risk of the structure entering the carriageway or falling below the elevated section.

8.2 **Clear zone and sight distance.** No part of the plant shall project into the carriageway, shoulder or required clear zone, or obstruct sight distance or visibility of signs, signals, delineators or lighting. A horizontal sight-distance check for each curve shall be part of the layout approval.

8.3 **Glare.** Modules shall have anti-reflective coating. The glare study shall show that reflected light does not cause discomfort or disability glare to drivers on either carriageway or on service roads and adjacent properties at any time of day; if it does, mitigation (tilt, orientation, anti-glare screens) shall be provided at the Developer's cost.

8.4 **Noise barrier.** Where noise barrier panels interfere with the installation, any removal, relocation or modification shall be approved by NHAI and the acoustic performance shall be maintained or improved.

8.5 **Street lighting.** Existing lighting shall not be obstructed or shadowed beyond approved limits; any pole or luminaire relocation is subject to NHAI approval.

8.6 **Fire safety.** Fire-resistant cable and equipment, no combustible storage, DC isolation accessible from a safe location, rapid shutdown and arc-fault protection as accepted by the Authority, signage for emergency services, and an emergency response plan agreed with NHAI and local fire services.

8.7 **Drainage and water.** Cleaning water and any runoff shall not fall on the carriageway or on persons or vehicles below, and shall not block or damage deck drainage. Waterless or controlled cleaning systems are also acceptable.

8.8 **Works on the corridor.** Work shall be done under the approved Traffic Management Plan, preferably during low-traffic hours; no stockpiling on the deck; all personnel trained and equipped for work at height and near traffic; NHAI's safety officer shall have the right to stop work.

8.9 **Liability.** The Developer is liable for damage or injury arising from the plant and shall maintain insurance as per Section 11. NHAI may order immediate removal or isolation of any element it finds unsafe.

9 Testing, Commissioning and Performance Acceptance

9.1 **Performance Acceptance Test (PAT).** The Performance Test shall be conducted for a period of thirty (30) days, with due intimation to the Authority, in accordance with IEC 61724-1. The weather-corrected PR shall be measured against the Guaranteed PR during the test period. Compliance with the Guaranteed PR shall be established based on the average PR achieved during the best seven (7) days within the said thirty (30) day period. Commercial operation begins only after the PAT is successful.

9.2 **Capacity test.** The DC capacity shall be verified by flash-test data of delivered modules and the AC capacity at the POI shall be demonstrated at rated output.

9.3 **Annual CUF assessment.** The CUF and PR for each Contract Year shall be calculated using data obtained from the POI meter and the weather station, and the corresponding report shall be submitted by the SPD to the NHAI within thirty (30) days of the close of the each Contract Year. In the event of any delay in such submission, NHAI shall be entitled to withhold payments payable under the PPA, and no interest or other compensation shall accrue on the withheld amounts for the period up to the date of submission of the required information.

10 Operation and Maintenance

10.1 The Developer shall operate and maintain the plant for entire term of the PPA in line with prudent utility practice.

10.2 **Cleaning.** Frequency to be set to meet annual energy commitment as per the PPA provisions with minimum being fortnightly and after dust events). Cleaning can be carried out from a

safe position (for example from a service road or by robotic/waterless systems on the structure) with NHAI permission and traffic management where lane closure is needed.

10.3 **Preventive maintenance and inspection** includes visual inspection of structure, anchors, clamps and fasteners; thermography at least annually; torque checks; relay and protection testing as required by BYPL and CEA; corrosion checks and touch-up; vegetation and debris control; calibration of sensors.

10.4 **Records and reports.** Monthly performance and availability reports with generation, PR, CUF, outages, defects and corrective actions; annual structural inspection report; all incidents (including falling-object, fire, vehicle impact) reported to NHAI within [48] hours.

10.5 **Spares.** A stock of critical spares (modules, clamps and fasteners, string cables, fuses, inverter modules, relays) shall be kept in Delhi NCR throughout the term.

11 Insurance and Compliance

11.3 Insurance (to be kept in force and to name the Authority as co-insured or additional insured where applicable): Contractor's All-Risk (construction and erection); operational all-risk and business interruption; public and third-party liability with a limit of not less than an amount as intimated by NHAI, covering injury or damage to road users and property; workmen's compensation.

11.4 The Developer shall comply with all labour, safety and environmental laws, and shall employ qualified and licensed personnel for electrical work in line with CEA and Delhi requirements.

Annexure A Minimum Datasheet Parameters

B.1 PV module (to be completed by the bidder)

Parameter	Unit	Required	Offered
Manufacturer, model, cell technology	–	As per Section 7.1	
Rated power at STC (Pmax) and tolerance	Wp	≥ [575]; no negative tolerance	
Module efficiency	%	≥ [22.0]	
Voc, Isc, Vmp, Imp	V, A	Declared	
Temperature coefficient of Pmax, Voc, Isc	%/°C	Pmax ≥ −0.30	
NMOT/NOCT	°C	Declared	
Bifaciality factor (if bifacial)	%	Declared	
Maximum system voltage	V DC	1,500	
Dimensions, weight, frame material and thickness	mm, kg	Declared	
Front / rear glass thickness and type	mm	Declared	
Mechanical load test (front / rear)	Pa	≥ 5,400 / 2,400 or as per design	
Year-1 and annual degradation	%	≤ 1.0; ≤ 0.40	
Product warranty / performance warranty	years	≥ 12 / ≥ 25	
IEC / IS test reports and laboratory	–	Attach	
BIS registration, ALMM List-I and List-II enlistment	–	Attach	
Junction box, connector, cable details and IP rating	–	IP68; IEC 62790, 62852	

B.2 Inverter (to be completed by the bidder)

Parameter	Unit	Required	Offered
Manufacturer, model, type (string / central)	–	–	
Rated AC power at 50 °C / maximum	kVA	Declared	
DC input voltage range, MPPT range, number of MPPTs	V	≤ 1,500 V DC	
Maximum DC input current per MPPT	A	Matched to module Isc with margin	
Maximum and weighted efficiency	%	≥ [98.5] / ≥ [98.0]	
AC output voltage, frequency and range	V, Hz	Per CEA and BYPL	
Power factor range (reactive power capability)	–	Per CEA / DERC	
THD of current; DC injection	%	≤ 3; per CEA	
LVRT / HVRT and frequency response	–	Per CEA / DERC; certificates	
Ingress protection, operating temperature, derating	IP, °C	IP65 (string); declared derating	
Protections (DC, AC, anti-islanding, arc-fault, SPD)	–	As per Section 7.2	
Communication and cyber-security features	–	Modbus / IEC 60870-5-104; IEC 62443	
Weight and dimensions	kg, mm	Declared	
Warranty	years	≥ [5]	
IEC / IS type test reports and lab	–	Attach	