

## **1. General**

This technical specifications must include all the specifications that are necessary for the installation and / or construction of the respective system, including supplementary services for contractual delivery.

The customer will provide the necessary connections to the existing electrical system (control cabinet). The data sheets for the components like Photovoltaic (PV) modules, substructure, inverter, cabinets, etc. must be enclosed with the offer. In case of contradictions, the paper exhibit in this document will have priority over subsequent documents.

The remuneration for feasibility analysis, project planning, construction and maintenance as well as other services listed in the price list has to be paid exclusively in accordance with the price sheets or a project-specific offer based on this technical specifications as well as the conditions of the framework agreement.

The generally recognized rules of technology in the Federal Republic of Germany as well as at the site, in particular relevant EU regulations, all relevant DIN regulations, all relevant industry and fire protection regulations, all public-law regulations on environmental protection and occupational safety, accident prevention regulations, VDI, VDE and VDS regulations, all regulations of the employers' liability insurance association, are valid in each case in its applicable version in the Federal Republic of Germany, in case they do not violate local law.

The regulations of the German Civil Code (BGB) of the Federal Republic of Germany and local law are valid. Mandatory law at the location takes precedence (e.g. building regulations).

## **2. On-site inspection and creation of a feasibility study**

The documents that must integrate this section are:

"On-site inspection" including coordination with client and contractor for electrical installation, energy supply company/distribution network operator, evaluation of handed over inspection documents for building and installation.

Feasibility study including profitability calculation with presentation of national/regional funding possibilities.

Creation of project-specific offer with parts list (based on the framework contract) and project- specific time schedule.

### 3. Planning and project specifications

All planning and project specifications required for the contractual construction of the respective project (construction and / or installation) must be carried out in accordance with specific regulations, and all national specifications of the countries where it is developed must be taken into account. However the main rule in consideration should be the generally recognized rules of technology in the Federal Republic of Germany as well as at the site, in particular relevant EU regulations as we mention on General rules.

### 4. Photovoltaic system

- Substructure made of aluminium/plastic compound, with elevation of at least 10° to 15°, incl. protective mats and additional ballast if necessary (protective mats must be 3 cm larger than the base area of the profiles/ballast stones, excluding prefabricated system components).
- Snow loading areas in countries or regions with heavy snowfall should be considered and measures should be provided to allow the entire facility to clear snow from damage free. Under certain circumstances, only south-facing installations with a row spacing of at least 60 cm can be placed.
  - Requirements for wind and snow load per site according to valid standards.
- Lightning protection.
  - The substructure (for aluminium versions) must always be capable of carrying lightning current.
  - If the substructure is made of plastic compound, the lightning protection concept must be adapted.
  - State of the art → compliance with separation distance.
- For existing properties, the lightning protection will be carefully dismantled and documented (file must be attached) as well as retrofitted by the installer after the PV system has been installed.
- Systems and protocols for fire protection of the respective buildings must be considered in planning and must be consulted with the building supervisor.
- All ballast stones must be installed and mechanically fastened so that they cannot slip (e.g. in tubs with up stands, perforated tape and/or clamps).

- Statically correctly designed, deviation from the specified number of pieces only after consultation with the client.
- Large systems can be mutually secured on roofs with high and low points if necessary.
- Alternatively, a substructure in plastic compound with thermally welded design can be used.
- PV Modules
  - Monocrystalline
  - At least 285Wp, tested and verified according to a light-induced degradation test (LID).
  - Plus Sorting
  - Efficiency at least 16.8%
  - Linear performance guarantee  $\leq 1\%$
  - Temperature coefficient of power ( $P_{\max}$ )  $< -0.4\%/^{\circ}\text{C}$ .
  - Supplier Bloomberg Tier 1 listed <https://www.renvu.com/Learn/Bloomberg-Tier-1-Solar-Panels-List-2020>

The solar modules used must comply with the currently valid version of IEC 61215.

The load-bearing capacity under snow load must be designed for a load of 5400Pa (this corresponds to approx. 540Kg/m<sup>2</sup>).

- Inverter
  - At least 2 inverters with at least 2 MPP trackers each for a 100kWp PV system.
  - Different inclinations, different orientations or different string lengths must not be mixed within one MPP tracker.
  - Efficiency at least 96%
  - Position preferably inside the building (only for Lidl).
  - If outdoor positioning, at least the following measures must be taken:
    - Protection against weather (rain, snow, sun and dirt).
    - Protection against damage by animals and theft/vandalism.
    - Keep at least 5m distance to heat pumps with natural refrigerant.

- Rated power ratio between generator output and inverter:
  - South facilities: 1.00 - 1.10
  - East/West facilities: 1.10 - 1.20
- Data logger
  - Connection of the PV system to the Schwarz network according to Schwarz IT requirements/guidelines.
  - Use only approved brands: Meteocontrol or be4energy.
- Generator junction box (GAK), if required: according to local requirements.
- Compliance with the application rule AR-E 2100-712 is required..
- Fire brigade switch/emergency stop switch for disconnecting the PV system DC/AC-side according to the specifications of the fire protection concept/fire brigade, e.g. in the fire alarm control panel (FACP) or emergency exit of the building, incl. automatic restart.
- DC over-voltage protection in accordance with generally accepted rules of technology incl. → data/sensor cables.
- Transformer measuring cabinet incl. protection technology → according to national requirements  
e.g. grid and plant protection, reactive power undervoltage protection, isolating strips and fuse protection.
- AC collector cabinet PV system with connection components inclusive fuses for the inverters and NH isolators if necessary over-voltage conductor.
- Wiring including opening/closing walls/ceilings/roof (fire protection if necessary).
- DC lines/cabling
  - At least 6mm<sup>2</sup>
  - Laid with low induction
  - Protected against UV radiation (in a closed cable duct and/or pipe)
  - Only connectors of the same make
  - Roof cladding must not bear additional loads or weights.
  - the voltage drop between the solar module and the inverter must not exceed 1.0 %.
- AC lines/cabling
  - The voltage drop between the inverter and the feeding point of the low-voltage main distribution board (LVMD) must not exceed 3.0%.

- Laying systems in general
  - Exterior hot-dip galvanized substructures, cable trays/cable ducts or mesh cable trays with cover.
  - Cable trays and their substructures must be secured against slipping.
  - Protection against sharp edges.
  - Space reserve in the channels according to manufacturer recommendations, but at least 20%.
  - Cable trays on ceiling must be securely closed with "metal cable ties", do not screw them, twist locks on covers are not secure enough.
  - Connection to electrical system (LVMD switch cabinet), free interface outlet to NH isolator.
- Connection to lightning protection/potential equalization (functional potential equalization) at least 16mm<sup>2</sup> .
  - The equipotential bonding conductor must be routed from the equipotential bonding rail in the building to the frame and visibly connected there, preferably near the irradiation sensors. Other metallic constructions such as cable trays can then be connected to the rack if necessary. Several rack blocks must be connected directly to each other (not via the cable trays or similar).
- Data logger/monitoring/network management with one irradiation sensor per alignment including over-voltage protection.
- Weatherproof labeling of all components and cables according to valid standards.
- Commissioning in accordance with the generally recognized rules of technology.
  - Measurement of open-circuit voltage and short-circuit current of the solar modules, irradiation and temperature must also be recorded.
  - The measurement of the low impedance pass between the frame and the protective earth conductor must also be documented by a photograph.
  - Thermography and characteristic curve measurement as required and on request (optional).
- Proof of function/performance at the end of the warranty period (recommended 6 months before the end of the warranty period) including thermography of the entire system is needed.
- Performance ratio: must be at least 80% guaranteed during the observation period .

**All designs in accordance with the generally recognized rules of technology.**

Costs for construction site equipment, crane, scaffolding, fall protection, waste disposal, etc. must be included in the prices.

→ If minimum standards/specifications cannot be met, these must be notified in written form with reasons in order to agree a special solution (written approval required).

### **5. Display for visualization (optional)**

Display for indoor installation with at least 55 inches screen diagonal, integrated or external controller for data acquisition and processing including operationally required software, mounting structure (wall bracket), cabling including opening/closing of walls/ceilings/roof (if necessary fire protection) as well as connection to power supply and operating devices. The Schwarz IT specifications must be observed.

- Execution/connection according to IT specifications.

Visualization with the following information/contents:

- Animated start page (layout by the client)
  - Display current yield (performance) of PV system in kWh
  - Display total yield of PV system in kWh
  - Display own consumption of solar energy in % (optional)
  - Display total CO2 emissions savings in kg
  - Display comparison value to savings (e.g. corresponds 3 circumnavigations of the earth by car, corresponds to XX hectares of forest area).
- Weather forecast for the next days (separate page).

### **6. Documentation**

In accordance with the appendix "PV system documentation checklist".

In addition, in the case of an in-roof solution or in inaccessible places, photo documentation must be prepared with regard to the mounting system and cable laying.

### **7. Warranty**

The minimum warranty will be 5 years on ALL system components.

- In the first year a performance guarantee of at least 98.00% of the rated power must be contemplate.

- After 10 years performance guarantee at least 90.00%
- After 25 years performance guarantee at least 80.00%
- 10 years warranty, if a service contract is concluded, over 10 years.
- Modules: 10-year product warranty → including on-site replacement (incl. wage and travel costs).
- Substructure: 10 years
- Inverter: 10 years → including replacement on site (incl. wage and travel costs)
- Inverter: from 10 to 15 years (optional) → price per kWp
- Specifications of the service contract:
  - Maintenance
  - Monitoring
  - Cleaning (see framework agreement - adjustment of the cycle depending on the ambient conditions).
  - Thermography (optional)

Warranty protection: 5% retention on the order amount, to be replaced by a bank guarantee.

### **8. Maintenance**

Maintenance of the PV system: at least in one annual cycle, in the 2nd quarter of each year.

Specifications of maintenance/service in accordance with EN 62446 and manufacturer's specifications, including:

- Visual inspection of substructure, PV modules, inverter, cabling and connections
- Inspection & cleaning of the inverters
- Testing plug and screw connections DC/AC
- Inspection of safety devices
- Check (randomly, but at least 5 %) of the fastening and screw connections of the substructure.
- Check the module clamps for correct seating
- Testing degree of soiling Modules → Definition of cleaning requirements
- String measurement: open circuit voltage (OCV), short circuit current (ICC), insulation resistance (IR).
- Inspection of the system monitoring
- Testing visualization and display values (display)

- Maintenance report with photo documentation and measurement protocols (within 10 days after completion of maintenance/service)
- Maintenance of plant documentation
- Reaction time in case of a fault: maximum 24 hours
- Complete elimination of failures: maximum 3 business days after the occurrence of the indication of failure or failure with documentary evidence of the work performed on the repair.

### **9. Repair**

Corrective maintenance measures must be carried out by the contractor's service technicians or by a subcontractor commissioned by the contractor in the event of faults in the PV system.

### **10. Thermography PV system complete according to valid standards (optional)**

During commissioning and/or before the end of the warranty period at the request of the customer thermal imaging during operational phase for:

- Localization of thermal abnormalities
- Detection of potential defects at cell and module level
- Detection of defective cells (e.g. hot-spot effect, cell breakage)
- Detection of incipient delamination
- Detection of defective bypass diodes
- Detection of defective module junction boxes and plug connections
- Detection of short circuits, faulty solder connections
- Analysis of the thermal images by means of software
- Preparation of a report including photo documentation of the thermally abnormal plant components and classification of the abnormalities as well as evaluation of the measurement results.

### **11. Characteristic curve measurement according valid standards (optional)**

During commissioning and/or before the end of the warranty period at the request of the customer. Characteristic curve measurement to determine the performance of individual modules or entire strings as a function of irradiation and module temperature, including evaluation and graphic display.



The measured values must be converted to Standard Test Conditions (STC) in accordance with standards.

### **12. Cleaning (optional)**

Cleaning PV system (as required), preferably in the 3rd quarter of the year.

Cleaning in accordance with the module manufacturer's specifications, approval must be submitted.

### **13. Monitoring**

Monitoring, remote monitoring and visualization PV system with daily cycle (365 days per year).

Remote monitoring specifications at least:

- Target/actual comparison of the PV system values
- Permanent recording of plant operating data
- Storage, processing and presentation of plant operating data on display visualization (see point 5. Display for visualization).
- Daily inspection/assessment of plant data and performance
- Data management and backup
- Defect detection and evaluation
- Online troubleshooting
- Escalation if online troubleshooting is not possible
- Monthly short report with target/actual comparison and malfunctions
- Report 1x at the end of the quarter as well as an annual report according to the requirements (Point 14. Requirements for the annual report).
- Annual transmission of all raw data in digital form, file format (Excel CSV)

### **14. Requirements for annual report**

- Country/company/location
- Contact person for the plant
- Plant details according to data sheet of the plant  
(size, orientation, type/number/m<sup>2</sup> modules, type/number of , nominal power ratio, strings).

- Stand/version Software of the components used (inverter, monitor, data logger, etc.)  
→last updates.
- Other information: Position assurance yes/no, green roof, fireman's switch, NA protection.
- DC overvoltage protection, lightning protection type/integration
- Characteristics mains connection/mains type (e.g. TT mains)
- Commissioning date
- Start and end of warranty (installation, inverter, modules, substructure)
- Budget/target/actual yield, given in kWh  
(in the report as monthly values and as a separate attachment with daily values in Excel).
- Budget/target/actual Performance Ratio (PR) incl. Definition of PR.
- Availability of the PV system
- Complete failure in hours
- Failure per inverter in hours (including partial failures)
- Last maintenance (including measures and replaced parts)
- Next maintenance
- Last cleaning
- Last thermography
- Faults - historical error messages and resulting measures including times for the elimination of the fault.
- Listing of service calls (with marking warranty or calculation)
- Other (e.g. snow removal/storm damage)
- Analysis and assessment of the plant as well as recommendations and outstanding issues, report/evaluation is to be transmitted as a file format (Excel-CSV).